

AN INTRODUCTION TO EDUCATIONAL RESEARCH

Dr. Ritu Bala



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Preface

Educational research is a diverse and dynamic field that encompasses the systematic investigation of various aspects of teaching, learning, and educational systems. Researchers in this field employ a wide range of methodologies, including quantitative, qualitative, and mixed-method approaches, to explore educational phenomena and advance knowledge within the discipline.

One significant area of focus in educational research is understanding effective teaching and learning strategies. Researchers investigate instructional methods, curriculum design, and assessment practices to identify approaches that promote student engagement, motivation, and academic achievement.

One key aspect of educational research is its emphasis on evidence-based practice, wherein findings from research studies are used to inform decision-making in educational settings. This helps educators and policymakers make informed choices about instructional strategies, curriculum development, and resource allocation, ultimately enhancing the quality of education provided to learners.

Moreover, educational research plays a crucial role in addressing equity and inclusivity in education. Researchers examine factors contributing to achievement gaps among different student populations, such as socioeconomic status, race, ethnicity, and gender, in order to develop interventions and policies aimed at promoting educational equity.

Educational research also contributes to the development and evaluation of educational policies and reforms. Researchers analyze the impact of policy initiatives on various stakeholders, such as students, teachers, and administrators, to assess their effectiveness and inform future decision-making.

Furthermore, educational research explores the integration of technology in educational settings. Researchers investigate the use of digital tools, online resources, and instructional technologies to enhance teaching and learning outcomes, as well as the impact of technology on student engagement and achievement.

In addition, educational research examines the professional development needs of educators. Researchers investigate effective strategies for teacher training, mentorship, and ongoing support to enhance instructional practices and improve student outcomes.

Finally, educational research plays a vital role in advancing theoretical frameworks and models of learning. Researchers contribute to the development of theories of learning, cognition, and motivation, as well as their application in educational contexts, to deepen our understanding of the learning process and inform educational practice.

Educational research is essential for improving teaching and learning practices, promoting educational equity, informing policy decisions, integrating technology into education, supporting educator professional development, and advancing theoretical knowledge within the field. Through rigorous inquiry and collaboration, researchers work to address complex educational challenges and ensure that all students have access to high-quality educational experiences.

Moreover, educational research contributes to the professional development of educators by providing insights into effective teaching and learning strategies, as well as opportunities for reflection and growth. By engaging with research literature and participating in research activities, educators can enhance their instructional practices and contribute to the advancement of the field.

The book offers a comprehensive overview of educational research methodologies and their applications, guiding readers through the process of conducting rigorous studies to enhance teaching and learning practices.

–Author

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Introduction

BACKGROUND

Research in distance education is typically carried out by Masters- and PhD-prepared individuals, and by research fellows of distance education institutions and conventional universities. Research leading to formal qualification or a degree is called degree-oriented research (*i.e.*, work that leads the researcher to earn a Masters, PhD, EdD). Project research, on the other hand, does not lead to any formal qualification or degree, but instead adds to the literature, and often forms the basis for policy formation or the rationale for action taken by bodies like universities, private sector companies, or governments.

MEANING OF EDUCATIONAL RESEARCH

Educational Research as nothing but cleansing of educational Research is nothing but cleansing of educational process. Many experts think Educational Research as under- According to Mouly, Educational Research is the systematic application of scientific method for solving for solving educational problem.) Travers thinks, Educational Research is the activity for developing science of behaviour in educational situations.

It allows the educator to achieve his goals effectively. According to Whitney, Educational Research aims at finding out solution of educational problems by using scientific philosophical method. Thus, Educational Research is to solve educational problem in systematic and scientific manner, it is to understand, explain, predict and control human behaviour.

Educational Research Characterizes as follows:

- It is highly purposeful.
- It deals with educational problems regarding students and teachers as well.
- It is precise, objective, scientific and systematic process of investigation.
- It attempts to organize data quantitatively and qualitatively to arrive at statistical inferences.
- It discovers new facts in new perspective. i. e. It generates new knowledge.
- It is based on some philosophic theory.
- It depends on the researchers ability, ingenuity and experience for its interpretation and conclusions.
- It needs interdisciplinary approach for solving educational problem.
- It demands subjective interpretation and deductive reasoning in some cases.
- It uses classrooms, schools, colleges department of education as the laboratory for conducting researches.

EX-POST FACTO EXPERIMENTAL RESEARCH

An *ex post facto* study is used when experimental research is not possible, such as when people have self-selected levels of an independent variable or when a treatment is naturally occurring and the researcher could not “control” the degree of its use. The researcher starts by specifying a dependent variable and then tries to identify possible reasons for its occurrence as well as alternative (rival) explanations. Such confounding (intervening, contaminating, or extraneous) variables are “controlled” using statistics.

This type of study is very common and useful when using human subjects in real-world situations and the investigator comes in “after the fact.” For example, it might be observed that students from one town have higher grades than students from a different town attending the same high school. Would just “being from a certain town” explain the differences? In an *ex post facto* study, specific reasons for the differences would be explored, such as differences in income, ethnicity, parent support, etc. It is important to recognize that, in a relational study, “cause and effect” cannot be claimed. All that can be claimed is that there is a *relationship* between the variables.

For that matter, variables that are completely unrelated could, in fact, vary together due to nothing more than coincidence. That is why the researcher needs to establish a plausible reason (research hypothesis) for why there might be a

relationship between two variables before conducting a study. For instance, it might be found that all football teams with blue uniforms won last week. There is no likely reason why the uniform colour had any relationship to the games' outcomes, and it certainly was not the *cause* for victory. Similarly, you must be careful about claiming that your Extension programme was the “cause” of possible results.

EX POST FACTO OF RULES OF LAWS

Ex post facto laws retroactively change the RULES OF EVIDENCE in a criminal case, retroactively alter the definition of a crime, retroactively increase the punishment for a criminal act, or punish conduct that was legal when committed. They are prohibited by Article I, Section 10, Clause 1, of the U.S., Constitution. An ex post facto law is considered a hallmark of tyranny because it deprives people of a sense of what behaviour will or will not be punished and allows for random punishment at the whim of those in power.

The prohibition of ex post facto laws was an imperative in colonial America. The Framers of the Constitution understood the importance of such a prohibition, considering the historical tendency of government leaders to abuse power. As ALEXANDER HAMILTON observed, “[I]t is easy for men ... to be zealous advocates for the rights of the citizens when they are invaded by others, and as soon as they have it in their power, to become the invaders themselves.” The desire to thwart abuses of power also inspired the Framers of the Constitution to prohibit bills of attainder, which are laws that inflict punishment on named individuals or on easily ascertainable members of a group without the benefit of a trial. Both ex post facto laws and bills of attainder deprive those subject to them of DUE PROCESS of law—that is, of notice and an opportunity to be heard before being deprived of life, liberty, or property.

The Constitution did not provide a definition for ex post facto laws, so the courts have been forced to attach meaning to the concept. In *Calder v. Bull*, 3 U.S., 386, 1 L. Ed. 648, the U.S., Supreme Court provided a first and lasting interpretation of the Ex Post Facto Clause. The focus of the *Calder* case was a May 1795 resolution of the Connecticut legislature that specifically set aside a March 1793 probate court decree. The resolution allowed the defeated party in the probate contest a new hearing on the matter of the will. The Court in *Calder* ruled that the Connecticut resolution did not constitute an ex post facto law because it did not affect a vested property right. In other words, no one had complete ownership of the property in the will, so depriving persons of the property did not violate the ex post facto clause. The Court went on to list situations that it believed the clause did address. It opined that an ex post facto law was one that rendered new or additional criminal punishment for a prior act or changed the rules of evidence in a criminal case.

In *Calder*, the Court's emphasis on criminal laws seemed to exclude civil laws from a definition of ex post facto—that is, it implied that if a statute did not inflict criminal punishment, it did not violate the Ex Post Facto Clause. Twelve years later, the U.S., Supreme Court held that a civil statute that revoked land grants to purchasers violated the Ex Post Facto Clause (*FLETCHER V. PECK*, 10 U.S., However, in 1854, faced with another opportunity to define ex post facto, the Court retreated from *Fletcher* and limited the prohibition to retroactively applied criminal laws.

In *Carpenter*, the Court noted that the esteemed legal theorist SIR WILLIAM BLACKSTONE had described ex post facto in criminal terms. According to Blackstone, an ex post facto law has been created when, “after an action (indifferent in itself) is committed, the legislature then for the first time declares it to have been a crime, and inflicts punishment upon the person who has committed it.” Using this as the understanding of ex post facto in 1789, the Court reasoned that it must have been the Framers' intent to limit the clause to criminal laws.

However, notes from the Constitutional Convention indicate that the clause should cover the retroactive application of all laws, including civil laws. The only exception for ex post facto laws discussed at the Constitutional Convention was in case of “necessity and public safety”.

Since the *Carpenter* ruling, the Supreme Court has struck down some retroactive civil laws, but only those intended to have a punitive intent. This construction of the Ex Post Facto Clause has done little more than raise another question: What is punitive intent? The answer lies, invariably, with the U.S., Supreme Court.

In 1989, the board denied parole to Morales and scheduled Morales's next hearing for 1992. Morales filed suit, arguing that the amendment was retroactive punishment and therefore unconstitutional. The district court disagreed. However, on appeal, the U.S., Court of Appeals for the Ninth Circuit reversed that decision, holding that the law effectively increased punishment for Morales, thus offending the Ex Post Facto Clause.

QUANTITATIVE RESEARCH

Believing that the research question was even more fundamental than the paradigm one felt allegiance to, several years ago we began to discuss the qualitative-quantitative debate from that perspective.

The dichotomy and the debate disappeared, and the ideas presented here began to develop. This book describes our stance at a point in time, not the conclusions of our ideas, which continue to emerge, to grow, and to build from our work as researchers and as teachers.

While clearly a work in progress, which continues to evolve, the framework of an interactive continuum presented here has been enlightening to colleagues and students who operate within the current world of often-misunderstood and frequently debated paradigm shifts. At the conclusion of this chapter, the reader should be able to:

- Describe the history of qualitative and quantitative research methods and the debate about their relative values
- Describe the typical purpose and outline of qualitative research
- Describe the typical purpose and outline of quantitative research
- Discuss the advantages and disadvantages of a dichotomy versus a continuum conceptualization of research design

Qualitative and quantitative researches have philosophical roots in the naturalistic and the positivistic philosophies, respectively. Virtually all qualitative researchers, regardless of their theoretical differences, reflect some sort of individual phenomenological perspective. Most quantitative research approaches, regardless of their theoretical differences, tend to emphasize that there is a common reality on which people can agree. From a phenomenological perspective, Douglas and Geertz believe that multiple realities exist and multiple interpretations are available from different individuals that are all equally valid. Reality is a social construct.

If one functions from this perspective, how one conducts a study and what conclusions a researcher draws from a study are considerably different from those of a researcher coming from a quantitative or positivist position, which assumes a common objective reality across individuals. There are different degrees of belief in these sets of assumptions about reality among qualitative and quantitative researchers. For instance, Blumer (1980), a phenomenological researcher who emphasizes subjectivity, does not deny that there is a reality one must attend to.

The debate between qualitative and quantitative researchers is based upon the differences in assumptions about what reality is and whether or not it is measurable. The debate further rests on differences of opinion about how we can best understand what we “know,” whether through objective or subjective methods.

William Firestone (1987), in an article in the “Educational Researcher”, differentiates qualitative from quantitative research based on four dimensions: assumptions, purpose, approach, and research role. Regarding assumptions, Firestone asks: is objective reality sought through facts or is reality socially constructed? Related to purpose, he asks: is it looking for causes or for understanding? To determine approach, he asks whether the research is experimental/correlational or a form of ethnography. Lastly, related to the researcher’s role, he asks whether the researcher is detached or immersed in the setting.

Shaker (1990), in a discussion of programme evaluation models, presents them as a metaphorical journey—moving from quantitative perspectives in the past to more recent naturalistic and qualitative assumptions. While positing a chronological continuum, Shaker would not seem to oppose our notion of question-driven research and evaluation. While he describes the “new identity” for evaluation as being “based on naturalistic approaches,” he places this in the context of a “pragmatic commitment to finding methods that yield results in practice as we find it, rather than as we wish it to be”.

The qualitative, naturalistic approach is used when observing and interpreting reality with the aim of developing a theory that will explain what was experienced. The quantitative approach is used when one begins with a theory (or hypothesis) and tests for confirmation or disconfirmation of that hypothesis.

It is important here to set the stage for abandoning the dichotomy. To do so, we examine a few of the key events in the chronicle of scientific evolution that established the debate in the first place. As long as one view of how we can explain the workings of the world reigns supreme, there is no debate.

The debate rests on a dichotomy characterized by a lessening of the dominance of one paradigm over another, leveling the playing field so that the debate could occur. In fact, the debate may be but one more phase in the ebb and flow of an everchanging philosophy of knowledge. For example, in *The Enlightened Eye*, Eisner (1991) cautions against the dichotomy and asserts that qualitative and quantitative research can be combined.

He warns against qualitative researchers merely adopting a “soft form of positivism”. The genesis of the current qualitative-quantitative debate in educational research occurred as far back as 1844, when Auguste Comte claimed that the methods of natural science could be justified in studying social science. Science, in this view, is the collection and study of facts that can be observed through sensory input. These are the traditional data investigated by natural scientists—the physicists, the chemists, the biologists.

This view holds that true science is accumulated through the study of phenomena that can be physically sensed, observed, and counted. The “unknowables,” as Herbert Spencer described them in his 1910 essay, those things that cannot be sensed but might rely on reason or thought, are banished from scientific investigation. Both Comte and Spencer were positivists.

Interestingly, this “positivism” was a move away from a more speculative, more “unknowable” view. It was a move away from relying on theological and metaphysical explanations of the world. It was a move towards what could be “positively” (confirmed through sensory data) determined. The philosophy maintained a grip on social science from the late 1800s through the early 1900s.

In the early 1900s, John Dewey, among others, questioned the absolutism of this position, viewing science as not separate and distinct from problem solving. His pragmatism considered science less rigidly than did the positivists. In his *Sources of a Science of Education* (1929), written some time after his initial speculations, he pointed out that practice should be the ground of our inquiry. Because of the value placed on experience for learning and the emphasis on practice, he appreciated the deeper complexity of what educational and social scientists study.

During the same period, a group of scholars who made up what became known as the famous Vienna Circle met and developed a new philosophy of science, logical positivism. Supporting Comte's positivism, they combined it with the symbolic logic of mathematics. Hypotheses derived using the rigour of mathematics (the symbolic) could be combined with fact gathering (the positivism) to test their confirmability (which was eventually modified to disconfirmability).

Although counter to an impetus by Dewey to diffuse the positivistic assumptions made by researchers, this hypothetico-deductive system was dominant in the middle years of the 20th century in psychology and sociology. Education, which borrowed traditions of inquiry from these disciplines, was affected as well. The respect for precision in measurement, mathematically systematic tests of hypotheses, and a quest for value-free science solidified this paradigm.

During the 1940s and 1950s, the quantitative paradigm dominated the social science and the educational research scene. Behaviourists and organizational theorists utilized empirical fact gathering and hypothesis testing almost exclusively in studying educational and social phenomena. In the mid- 1960s, while the quantitative perspective continued to prevail, a shift began as skepticism towards the domination of logical positivism and the evident chasm between human social systems and mathematical logic grew. New epistemologies began to emerge that acknowledged, for example, the value-laden nature of human social interactions. That human beings construct reality for themselves and that knowledge itself is transmitted in social ways were beginning to be assumed. Questions arose about the tenability of applying natural science methodology to these complex human dynamics.

In 1962, in *The Structure of Scientific Revolutions*, the most significant work on this issue, Thomas Kuhn explored the shifts in science's dominant paradigms. His doctorate in theoretical physics led him to look back into the history of science as he sought to know more about its foundations. He describes how, by randomly exploring the literature, he was exposed to Jean Piaget and, in the late 1950s, to a historical analysis of social science and psychology. Kuhn's study of methodology drove him to leave physics and become a historian of science.

He conceptualizes the notion of paradigms, "universally recognized scientific achievements that for a time provide model problems and solutions to a community

of practitioners,” and proposes that competing paradigms emerge chronologically when the dominant one no longer serves the explanatory needs of the scientific community.

For the most part, using the context of physics from the perspectives of Sir Isaac Newton and Albert Einstein, Kuhn explains these periods of competition, or scientific revolutions, in the natural sciences. He acknowledges that competing paradigms can possibly coexist on equal footing following such a revolution, or “paradigm shift,” although, he cautions, it may be only rarely possible. He proposes that the predominant paradigm affects researchers not only methodologically but also in how they see the world. Kuhn’s conceptualization of “paradigm” has been reinterpreted by others since his work, and many definitions are incorporated in the literature of the 1990s.

The quantitative paradigm continued to reign over social science and, according to Culbertson (1988), prevailed in education until the mid-1980s. At that time the logical positivists were losing supremacy. (The strong traditional bias towards quantitative science might even be based on Americans’ preference for facts we can observe and count, a sense that that’s what science “is.”)

Concurrent with Kuhn’s early notions of paradigms in the 1960s, society was undergoing radical changes. While some began to question the efficacy of the positivists’ tools in explaining human organizational and social phenomena, education was moving into a more complex social context. Culbertson points to such 1960s and 1970s issues as racial integration, poverty, equal opportunity, schools as tools in global economic competition, the Soviet Union’s threat to our math and science preeminence, and the need to account for the success and failure of the nation’s children and posits that, in this context of increased complexity, some began to search for policy tools that the quantitative paradigm did not seem sufficiently able to explain.

That education served economic, political, and policy ends enhanced the opportunity for scholars interested in the culture of schools to begin to use anthropological strategies in their inquiry. These same interests fed the scholars’ attempts to approach their research from the perspective of the critical theorists, as well as that of the feminists.

Although always an important issue, the policy makers’ interest in the world of classroom practice grew, and they increasingly expressed concerns that research and practice were unconnected and that this disconnection was in part due to the use of tightly controlled laboratory-like quantitative assumptions. A move among some social scientists in the direction of deriving theory from practice, rather than the other way around, characterized this change as well. Graduate programmes preparing educational and social science researchers as well as professional journals

have increasingly directed their attention towards qualitative research. Allotting time and space to what had been considered the “alternative” paradigm led to wide discussions in the journals and at professional meetings. The editors of the *American Educational Research Journal*, for example, announced in 1987 that particular emphasis on qualitative methodology would be forthcoming as they evaluated manuscripts.

This was a major legitimization of the paradigm for educational researchers. A plethora of books, articles, and presentations on the trustworthiness of the qualitative paradigm materialized. Some extolled the virtues of qualitative research as the only avenue to “truth,” while others claimed that only by holding onto the quantitative traditions can we have confidence in our knowledge base. In many forums the debate was manifest. Which is more scientific: the deductive methods of the logical positivists (quantitative researchers) or the inductive methods of the naturalists (qualitative researchers)? Can the results of qualitative research be generalized as are the results of quantitative research? Can science be value laden (qualitative) or only legitimate if value free (quantitative)? What epistemological assumptions are violated by adopting one paradigm or the other?

While to some the debate has ended, to others, especially those we encounter in researcher-preparation programmes, the debate has either not yet materialized to the full extent of its fury or continues unabated. Our strong sense is twofold. First, we continue to prepare students for an “either-or” world, a dichotomous world that no longer exists. We still prepare students who leave our colleges and universities with a monolithic perspective. Either they become well-trained statisticians, or they become cultural anthropologists, methodologically weak in asking research questions and in justifying either one or the other set of strategies. Second, researchers in education and in the social sciences have not yet constructed a way to ensure their success in utilizing both paradigms. The interactive continuum model in this book serves as a kind of framework directed towards both those needs.

The dichotomy of qualitative and quantitative research is one we deny but one we exploit here for heuristic purposes. The dichotomy, while not an ontological construct, does allow us to separate the idea. We slice it thin to examine it and make the case in this chapter that it does not exist in the scientific research realm. All research in education stands on basic underlying assumptions. This is true for quantitative methods as well as qualitative methods. To the extent that these assumptions withstand the scrutiny of scientific inquiry, the methods can be supported, taught to novice researchers, and used professionally and ethically without reservation. Since the mid-1980s when quality in all educational professions came under public review, it has become particularly crucial to delineate the foundational bases of educational research. Within the realm of this book, such bases will be examined.

INVESTIGATIVE AND COMPARATIVE STUDIES

All fields of study appear to be marked by similar phases of growth. In the beginning, contributions to the field tend to be discrete and unsystematic, prompted by the curiosity of the observers and their inherent interest in the subject. There are no rules, just the special insights and motivations of single observers, whose accounts are descriptive and usually lack systematic reporting or an expressed framework of theory. As work in the field of study increases, reporting becomes more systematic and comprehensive, and the reporters are more self-conscious about the accuracy of their data and more concerned about the ways in which they arrive at conclusions from the data.

The curiosity of observers becomes more focused on the possibilities of practical applications of new knowledge, and they are inclined to be critical of their own work and that of their colleagues. Particular types of studies emerge, marked by particular theoretical approaches to the subject, characteristic ways of observing and reporting, and broad agreement on what is or is not relevant. Practitioners in the field become aware of the precedents and of their intellectual ancestors, as well as the kinds of effort their contemporaries are directing at similar targets of study.

Comparative education has demonstrated all these characteristics during its development. The literature includes a wide array of subjects and approaches, symptomatic of the varied motives for studying foreign educational systems. It encompasses narrative description of single nations prompted by interest and curiosity, selective and structured observations motivated by the desire to apply lessons from abroad to the solution of educational problems at home, and encyclopedic codification of the “facts” about many countries.

Such work may be impressionistic and even normative, providing a wealth of information and insights about the nations studied. In addition, it often reveals much about the culturally determined predilections of its authors. Historical reviews of the literature in comparative education show clearly that systematic studies of foreign education increased dramatically as nations began to develop their own public school systems.

Interest in foreign educational practices has been stimulated by nationalism, the growth in international communications, and the aftermath of major wars. For some, the motive was to help develop improved education modeled on foreign practices; for others, foreign study, travel, and teaching were seen as means to ease tensions among nations and foster an international perspective.

Two general questions have especially shaped the investigations of writers in comparative education: Why do educational thinking and practices differ among

nations? What are the differences and similarities? The conceptual frame within which answers have been offered becomes evident from a brief review of the literature since the beginning of the 20th century, when Sadler emphasized the intimate and interactive relation of educational and historical facts.

EDUCATION SYSTEMS OF NATIONS

The education systems of nations differ because of different historical and cultural traditions, but they are similar because there are common elements in human societies. In addition, important events transcending national boundaries have influenced their affairs — the Protestant Revolution, Marxism, the Industrial Revolution, Imperialism (or the achievement of national independence from colonial control), for example. The interplay among such factors has occupied the attention of recent generations of comparative educators. Comparative education writing has been influenced by several important perspectives. First, the realization that educational phenomena are part of the whole fabric of a nation's culture and history for the most part put an end to works that described and assessed schooling without reference to the larger cultural context of a country. Studies thereafter tended to set educational events against a historical background and to describe the genesis of different types of schools, educational philosophies, and school systems as parts of a series of political and social events. Kandel and Ulich, especially, focused upon the links among history, national culture, political ideology, and schooling.

Much attention was given to “national identity” as the key to understanding a nation's special educational characteristics. It was conceivable that this approach would end opportunities for comparison because of the tendency to assume that each nation and its education were unique. This danger was averted, however, by the great attention given to common factors and common problems presumed to affect many countries. The major assumption that characterized comparative education work during the first half of the 20th century was that such study could illuminate the past growth and current dynamics of educational change in whole societies.

It was not until after World War II, however, that the predominantly historical, philosophical, and theoretical approaches were challenged by more pragmatic considerations. Over a hundred years before, many writers had been prompted to study the schools in foreign countries with a view to improving classroom practices and school system policies in their own lands. From about 1950, this motive prompted a renewal of interest in comparative studies, whether in highly developed nations seeking a way out of the disorder of the postwar period or in the less developed world which was confronting the problems of newly achieved independence. Educational reform and planning for national survival and growth were everywhere of paramount importance.

Economists in particular led the move towards regarding the education system of a nation as its means for investing in human potential, as its way of developing national resources. But the problems were not only economic. The survival of a nation depended as much on its success in dealing with political and social problems as on the most efficient allocation of human resources. For the first time, some nations began to regard reform in education as a possible means of achieving a sense of national unity among disparate sub-populations, a tool for ameliorating gross disparities in status and opportunity among social classes, and a mechanism for improving skills and the quality of life. To study the experience of nations other than one's own seemed pertinent. Comparative study of education and of those social, political, and economic dimensions of society closely bound up with education was encouraged by these developments.

The social sciences thus provided a leavening for the predominantly historical and philosophical approaches of earlier comparative educators. Contemporary work has developed a greater specificity of criteria and a sharper awareness of causal relations. The underlying general questions now tend to be restated more in the following form: What factors in the school system or in the social, political, or other structures of the society explain variability in pupil achievement, administrative structure, school financing, instructional methodology, and other educational phenomena? To the questions of what the similarities and differences in educational practices among nations are and what explains these similarities and differences, a third question was added: What are the outcomes of these similarities and differences?

Comparative educators have for a long time been especially concerned with the availability of data comparable across nations, with controlling the biases of observers and interpreters of data, and with integrating the data, concepts, and analytic techniques of several academic disciplines. The work of international organizations has greatly improved the availability and, to some extent, the comparability of data. Collaborative work involving persons from different nations and disciplines has strengthened the methodological grasp of the problems involved. Further, the use of statistical analysis, model theory, and systems analysis for the purposes of comparative education has been heralded by some practitioners as signifying the emergence of the field as a science.

As a result, a new kind of comparative education research has developed: the empirical cross-national study in which large amounts of data are gathered and analyzed and a variety of social science concepts and techniques are used to test hypotheses about the relations between educational variables and political, economic, and social characteristics. Interest in the methodological problems of cross-national comparison has been sharpened, and much attention has been given to the possibilities of using those strategies and tactics that had become

commonplace in empirical social science research. International organizations, such as UNESCO and other specialized agencies of the United Nations, and the Organization for European Cooperation and Development (OECD) were able to collect educational and other social data systematically and on a vast scale.

These agencies have also made valuable contributions to educational planning and policy efforts, for example, the series of studies on educational finance and planning produced by the International Institute of Educational Planning (a UNESCO agency), and a set of OECD country studies in which national policy and plans have been critically reviewed and analyzed by international teams of educational experts. Technical assistance programmes have encouraged the exchange of skilled professionals among developed and underdeveloped countries, and this has made evident the commonality and immediacy of socio-educational problems in many lands.

Thus the burgeoning of data sources, increasing methodological sophistication, the meshing of social science expertise with education, and the presence of urgent problems requiring attention at the national policy level all have combined to give renewed power and variety to comparative studies in education.

An excellent example of this type of work is the massive survey undertaken by the International Association for the Evaluation of Educational Achievement (the IEA project). This project has been devoted to cross-national assessment of student achievement in selected school subjects and attempts to explain variance in such achievement. The first project was a study of mathematics achievement in 12 countries. The most recent phases of work covered science, reading comprehension, and literature in 21 countries, and reports on three more school subjects — civic knowledge and English and French as foreign languages — are in preparation.

In addition, overall studies of the six-subject surveys are in preparation. Data were not, of course, collected merely on achievement. A vast amount of information in standardized form was obtained on student home background, school practices, teacher characteristics, and the nations' school systems, as well as selected social and economic data. Results were compared at three levels: among students, among schools, and among nations. The main statistical technique used for explaining variance in achievement was multiple regression. The problems inherent in the new wave of empirical cross-national research are somewhat different from those of the earlier generation of comparativists, but they are not altogether unique.

The latter could be faulted on grounds of personal or cultural subjectivity and bias, or because their global perspective was too theoretical, or because their descriptive detail was merely interesting or idiosyncratic and not generalizable. The more empirical studies, even when thoughtfully planned and rigorously executed, are subject to such familiar methodological criticisms as representativeness, the

accuracy of data, and the appropriateness of analytical design. Two general concerns, however, are more important. First, the findings should have some relevance to decision making in education (whether at the national policy level or in the school or classroom in particular pedagogical terms), and second, the subtleties of human interaction in the teaching-learning process should not be neglected by undue emphasis upon easily quantifiable and more generally conventional dimensions of education.

In reference to the large-scale survey approach of IEA, the technical problems, while important, are not insuperable. If there is enough time, experience, cooperation among experts, and money, it is possible to reduce weaknesses in sampling, data collection, analysis, and inference to reasonable levels. Relating comparative studies of this kind to policy is a more difficult task, however. At one level is the widespread problem of how to communicate scholarly research findings to practitioners; at another is the selection of problems for investigation and the search for relations among factors that bear upon important professional policy issues. The IEA study does achieve this to some extent. For example, it illuminates the arguments over selective versus comprehensive schooling, documents and refines knowledge about the relation of sex of pupil to achievement in different subjects, and highlights the variable relations between school and home factors in accounting for pupil achievement in different subjects, at different ages, and in different countries. Furthermore, first attempts were made, notably in the literature and civic knowledge studies, to gather and to compare data on noncognitive variables.

The trend of the past decade towards empirical, quantitative, large-scale research has not been without its severe critics. In drawing upon the quantitative techniques of economists, psychologists, sociologists, anthropologists, and political scientists, researchers run the risk of becoming distracted from those topics that are more central to educational studies: curriculum, teaching methodology, and classroom and school organization. Furthermore, it is argued, enthusiasts for empirical methodology may ignore its limitations as an investigative strategy. Critics also tend to stress the inappropriateness of applying models of investigation drawn from the physical sciences to the humane arts, such as education. However, few practitioners are unaware of the differences in orientation inherent in the body of comparative studies: theoretical and practical, descriptive and analytical, objective and melioristic, philosophical-historical, and empirical. Each orientation has made and continues to make its own particular contribution to the understanding of data and educational problems. But few researchers today will deny the complementary nature of the approaches that characterize the predominantly historical studies of the 1930s and 1940s and the empirical studies of the past decade.

Schooling is a mass enterprise. As such there is value in analyzing its correlates and outcomes, using techniques of mass data collection and analysis. Because

education is an international enterprise that is not limited to any particular time and place, it is therefore properly studied cross-culturally. This is not to reject the view of education as a small-scale individual process in which techniques of micro-observation, analysis of small-group behaviour, and observations of classroom interaction and culture are desirable. The two approaches should properly be regarded as complementary and, as they are developed, they should contribute to better understanding of the educational process at all levels.

In education and in the social sciences at large, approaches range from attempts to identify the regularities of human behaviour in social settings to emphasis upon the special, even unique qualities of the phenomena studied. Comparative education is no exception. At one end of the scale lies a group of works intended to test particular hypotheses systematically: quantified data are statistically analyzed and inferences and predictions are made, with conventional caveats. At the other end are studies of a different nature: colourful, intuitive, eclectic, impressionistic, ranging widely over history, philosophy, and education, spiced with social comment. Whether a particular piece of work has value is not so much a matter of where it stands on this particular range of alternative approaches as it is of how well the work has been done in its own terms. Comparative education studies include a valuable scholarly tradition in the more humanistically oriented direction, and in recent years the field has been enriched by a growing array of works built upon empirical social science models. Viewed as complementary modes of study, both can contribute substantially to knowledge in comparative education.

COMBINE QUALITATIVE AND QUANTITATIVE RESEARCH

Qualitative studies in psychology can be fascinating and insightful but they may leave readers with a quantitative disposition worrying about the generality of their findings. Quantitative studies, on the other hand, whilst providing data from larger and more representative samples, seem more mechanical and arid to qualitative researchers. But both methods have advantages and disadvantages and the results from different methods can complement each other.

This paper considers these issues in the context of studying the problems that students face in essay writing. It contrasts the recent results from a qualitative study with those from a quantitative one (described in this paper). At the time of writing we have copies of four of Street and Lea's articles in front of us. Only in the major one are we told how many students, lecturers and institutions were involved in their study:

- 'The analysis of the research data has concentrated on the differing interpretations and understandings of academic staff and students with

regard to academic writing within two contrasting university settings. 10 interviews were conducted with staff in the older university and 21 students were interviewed, either individually or in small groups. At the new university 13 members of academic staff and 26 students were interviewed.'

But these are the only numerical data given. We are not told, for example, what proportion of the students are men or women, traditional-entry or mature students, and what disciplines they are studying. And there are no quantitative data to qualify their results.

The actual results are of great interest. Street and Lea differentiate between three different, but overlapping, sources of difficulty for students writing essays and reports, and how their institutions deal with them.

These are:

- Difficulties with 'interpretation' *e.g.*, knowing what is expected within and between different departments, and even between different tutors within the same department. These are largely ignored by many tutors, but students' ignorance of these matters is criticised in their feedback.
- Difficulties with 'deficits' *e.g.*, grammar, spelling, punctuation and style. These are mainly dealt with by study skills courses, and handouts/guides for students.
- Difficulties stemming from 'institutional failings' - *e.g.*, the inability of staff to mark written work within a reasonable time span and with sufficient detail because of limited staff resources and the large numbers of students. These difficulties are ignored, defended or deplored by different members of staff.

Street and Lea place their greatest emphasis on the second area of difficulty - one that has not really been explored in previous research on essay writing (although see Hinkle, 1997). But are they right to do so? How widespread are the difficulties faced by their 47 students, and which do they find the greatest burden? We cannot answer questions such as these because of the qualitative nature of their reports.

Nonetheless, the findings, the commentary and the suggestions are so interesting that we set out to gather some more - quantitative - evidence to try to build upon this pioneering study.

Questionnaire Method

We devised a questionnaire on essay writing that addressed the three concerns discussed by Street and Lea. Thus there were questions about students' experiences of difficulties connected with 'deficits', 'interpretation' and 'institutional failings'.

The questions were largely based upon the comments and discussion provided in Street and Lea. We gave this questionnaire to 102 *second-year* psychology students attending a lecture at Keele University at the beginning of their first-semester.

These students were asked to complete the questionnaire with reference to the difficulties that they might have faced when writing their essays and reports in their *first-year* at Keele. Students at Keele typically study two principal subjects and two subsidiary subjects in their first-year, so they would have had to write essays/reports in four different subject matters during the year. (It is this kind of complexity that Street and Lea had in mind in their study and which has not been commented on before.)

In our study the responses from two overseas students who had not been at Keele in their first-year, and from six students studying conductive education (who did not follow a normal subsidiary programme) were deleted, making a total of 94 respondents. (The total number of students in this cohort was 146 - so our data come from 64 per cent of the class.)

STUDY OF RESEARCH DESIGN METHODS

The main features of the study design and methods you select follow the question that has been posed. For example, you may be using a survey by questionnaire or interview; a case study of one or more person or organisation; a trial, which may be randomly controlled or use matched or waiting-list controls. It may be ethnographic, requiring time in the field to look at relationships, culture or communication, or action research, where practical problems are considered and where the feedback, changes and subsequent evaluation of change are all part of the research – rather like audit in its cyclical design.

Action research is a common mode of educational research. It appeals to those who like the idea of change and the feeling that the research they do actually contributes to it. It joins together both research and implementation, and is a much messier, more participative research method than most; so people who start it should not be those who demand precision or decimal points in their answers, and they should enjoy being involved with the teams and individuals who actually put the changes into practice.

CROSS-SECTIONAL DESIGNS

Research may also be cross-sectional or longitudinal; depending on what is the right way to answer the question and what resources are available. For example, cross-sectional designs can provide answers to the immediate success of a programme if success is seen in terms of, for instance, course satisfaction. They can also be used to see, for example, if different people are more or less satisfied

depending on their learning preference, or to consider any other differences between them or between course presenters, or an interaction between both. But if you want to assess what really changed as a result of your course, then it has to be longitudinal.

Longitudinal Design

Longitudinal design is expensive, not only because you have to have the researchers available over the length of the study, but also because you might have to spend funds on tracking your subjects over time. However, the benefits of longitudinal cohort studies are that you can answer more complicated questions. For example, if you were studying job satisfaction in doctors using a cross-sectional design, you would probably find that around a quarter were pretty dissatisfied. If you had a large enough sample, you could break it down into specialties and see that one particular group (*e.g.*, surgeons) were very satisfied, while another (*e.g.*, psychiatrists) were very dissatisfied.

You would be likely to conclude that the work role of psychiatrists has more factors likely to produce dissatisfaction than the role of surgeons does. However, a longitudinal study might have assessed these doctors as students or house officers and looked at personality or at satisfaction then, and would probably have found that many of those who are disgruntled now were disgruntled then. This then allows us to see how much of the dissatisfaction is due to the person and how much is due to the job, which in turn means we may not need to continue to plough resources into the job alone, but also into individual intervention or selection issues.

Your research question and available resources will determine over what period you should assess and how many assessments you will need to make. Although it will vary according to the intervention made, where clinical interventions are the subject of research, patients are usually assessed during a baseline period, immediately after the intervention, a few weeks or months later, and after a year or two. Ideally, educational interventions would not differ much from this, but a minimum would be before, immediately after and 6–12 months later.

RESEARCH IN QUANTITATIVE AND QUALITATIVE MEASUREMENT

Quantitative research relies primarily on numbers as the main unit of analysis. It is more commonly used as a primary method in scientific and clinical research, such as drug trials or laboratory experiments where tests may need to be repeated many times, for example to ensure that a new drug is safe. Although quantitative methods, such as surveys, are used in educational research, the vast majority of research is relatively small scale, intensive, focused on change and involves human

perceptions. Educational research relies much more heavily on qualitative methods. One of the most common instruments to gather numerical data in education (particularly in evaluation of programmes) is the questionnaire survey, using a series of closed questions to which responses are given against a Likert or other type of scale.

Open questions can also be included to gather richer data. Large amounts of data can be gathered from a wide number of people and the results can be analysed by computer (either by an optical mark reader or through an online survey instrument such as 'Survey Monkey'), thus making it fairly straightforward to research a large sample of respondents. Survey questionnaires can be given out and collected face to face, sent by post or posted online. If achieving a high response rate is important, then note that the less personal involvement there is with potential respondents, the lower the response rate. So, typically, online surveys may have a response rate of under 20 per cent, whereas if the questionnaires are given out and collected face to face, you may achieve a very high response rate.

QUALITATIVE RESEARCH

Qualitative research relies primarily on words as its unit of analysis and its means of understanding. However, it can also use voice tone, loudness, cries, sighs, laughs, and many other ways of human communication. The words may be spoken in individual interviews (face to face or on the telephone) or groups, or they may be written, so you may have to analyse the spoken words of an interview, focus group or conversations (for example between a patient and health worker), or the written words of an account or description or diary record.

On the whole, qualitative research tends to be small scale, simply because it is hugely labour intensive. For example, interviews or focus groups will usually need to be transcribed before they can be analysed. In addition, the researcher is often more involved with the person producing the words, and so it is sometimes helpful for others to conduct the analysis; again this can be costly.

Having said that, nothing else can provide the same level of richness as qualitative data, and at the very least, adding space for respondents to provide some words to describe what might be otherwise gathered by numbers is immensely useful to the researcher, and may even, in some situations, be a help to the subject.

Qualitative methods range from the classification of themes and interconnections, content analysis, grounded theory and discourse analysis, and reliability and validity are just as important as they are in quantitative analyses. There are computer programmes to assist in analysis, and although these might not necessarily save time, they often offer more systematic ways of coding data and identifying connections and themes.

Number of Research Methods

Triangulation is the term used for bringing a number of research methods to bear upon a question. For example, to study the effect of threatened closure of a hospital on its staff you might want to interview a selected few at different levels and in different professions; a questionnaire survey of almost everyone; personnel data of sickness, absence, turnover, etc.; a network analysis of rumour; an ethnographic study of a long-stay ward looking at staff and patients interactions; and so on. A triangulation of methods such as these would provide an exceptional in-depth look at such an event, but it is also useful simply to combine some form of qualitative and quantitative data, as suggested above.

QUALITATIVE AND ETHNOGRAPHIC RESEARCH

Qualitative and ethnographic research developed in education in the late 1970s. Ethnographic researchers drew on theory and methods in anthropology and sociology, creating a distinction between ethnography of education (work undertaken by anthropologists and sociologists) and ethnography in education (work undertaken by educators to address educational issues). Other forms of qualitative research drew on theories from the humanities and other social and behavioural sciences, adapting this work to educational goals and concerns, often creating new forms (*e.g.*, connoisseurship, a field method approach, interview approaches, and some forms of action research).

In the early development of these traditions, educational researchers struggled for acceptance by both other professionals and policymakers. This phase was characterized by arguments over the value of qualitative methods in contrast to the dominant paradigms of the time—quantitative and experimental approaches. Qualitative and ethnographic researchers argued that questions important to education were left unexamined by the dominant paradigms. Some qualitative researchers argued for the need to include and represent the voices of people in their research, particularly voices not heard in other forms of research involving large-scale studies.

Questions asked by qualitative and ethnographic researchers generally focus on understanding the local experiences of people as they engage in their everyday worlds (*e.g.*, classrooms, peer groups, homes, communities). For example, some researchers explore questions about ways in which people gain, or fail to gain, access to ways of learning in a diverse world; others focus on beliefs people hold about education and learning; while still others examine how patterns learned within a group are consequential for participation in other groups and situations.

A broad range of perspectives and approaches exist, each with its own historical tradition and theoretical orientation. A number of common dimensions can be identified across these perspectives and approaches. Qualitative and ethnographic researchers in education are concerned with the positions they take relative to participants and data collected. For example, many qualitative and ethnographic researchers engage in observations over a period of time to identify patterns of life in a particular group.

The theoretical orientation chosen guides the design and implementation of the research, including the tools used to collect (*e.g.*, participant observation, interviewing, and collecting artifacts) and analyze data (*e.g.*, discourse analysis, document analysis, content analysis, and transcribing video/audio data). Theory also guides other decisions, including how to enter the field (*e.g.*, the social group, classroom, home, and/or community centre), what types and how much data to collect and records to make (*e.g.*, videotape, audiotape, and/or field notes), who to interview (formally and/or informally), how long to remain in the field (*e.g.*, for ethnography, one or more years), and what literature is relevant. It also influences relationships researchers establish with people in local settings, which in turn influences what can be known. Some theoretical perspectives guide researchers to observe what is occurring from a distance by taking the role of passive observer, recording information for analysis once they leave the field. Such researchers often do not interview participants, preferring to “ground” their observations in patterns in the data, without concern for what members understand. These descriptions are called *etic*, or outsider descriptions, because the observer is not concerned with members’ understandings.

This approach is in contrast with ones in which researchers join the group and become active participant-observers, at times participating directly in events. Such researchers also make videotape records that enable them to step back from what they thought was occurring to examine closely what resulted from those actions. Those not using video or audio records reconstruct events by constructing retrospective field notes, drawing on their memories of what occurred to create a written record to analyze when they leave the field. Just which type of approach and position researchers take depends on their research goal (s) and theoretical orientation (s) as well as what participants permit.

ADVANCE TO RESEARCH QUESTIONS

Research questions in a qualitative study are generated as part of the research process. Qualitative and ethnographic researchers often begin a study with one or more initiating question (s) or an issue they want to examine. Qualitative and ethnographic research approaches involve a process of interacting with data, reflecting on what is important to members in the local setting, and using this to

generate new questions and refine the initial questions. This interactive and responsive process also influences the data that are collected and analyzed throughout the study. Therefore, it is common for researchers to construct more detailed questions that are generated as part of the analysis as they proceed throughout the study, or to abandon questions and generate ones more relevant to the local group or issues being studied.

For example, in one study of a fifth-grade classroom, the initial research questions were open ended and general: (1) What counts as community to the students and teacher in this classroom? (2) How do the participants construct community in this classroom? and (3) How is participating in this classroom consequential for students and the teacher? As the study unfolded, the research questions became more directed towards what the researcher was beginning to understand about this classroom in particular.

After first developing an understanding of patterns of interactions among participants, the researcher began to formulate more specific questions: (1) What patterns of practice does the teacher construct to offer opportunities for learning? (2) What roles do the social and academic practices play in the construction of community in this classroom? and (3) What are the consequences for individuals and the collective when a member leaves and reenters the classroom community? This last question was one that could not have been anticipated but was important to understanding what students learned and when student learning occurred as well as what supported and constrained that learning. The shifts in questions constitute this researcher's logic of enquiry and need to be reported as part of the dynamic design of the study.

ADVANCE TO DESIGN AND DATA COLLECTION

In designing qualitative studies, researchers consider ways of collecting data to represent the multiple voices and actions constituting the research setting. Typical techniques used in qualitative research for collecting data include observing in the particular setting, conducting interviews with various participants, and reviewing documents or artifacts. The degree to which these techniques are used depends on the nature of the particular research study and what occurs in the local group.

Some studies involve in-depth analysis of one setting or interviews of one group of people. Others involve a contrastive design from the beginning, seeking to understand how the practices of one group are similar to or different from another group. Others seek to study multiple communities to test hypotheses from the research literature (*e.g.*, child-rearing practices are the same in all communities). What is common to all of these studies is that they are examining the qualities of life and experiences within a local situation. This is often called a situated perspective.

ENTERING THE FIELD AND AHEAD ADMITTANCE TO INSIDER KNOWLEDGE

Entering the research setting is one of the first phases of conducting fieldwork. Gaining access to the site is ongoing and negotiated with the participants throughout the study. As new questions arise, the researcher has to renegotiate access. For example, a researcher may find that the outcomes of standardized tests become an important issue for the teachers and students.

The researcher may not have obtained permission to collect these data at the beginning of the study and must then negotiate permission from parents, students, teachers, and district personnel to gain access to these scores.

Qualitative research involves a social contract with those participating in the study, and informed consent is negotiated at each phase of the research when new information is needed or new areas of study are undertaken.

At such points of renegotiation, researchers need to consider the tools necessary and the ways to participate within the group (*e.g.*, as participant-observer and/or observer-participant, as interviewer of one person or as a facilitator of a focus group, or as analyst of district data or student products). How the researcher conducts observations, collects new forms of data, and analyzes such data is related to shifts in questions and/or theoretical stance (s) necessary to understand what is occurring.

USED OF RESEARCH TOOLS

One of the most frequently used tools, in addition to participant observation, is interviewing. For ethnography and other types of field research, interviews occur within the context of the ongoing observations and collection of artifacts. These interviews are grounded in what is occurring in the local context, both within and across time. Some interviews are undertaken to gain insider information about what the researcher is observing or to test out the developing theory that the researcher is constructing.

In contrast, other forms of qualitative research may use interviews as the sole form of data collection. Such interviews also seek meanings that individuals or groups have for their own experience or of observed phenomena. These interviews, however, form the basis for analysis and do not require contextual information from observations. What the people say becomes the basis for exploration, not what was observed.

Other tools used by qualitative and ethnographic researchers include artifact and document analysis (artifacts being anything people make and use). The researcher in a field-based study collects artifacts produced and/or used by members of the group, identifies how these artifacts function for the individual and/or the

group, and explores how members talk about and name these artifacts. For some theoretical positions, the artifacts may be viewed as a type of participant in the local event (*e.g.*, computer programmes as participants). Some artifacts, such as documents, are examined for links to other events or artifacts.

This form of analysis builds on the understanding that the past (and future) is present in these artifacts and that intertextual links between and among events are often inscribed in such documents. In some cases, qualitative researchers may focus solely on a set of artifacts (*e.g.*, student work, linked sets of laws, a photograph collection, or written texts in the environment–environmental print). Such studies seek to examine the range of texts or materials constructed, the patterned ways in which the texts are constructed, and how the choices of focus or discourse inscribe the views that members have of self and others as well as what is possible in their worlds.

Although some qualitative studies focus solely on the documents, field-based researchers generally move between document analysis and an exploration of the relationship of the document to past, present, and future actions of individuals and/or groups. These studies seek to understand the importance of the artifact or document within the lives of those being studied.

CONTINUING DATA ANALYSIS

While conducting fieldwork, researchers reread their field notes and add to them any relevant information that they were not able to include at the time of first writing the notes. While reviewing their field notes, researchers look for themes and information relevant to the research questions. They note this information in the form of theoretical notes (or write theoretical memos to themselves) that may include questions about repeated patterns, links to other theories, and conceptual ideas they are beginning to develop. They also make methodological notes to reconstruct their thinking and their logic of enquiry. Sometimes they make personal notes that reflect their thoughts and feelings about what they are observing or experiencing. These notes allow them to keep from imposing their own opinion on data, helping them to focus on what is meaningful or important to those with whom they are working.

Researchers constantly use contrast to build interpretations that are grounded in the data, within and across actors, events, times, actions, and activities that constitute the social situations of everyday life. Many qualitative (particularly ethnographic) researchers examine material, activity, semiotic (meaning-carrying), and/or social dimensions of everyday life and its consequences for members. The analytic principles of practice that they use include comparing and contrasting data, methods, theories, and perspectives; examining part-whole relationships between

and among actions, events, and actors; seeking insider (*emic*) understandings of experiences, actions, practices, and events; and identifying through these what is relevant to the local group.

COVERAGE RESEARCH FINDINGS

The final step in qualitative and ethnographic research is writing an account. The researchers make choices about how to represent the data that illustrate what was typical about the particular group being studied. Another choice might be to highlight actions of the group that were illustrative of their particular patterns of beliefs.

In some studies, several cases are chosen to make visible comparisons across different activities within the group, or across different groups that may have some activities in common. For example, researchers who study classroom interactions might bring together data from different classrooms to make visible principles of practice that are similar in general terms such as asking students to understand various points of view. However, in each classroom, the actions of juxtaposing points of view will be carried out differently due to the different experiences within each classroom.

Researchers also select genres for writing the report that best enable the intended audience to understand what the study made visible that was not previously known or that extended previous knowledge. The researcher does not seek to generalize from the specific case. Rather, qualitative or ethnographic researchers provide in-depth descriptions that lead to general patterns. These patterns are then examined in other situations to see if, when, and how they occur and what consequences they have for what members in the new setting can know, do, understand, and/or produce. In qualitative and ethnographic studies this is often referred to as transferability, in contrast to generalizability.

PROCESS-ISSUES IN DISTANCE EDUCATION

Quality lies in its processes. Output is the result of such processes. A process is a sustained phenomenon marked by gradual changes through a series of actions that lead towards a particular result.

Good quality inputs coupled with weak processes often do not lead to desirable outcomes. On the other hand, good quality processes coupled with minimum essential inputs often do lead to desirable outcomes. An “issue” is a point of debate or controversy on which the parties take variety of position, ranging from affirmative to negative. By speaking of process-issues, the focus is on how the series of actions are brought about to achieve the desired goal of distance education.

RESEARCH DESIGN

This study used a qualitative research design to provide a more comprehensive picture of each aspect of the study. It must be noted, however, that the findings and recommendations of this study have limited application to other contexts, and therefore one cannot generate axioms that are widely applicable to other situations. What this study does yield, however, are interesting insights into suggested areas for further research, specifically those using qualitative designs as a basis for developing insight and gaining understanding into process-issues of distance education.

SAMPLE

The study was conducted on a convenience sample of thirty experts. Experts (*i.e.*, departments heads, professors, readers, senior lecturers, tutors, and directors) knowledgeable on the current trends in distance education formed the sample of our study. This sample was drawn from India's open, conventional, and national level institutions and universities: National Council of Educational Research and Training, New Delhi; National Institute of Educational Planning and Administration, New Delhi; National Institute of Open Schooling, New Delhi; Indira Gandhi National Open University, New Delhi; Association of Indian Universities, New Delhi; Institute of Applied Manpower Research, New Delhi; Kota Open University, Kota, Rajasthan; M.S. University of Baroda, Vadodara; and Devi Ahilya Vishwavidyalaya, Indore.

METHOD

A semi-structured interview called: "Process-Issues for Organizing Research in Distance Education: Interview Schedule" was used to collect data. Items comprising the interview schedule were written and structured to encourage respondents to focus on particular topics on process-issues such as: selecting priority areas of research, issues related to quantitative versus qualitative research, processes of enhancing different types of research, and issues on selecting appropriate methodology of research in distance education. The interview schedules also included open-ended questions, so respondents could elaborate on points of interest.

Data Collection

Data collection took place during semi-structured, face-to-face interviews conducted over a three month period from January 2001 to March 31, 2001. Interviews typically lasted between 45 to 60 minutes, but some lasted as long as 1.5 to 2 hours. The interview process was divided into three stages: pre-interview, interview, and post-interview stage. Respondents were given a copy of the schedule

prior to the interview, a time and place was agreed upon, informed consent was obtained prior to conducting the interview, and the results of each interview was transcribed immediately.

Data Analysis

Content analysis was used to analyze the transcribed data of each interview. Each transcription of each interview was read line-by-line, and then divided into meaningful analytical units called “categories.” After locating the meaningful categories, the research team coded them. Triangulation was used for cross-checking and verification of data through the use of different information sources. This includes a variety of data sources, the interviews, theoretical models, and research methods. Stronger conclusions can be drawn from comments made by more than one responding expert. Also, conclusions drawn from the interview data could be compared to previous results and related literature. A peer consultation among researchers was used to test and re-test the findings.

PROCESS-ISSUES IN SELECTING RESEARCH AREAS AND METHODOLOGICAL APPROACH

The quality of a research study is dependent upon the nature of the problem undertaken by the researcher, and the research design and supportive methodology selected to explore the problem. At this point, researchers are confronted with various and often conflicting aspects of research. The need to study the underlying research design, method, and process issues in research in distance education is clear.

As such, it is interesting to note that the following four issues emerged while interviewing the respondents.

1. Priority areas of research
2. Issue of quantitative versus qualitative research
3. Enhancing different types of research
4. Methodology of research in distance education.

Priority Areas of Research

Distance education is changing with an alarming speed, particularly as educational processes become increasingly globalized in terms of physical reach and scope of courses and programmes of study offered. Different viewpoints on distance education are emerging, reflecting the rapidly evolving nature of this increasingly important educational discipline. Workshop participants at the Open University, Hong Kong determined that research examining both on short-term and/or local problems, as well as long-term research that can be applied to other contexts, is

needed to contribute to the growing body of knowledge' on the subject. Moore (1995) advocated not to undertake more media-comparison studies or other meta-analysis. He suggested focusing on the features of particular media to see how they contribute to learner outcomes, what possibilities exist in various settings, whether things are working, and if not, how to fix the situation.

The following views, which reinforce the thoughts outlined above, emerged during our interviews of the distance education experts:

- Around 80 per cent of the distance education experts (respondents) felt that emphasis on current research should be placed on media and technology. They emphasized the need for research on the process-related issues of design, development, and effectiveness of materials; use of media by students; organization of radio programmes, TV programmes, tele-conferencing, audio conferencing; and each modality's effectiveness. This group felt research was necessary to examine multi-channel learning systems (*i.e.*, to determine how much of learning can be attributed to print, how much to tutoring, and how much to a combination of two or more media). Comparative studies on different formats from the same media were also determined as necessary areas for further research – for example, comparative studies examining alternative format in print materials to see which format is more effective for learning.
- Approximately 60 per cent of respondents interviewed advocated research conducted on examining learners and learning. They indicated research should be undertaken on adult learners' learning styles; factors that motivates students to learn; research on "how" students learn using print, audio, video materials; problems students confront while working with materials; and students' needs, attitudes, previous knowledge, socio-economic background, characteristics, aspirations, and study habits.
- More than 50 per cent of respondents opined that research should examine evaluation processes. They cited the importance of follow-up studies to examine the influence of specific training programmes, and utilization of training programmes in the classroom. These respondents also felt research should examine student evaluation; feedback on assignments; what exactly students perceive they will achieve upon completion of their studies versus actual employment opportunities available upon successful completion their course(s).
- Approximately 30 per cent of respondents advocated further research on student support services. These respondents felt that research should examine the use of study centres, resource availability versus actual utility at study centres; and the student support processes of counselling,

teaching, educational delivery mechanisms, and staff working study centres (*i.e.*, staff members' attitude and involvement in facilitating learning of distance learners).

- Approximately 25 per cent of respondents held the opinion that the basis of research should depend on individual and institutional practices. When viewed from this perspective, allocating priority to research initiatives depends on unique problems encountered by each institution. In sum, each aspect/dimension has its own unique importance, and that any “importance” placed on research must be based on the “institutional context” in which the given research activity seeks to gain insight and give meaning to. The basis of prioritizing research rests on the underlying institutional practices it seeks to clarify, explain, or remedy – specifically the objectives of a given institution; the specific problems each institution faces; the kind of innovations and changes a given institution wishes to introduce; the mission of the institution; the academic programmes they seek to offer; the particular media-mix adopted; and the kinds or models of distance education they seek to offer students.
- Some respondents (approximately, 13 per cent) felt that research should focus on distance learning planning and management. In India, there are currently three types of distance education institutions operating at the level of higher education:
 - National open universities;
 - State open universities; and
 - Directorates of distance education of conventional universities.

In this system, each institution shares similar and at times overlapping concerns and problems – *e.g.*, establishing higher standards, coordination of activities, staff training, research, course development, to name just a few. Moreover, each institution fully expects to expand its activities by expanding student enrolment. However, due to jurisdictional and bureaucratic overlap, many of these institutions tend to fall short in maintaining quality educational programming for students. As the old saying goes: one can excel at a few things, but one cannot excel at everything. Currently, there is no all-encompassing policy to guide India's educational system at the macro level. As such, when questioned, this group of respondents felt that research on planning and management must have top priority in India at this time. According to these respondents, research studies on organizational models are most important. They also feel that research on student support mechanisms (*i.e.*, home-based support, workplace-based support, institution-based support, study centre-based support, and media-based support) is similarly important.

- Some of the respondents (13%) placed emphasis on research on staff development. These respondents felt that research needs first to identify various staff categories/groups that require training, followed by research to formulate effective training strategies and mechanisms to address staff development needs.

METHODOLOGY OF RESEARCH IN DISTANCE EDUCATION

“One of the major challenges of researchers in distance education in the future will be to devise methods for conducting research. This involves method of data collection and data analysis that corresponds to the theoretical complexity of the field”. Berge and Mrozowski (2001) in reviewing the literature ($n = 890$ studies) in distance education over a ten-year period from 1990 to 1999, found that 75 per cent of the articles and dissertations used a descriptive methodology.

In spite of this finding, qualitative techniques are nonetheless evolving and new research methodologies emerging (*e.g.*, transferred from other disciplines). In the studies researched by Berge and Mrozowski, researchers used a variety of techniques for conducting distance education research, incorporating a variety of investigative techniques and few formal experimental or quasi-experimental designs. For example, student self-reporting, extensive interviewing of students, conversation and discourse analysis, or a combination of these methods, were often used to collect the necessary data.

Furthermore, these studies typically focused on a smaller group of subjects and took a deeper look at the subjects verbal and written behaviours.

This is an important step in refining research methods specific to distance education, in that they are designed to capture a wider and richer range of data needed to advance the field.

With the changing scenario of methodology of research in distance education, respondents engaged in the interviews voiced the following viewpoints on the issue of methodological approaches:

- There is no substantial difference in the methodologies of conducting research in distance education than in the formal system. It follows the same lock-step process in selection of problem, formulation of a hypothesis and research objectives, formulation of a measurable research question, question formulation, data collection, data testing, data analysis, drawing conclusions, etc. However, in terms of selecting a research sample, the procedure of data collection will automatically change the process. For example, a blank audiocassette could be sent to learners with a questionnaire wherein the learners will be asked to complete the

questionnaire by responding the answer in the audiocassette. In sum, this tends to present a different procedure of data collection. Similarly, instead of sending questionnaire via postal mail, the researcher can use the Internet.

- Since distance education learners are studying in a situation that is typically non-contiguous, application of a qualitative research design and methodologies are likely more appropriate than the application of a quantitative design and methodologies. When research is designed to examine distance students study habits, learning strategies, learning contexts – and how to improve upon all elements of the system geared to meet the learning needs of distance learners such as course design, development and delivery, and related student support systems – qualitative research methodologies tend to be more appropriate.
- To enhance inter-disciplinary research, inter-institutional mobility and interactions of researchers, it is necessary to share the uniqueness of specialized perspectives. Researchers can receive feedback from other researchers and vice-versa. Communication technologies are undergoing radical changes for mass data collection and data analysis. Individual researcher can interact with fellow researchers working in other disciplines, any time, any place. To expand the interdisciplinary scope of research, deliberate steps must be taken to integrate researchers and their disciplines – systemic researchers and subject pedagogues alike. The successful convergence of the ideas from related disciplines can enhance the quality of education.

THE BIRTH OF EDUCATION AS A FIELD OF STUDY AND RESEARCH

The study of and research on education traces its roots back to the late 1830's and early 1840's with the revival of the common school and it is the first time that both school supervision and planning were influenced by systematic data collection.

These data collection efforts, according to Robert Travers, involved “an examination of the ideas on which education was based, an intellectual crystallization of the function of education in a democracy, and the development of a literature on education that attempted to make available to teachers and educators important new ideas related to education that had emerged in various countries.” Horace Mann and Henry Barnard were early pioneers in educational data collection and in the production and dissemination of educational literature during the mid to late-nineteenth century.

Additionally, they held prominent educational leadership positions by being the first secretaries of educational boards of Massachusetts (Horace Mann) and of Connecticut (Henry Barnard). In many ways, the trends in the early history of educational research were components of the trends in American culture of the time.

The founding of Johns Hopkins University as the first research university in 1876 set the stage for new elite research universities to be founded such as Stanford University and the University of Chicago. Additionally, the Morrill Act of 1862 allowed for the establishment of 'land-grant' colleges and universities, many of which would rival the more established elite institutions on the east coast in research and knowledge production, across the United States. As Ellen Condliffe Lagemann points out, research universities quickly became the leaders in creating and disseminating new knowledge, the professionalization of many professions and they became the "spawning grounds" for research on education at the end of the nineteenth century.

During this time period, there was a belief that the social world could be "acted on and changed through scientific practices ...and that teaching and the social welfare professions embodied scientific analysis and planning." The restructuring of higher education in the United States from a focus on teaching to a new focus that included both teaching and research activities led to new schools of thought and approaches to science. Professors at universities were now expected to teach and to plan and conduct original research. Numerous pioneers of American education began their work and research in the major research institutions of the day. Perhaps one of the most well known of these scholars was John Dewey, Chair of the Department of Philosophy at the University of Chicago from 1896 to 1904, who introduced a new approach to the study of education and became a leader in pedagogy.

Dewey's experimental Laboratory School was based more on psychology than on behaviourism which had long influenced educational research activities. John Dewey's progressive education philosophy opposed testing and curriculum tracking and relied more on argument than on scientific research and its evidence. He worked to combine philosophy, psychology and education. Surprisingly, John Dewey never proposed future areas of enquiry or suggested future research directions in his writings and he never published any evidence on the effects his Laboratory School experiment had on children. Dewey's influence on educational practice outside of his Laboratory School was quite limited and overestimated. Ellen Condliffe Lagemann summed up John Dewey's legacy on educational research as follows: "to suggest that Dewey had served as something of a cultural icon, alternatively praised and damned by thinkers on both the right and left, might capture his place in the history of education more accurately than to say he was important as a

reformer. Certainly, his ideas about a science of education did not create a template for educational study.” In 1904, John Dewey left the University of Chicago for Teachers College at Columbia University where he remained as a professor of Philosophy until his death in 1952.

Within five years of John Dewey’s departure, Charles Judd arrived in 1909 to serve as Chair of the School of Education at the University of Chicago. Charles Judd differed substantially from John Dewey in his approach to educational research. Charles Judd, a psychologist, sought to bring a rigorous and scientific approach to the study of education. Judd was a proponent of the scientific method and worked to integrate it into educational research. This was evidenced by the University of Chicago’s School of Education reorganization into the Department of Education within the Division of the Social Sciences shortly after Judd’s arrival on campus. Judd’s preference for quantitative data collection and analysis and his emphasis on the scientific method, with a particular focus on psychology, was one of the leading schools of thought on educational research during the early decades of the twentieth century.

In 1904, the same year that John Dewey left the University of Chicago for Teachers College at Columbia University, the psychologist Edward Thorndike, also of Teachers College, published *An Introduction to the Theory of Mental and Social Measurements* which argued for a strong positivistic theoretical approach to educational research. Thorndike held a similar epistemological approach to the study of education to that of Charles Judd at Chicago. Thorndike favoured the separation of philosophy and psychology. He did not care for the collection of data for census purposes but rather the production of statistics and precise measurements that could be analyzed. Thorndike became a very influential educational scholar and his approach to educational research was widely accepted and adopted across academia both in the United States and abroad. What Ellen Condliffe Lagemann describes as “Edward Thorndike’s triumph and John Dewey’s defeat” was critical to the field and to attempts to define an educational science.

EDUCATIONAL RESEARCH AND THE INTER-WAR YEARS

The inter-war years were a time of transformation in educational research. By 1915, the study of education had been established at the university level with 300 of the 600 institutions of higher education in the United States offering courses on education. This time period also experienced an increase at the doctoral level of study which saw enrollments higher than any other discipline other than chemistry. While faculty at institutions such as Harvard, Teachers College and the University of Chicago, which had dominated the educational research landscape decades earlier, continued to make significant contributions to the study of education, there were scholars at many other institutions making additional valuable contributions to

educational research scholarship. At the conclusion of World War I the focus on educational reform in the United States began to change to a more social control and efficiency and there was an opportunity for many educationists to provide guidance to public schools in the United States.

Disagreement among educational research scholars persisted during this time period and there was little consensus on the aims of education. With the population of the United States growing rapidly and the demographic make-up of its people changing due to the arrival of immigrants from across the globe coupled with the migration of African Americans from rural areas and the Southern states to the urban cities in the Northeast and Midwest the student bodies at public schools were diversifying at a rapid pace. The arrival of new immigrants to the United States coincided with the “testing movement” that emerged during World War I when the United States Army was testing its recruits. The most prominent psychologists of the time, including Edward Thorndike, were either involved with or supported the Army’s testing. The testing movement attracted both psychologists and sociologists alike and it was the sociologists, primarily in the Department of Sociology at the University of Chicago, who challenged and actively researched the racial differences in intelligence quotients. Otto Klineberg from Columbia University also played a leading role in studying racial and cultural differences in intelligence quotients and their measures.

Educational Research - Post World War II and the Future

Educational research continued to flourish in the years and decades after World War II ended. During this time period, the growth in schools of education and in the number of courses on education at institutions of higher education continued to rise. Additionally, more academic journals with a focus on educational issues emerge as a means to disseminate new knowledge. These exciting changes in educational scholarship were not confined to the ivory towers in the United States. Even as Europe was rebuilding, the study of education across the continent was on the rise and in the United Kingdom, for example, the rise of professional graduate degrees in education was significant. Scholarly debates on the aims of education as well as epistemological discourse persisted.

In the decades after World War II, and in particular at the start of the 1960’s, a post-positivist movement in educational research starts taking shape. While positivistic approaches to educational research continued to be put forth during the post-war years and continued to be favoured by many social scientists, we start to see the introduction of, and in some case the reemergence of, other epistemological approaches. Constructivism, functionalism and postmodernism theoretical frameworks, among others, have offered strong criticisms of positivism. Vigorous debates on the virtues of the various theoretical perspectives about knowledge,

science and methodologies have played a very important role in educational research. Frequently, these critical discussions and analyses have found both a platform and a captive audience in the field of comparative education. These philosophical debates continue today both in and outside of academia.

The United States federal government also began to take a much more active role in educational research in the post-war years. Specifically, in 1954, the United States Congress passed the Cooperative Research Act. The Cooperative Research Act was passed as a means for the federal government to take a more active role in advancing and funding research on education in academia. Additional legislation and federal initiatives during the 1950's and 1960's that supported and/or funded educational research and provided a means for the dissemination of new educational knowledge included the National Defence Education Act of 1958 and the establishment of the Educational Resources Information Centre (ERIC) in 1966.

These are but a few of the many examples of the new role the federal government was playing in educational research during this time period. To be sure, the federal government has continued to play a significant role in educational research since this time period. Since the 1970's, according to Robert Travers, "virtually every bill authorizing particular educational programmes has included a requirement that the particular programme be evaluated to determine whether the programme was worth the money spent upon it." For a long period of time, public focus on education and schools focused on resource allocation, student access, and the content of the curriculum and paid relatively little attention to results. This new "evidenced-based movement" is one that remains with us today. Patti Lather describes the evidenced-based movement as "governmental incursion into legislating scientific method in the real of educational research" and that the federal government's focus on evidence-based knowledge is much more about policy for science than it is about science for policy. The federal government has a vested interest in and support for "applied research" over "basic or pure research". This, of course, is challenging for social scientists and educational researchers who are positivist in their approach to science and knowledge.

A distinctive form of research emerged from the new assessment or evaluation movement in recent decades. Educational assessment, in many ways, is a form of "action research". Action research does not aim to produce new knowledge. Instead, action research aims to improve practice and in the context of education it aims to improve the educational practice of teachers. Action research, as Richard Pring points out, "might be supported and funded with a view to knowing the most effective ways of attaining particular goals – goals or targets set by government or others external to the transaction which takes place between teacher and learner." Action research proponents, Yvonna Lincoln and Egon Guba, highlight that "the call for action...differentiates between positivist and postmodern criticalist theorists."

A new and interesting approach to educational research can be found today at the University of Chicago. The Department of Education at the University of Chicago was closed in 1997 to much surprise around the world. Despite the closing of the Department of Education, a sprinkling of educational research activities by faculty and available education course offerings can be found in a variety of academic departments and professional schools. In addition, the University of Chicago has also operated the North Kenwood/Oakland Charter School under the Centre for Urban School Improvement since 1998. Campus interest in urban schools and educational research led to the creation of a new Committee on Education in 2005, with a home in the Division of the Social Sciences, chaired by Stephen Radenbusch who joined the faculty in the Department of Sociology and whom the University lured from the School of Education at the University of Michigan.

The University of Chicago Chronicle highlighted the arrival of Stephen Radenbusch and noted that the Committee on Education “will bring together distinguished faculty from several departments and schools considered to be among the best in the world into common research projects, seminars and training programmes. The committee will engage faculty and graduate students from such areas as public policy, sociology, social service administration, economics, business, mathematics and the sciences to collaborate on the most critical issues affecting urban schools.” The interdisciplinary focus of Chicago’s Committee on Education and its Urban Education Initiative plans to create a “Chicago Model” for urban schools that will “draw on and test the best ideas about teaching, learning, school organization, school governance, teacher preparation, and social service provision.”

While interdisciplinary research and collaboration is no stranger to the University of Chicago, it is a new and innovative approach to the study of education. The Committee on Education at the University of Chicago is highly quantitatively driven and data focused. If this interdisciplinary approach to educational research is successful and is modeled by other institutions of higher education, both in the United States and abroad, it will be interesting to see if a positivistic approach similar to that found at Chicago is followed or if a more relativistic approach is pursued. Either way, interdisciplinary collaboration may very well be the next chapter in the history of educational research.

2

Framework for Research and Theoretical Modeling

INTRODUCTION

Currently, there is considerable research into the teaching and learning of statistics at all levels of education. In higher education, statistics education is a fast growing and important area. In the next part, we introduce our perspective on activity theory pertaining to statistics education. I summarise some of the literature on statistics education relevant to my investigation and outline some issues arising from the research. Following that I introduce some aspects of my research design and approach. While full details of my methodology and procedures, I give some background to the two studies making up the project in this part—who the participants were and the setting for each of the studies. I explain the fundamentals of the Gothenburg phenomenographic method and my adaptation of it for Study Two. I outline the ideas underlying my development of the Approaches to Learning Statistics Questionnaire. I also explain how my study fits into an emerging form of research concerned with investigating individuals engaged in socially meaningful practices. I introduce my theoretical model, drawing on Leont'ev's framework.

I firstly look at other important theories informing mathematics education and how activity theory fits with them. I describe some key elements of activity theory and include some major influences on its development in the former Soviet Union. I explain the structure of activity and its analysis. I frame my project, including the principal research question, in terms of an activity theory approach. Finally I summarise the key ideas of this approach.

PERSPECTIVE ON ACTIVITY THEORY

The theory of activity, based on the work of Vygotsky was expounded mainly by A. N. Leont'ev. It was an extremely influential theory in the former Soviet Union, and was developed and extended by important psychologists there, including Luria, Gal'perin, P. Ia. Zinchenko, and, after them, Davydov, V. P. Zinchenko, as well as many others. It emphasises the role of external, practical activity in cognition.

According to Leont'ev it is an important proposition that:

- Internal psychological activities originate from practical activity, historically accumulated as the result of the education of man based on work in society, and that in separate individuals of every new generation they are formed in the course of ontogenetic development.

That is, higher mental abilities develop in the individual from activities that are rooted in the ongoing practical and communal life by which societies organise and reorganise themselves.

The philosophical foundations for this approach are the theories of Marx, Engels and Lenin. Their concern was with the economic foundations from which development arises, both individual development and societal progress. Following their theories, Leont'ev explained that people actively develop knowledge on the basis of life experiences, which have an economic, social and political context, and are mediated by cultural tools.

The idea of mediation arises from Engel's proposition that the work done by humans is mediated by the tools they develop. Vygotsky extended the idea of physical tools as mediators to include mediation of cognitive processes by psychological tools—speech and semiotic systems.

An eminent Western analyst of Leont'ev's activity theory, Wertsch, describes the activity framework as being concerned with how abilities are developed:

- To carry out socially formulated, goal-directed actions with the help of mediating devices.

While the Russian word *deyatel'nost'* is commonly translated into English as “activity”, the ideas incorporated in the construct are, to me, better embodied in the word “engagement”. This word conveys notions of purpose and affect and includes intellectual, as well as physical, processes. All of these are bound up with the social world surrounding the individual. Activity, in ordinary English usage, usually refers to physical activity—behaviour.

Indeed, in early Russian publications, activity referred to physical labour, which was mediated by tools. Later, the notion of activity was developed to include mental

actions, such as remembering and reflection, and included Vygotsky's idea of mental tools as mediators, rather than only material tools of work. Activity, in the sense of engagement, both produces thought and is a product of the individual's awareness—her reflection on her environment.

According to Leont'ev activity, with its corresponding goals, means and conditions, dialectically forms and reforms individuals and their social worlds. That is, activity both orients individuals in the world in which they live and changes that world in cycles of mutual transformations.

Activity is described by Leont'ev as a functional unit of life:

- A system with its own structure, its own internal transformations, and its own development.

Throughout this thesis, I will try to explicate Leont'ev's ideas about the configuration of an activity system as a functional and dynamic unit. In this way I try to shed light on how students' learning activities develop and how they both shape and are organised by the setting surrounding them. The activity of learning is a process in which people grapple with new information—to make it meaningful, to solve problems and to adapt to new conditions. Rather than stressing the nature of the information received by the learner, the emphasis of my investigation is on the individual acting in her social and cultural world—what the learner does, why she takes those actions and how her actions relate to the learning arena.

Varela, Thompson and Rosch describe cognitive capacities as:

- Paths that exist only as they are laid down in walking.

Their metaphor beautifully illustrates the inseparability of personal meaning and setting; the co-emergence of thought and action. These notions are fundamental to my interpretation, application and extension of activity theory. Activity theory emerged from a culture and era very different to my own. The insights offered by this theory, in part due to these very differences, highlight the problematic nature and complexity of human learning.

THEORETICAL MODEL

OVERVIEW

In order to present a model of how learning Statistics is derived from statistical activity, it is important for me to explain both the context of the learning I am investigating and the theory by which I interpret the findings. The scene for my two investigations. The research tools I use, such as naturalistic inquiry, phenomenography and statistical analyses, provide the means for investigating local occurrences. I use these tools to explore relationships and events as they occurred for particular individuals in a setting which was bounded spatially and in time.

It is by means of the theoretical framework, that is, by my application of activity theory, that I try to provide insights that transcend the particular context. To start off, I locate frameworks which draw on Vygotsky's theory in terms of some other major theories of education, particularly those which are currently important to research in mathematics education. An outline of activity theory, as expounded by Leont'ev. I introduce my approach to understanding students learning Statistics from an activity theory perspective.

COMPARISON WITH OTHER THEORETICAL APPROACHES TO LEARNING

Western researchers are increasingly finding that a Vygotskian perspective provides a helpful lens with which to view the complexities of mathematical learning. This approach takes into account the fundamental role of social interactions and historical or cultural influences on learning. It aims to understand how language and symbols mediate meaning. Vygotsky's work on cognitive development contributed to the evolution of cognitive psychology. In this framework, not only are the actions of learners important but also their goals and how the actions are situated in a sociohistorical context. For Vygotsky and the activity theorists who followed him, the context for all activity is important, and collective external activity precedes individual internal activity.

The emphasis on the melding of the individual with society is particularly relevant to the analysis of adult learning, as adults are cognitively fully developed in the biological sense but generate new knowledge through participation in activities which are socially and culturally rooted. Hence, while Vygotsky's interest was mainly in the development of the child his explanation of learning through interpersonal interactions, and Leont'ev's interpretations and ideas, are useful for extending research on adult development. The Vygotskian framework provided a stimulus for theories of situated cognition in which a setting is defined as the relationship between an actor and the arena in which she or he acts. Cognitive skills take shape in the course of individual participation in socially organised practices. Research into situated learning recognises the cultural dimensions of learning and practices, for example, the cultural aspects of literacy; numeracy; apprenticeship and interactive expertise or working intelligence.

Issues addressed by researchers working in this paradigm often concern the effects of cultural artefacts—the devices and technologies, such as computers or internet systems, through which we “manipulate reality”. Varela et al propose that knowledge is “amplified” by technology.

To them, knowledge is seen as:

- Tangibly and inextricably linked to a technology that transforms the social practices which make that very knowledge possible.

These issues are highly pertinent to a study of statistical learning, as statistics is an artefact of Western culture. It is linked to our technology and it both moulds our thinking—the way we understand our world—and is used to produce changes in our environment. Theories of situated cognition resonate with activity theory approaches in their recognition of cognition as constituted in the social, vocational and cultural life of people. Consonant with Leont’ev’s theory research in this area acknowledges the role of tools in mediating cognition. However, in theories of situated learning, consideration is given to the importance of informal learning, an area little addressed by Vygotsky or Leont’ev.

One of the strengths of the conceptual frameworks provided by Vygotsky and Leont’ev is the integration of affective and motivational dimensions into explanations of cognition. There have been many researchers in diverse areas of education, who seek to show that motivational goals and intentions give meaning to learning—they are what drives the process. For example, Ausubel, Novak and Hanesian characterise all learning as meaningful learning.

Ames and Ames argue that goals:

- Provide the mechanism for filtering perceptions and other cognitive processes.

Bandura explains the link between intentions and behaviour by means of the construct of self efficacy:

- The conviction that one can successfully execute behaviour.

Studies by Volet; Volet and Chalmers and Volet and Lawrence show the importance of goals as mediators of university students’ learning. Education research increasingly recognises that the attitudes, beliefs, motivation and intentions expressed by learners are important, not only for understanding the actions of those learners, but also for the insights provided into cognitive theory. However, much of the literature in the area of affect and motivation lacks a unifying theory. In Leont’ev’s theory, the role of motivation and of goals in cognitive processes is systematised by means of his three levels of analysis of activity.

In mathematics education, research into affect and related areas, such as beliefs and perceptions, is extensive. The breadth and depth of these studies reflect an awareness of the importance of charting the changing trends and many dimensions of affect in learning. For example, Mcleod reviewed the research since 1970 in the *Journal for Research in Mathematics Education* on affective issues in mathematics learning, showing that such studies are central to the goals of mathematics education. These studies explore many different aspects of the affective domain. One major area of interest to mathematics educators is that of students’ attitudes to learning mathematics, particularly gender effects. Fennema summarises work using attitude scales, such as the Fennema-Sherman Scale, for measuring gender effects in affective issues and achievement in mathematics.

Her research showed major differences between males and females on a number of variables, such as confidence in learning mathematics, or perceived usefulness of mathematics. Recent work on the Fennema-Sherman Scale by Forgasz, Leder, and Gardner suggests that changes in response patterns challenge the reliance that has been placed on this important instrument. They recommend revising it, particularly the scale referring to mathematics as a male domain. This indicates that important transformations are taking place in students' attitudes to mathematics. An area of research related to attitude studies concerns students' perceptions and beliefs about mathematics. Schoenfeld pointed out that students' performances on mathematical problems were often undermined by their beliefs about mathematics, such as the belief that a mathematical problem should always yield a solution quickly.

There have also been recent studies on factors affecting students' motivation to learn mathematics showing that classroom environment, goal setting and type of task are critical elements. Research in statistics education, too, confirms the importance of students' attitudes, beliefs, interests, expectations and motivation to their learning. Affective issues are related to the ways in which students evaluate and regulate their learning—key elements in defining their activities. In this regard, a helpful distinction was made by Semenov, a Soviet psychologist, who applied activity theory to the study of thought processes. He distinguished the “intellectual plane of thought”, which pertains to the development of the content of a problem, from the “personal plane of thought”, which refers to the individual's evaluation of his or her efforts—reflections on the meaning and success of the ongoing mental activity.

While Semenov was referring to problem solving, his distinction extends usefully to students' appraisals of studying a statistics course. In my project I will differentiate between students' so called “objective” or practical evaluations of Statistics—evaluations in terms of extrinsic and culturally framed factors such as jobs, or higher study, and their personal assessment of it in terms of their liking for or interest in it and feelings about learning it.

A framework for the role of values in learning mathematics was developed by Southwell. This extends McLeod's research on the relationship between beliefs, attitudes and emotions in mathematics education. Southwell sees values as closely related to beliefs but “more complicated and encompassing”. She denotes values by a triangle consisting of the three elements of valuing: cognition, affect and volition.

She does not distinguish between values and valuing, which renders her framework problematic to me. However, the three aspects of valuing she specifies, tie in with Semenov's notion that the plane of thought has intellectual and personal aspects. Southwell's notion that volition is an aspect of valuing also accords with

Leont'ev's insistence that activity is purposeful. Leont'ev proposes that need always stands behind thought or action. However, unlike Southwell, Leont'ev explains how purpose, needs and goals are socioculturally framed. That is, he explicates these relations in terms of individual's activities, rather than simply stating that such relations exist. The focus on learning as "embedded in social situations, practices and cultures" is one of the key elements differentiating activity theory from constructivism, a major theory in mathematics education. While activity theorists assert that all learning is socially constituted, constructivism emphasises that all learning is the construction of meaning by the individual. In both cases action is required on the part of the learner. Constructivist ideas are drawn initially from Piaget's work, but constructivism has developed in various forms, such as radical constructivism or social constructivism.

Constructivist thinking has been instrumental in challenging the way educators regard learning—and therefore teaching. Piaget's work led to the idea that a mathematics classroom could be a place where children could direct their own learning, pose their own problems and discover their own mathematics. The impact of these ideas on research into mathematics education has been extensive, so much so that Ellerton asks whether we have become too comfortable with constructivism. What do we really mean by the constructivist teacher?

Relation between Constructivism and Vygotskian Approaches

Vygotskian perspectives are often contrasted with theories of learning based on constructivism. A Piagetian approach considers learning as the result of individual constructions of the environment, namely assimilation and accommodation. Assimilation is the process whereby the individual integrates new perceptions or situations into her or his existing individual schemes, and accommodation is the individual's effort to adjust schemes to the environment. The essence of this approach is the focus on the individual and on stages of maturation as prerequisites for the development of mental facilities.

Vygotsky recognised the genius of Piaget's work and was influenced by it, though disagreeing with Piaget's conception of:

- The role of egocentrism in the developmental relationship of language and thought.

According to Vygotsky:

- The developmental uniformities established by Piaget apply to the given milieu, under the conditions of Piaget's study. They are not laws of nature but are historically and socially determined.

Thus Vygotsky criticised Piaget for his failure:

- To take into account the importance of the social situation and milieu.

Piaget, in turn, was aware of Vygotsky's theories. Indeed, Piaget modified some of his theories in the light of Vygotsky's criticisms. However, Bodrova and Leong point out that this happened after Vygotsky's death. For this reason, the works of Vygotsky's students, more than of Vygotsky himself, have some common ground with Piaget's ideas.

Bodrova and Leong express the opinion that this:

- Has caused many psychologists to erroneously consider the Vygotskian framework as part of Piaget's constructivist tradition.

Piaget, like Vygotsky, explained cognitive development, such as mathematical development, as a result of children interacting with their environments. However, while Piaget viewed learning as subordinate to development, Vygotsky insisted that learning, by which he meant formal or school learning, directly influences development.

According to Vygotsky:

- Instruction is one of the principal sources of a schoolchild's concepts and is also a powerful force in directing their evolution; it determines the fate of his total mental development.

To Vygotsky, thinking itself, together with the cognitive structure required for thought and indivisible from the function of that thinking, is generated by internalisation of social relations. Meaning making takes on different forms in the interpretation by constructivists and Vygotskian theorists. In the former, it is a personal contribution of the learner who is involved in the education process.

In a Vygotskian approach, meaning making is bound up with cultural values, such that:

- The qualities of thinking are actually generated by the organizational features of the social interaction.

Vygotsky explained that higher mental processes develop through interaction with others.

He expressed this as follows:

- From the very first days of the child's development his activities acquire a meaning of their own in a system of social behaviour and, being directed towards a definite purpose, are refracted through the prism of the child's environment. The path from object to child and from child to object passes through another person. This complex human structure is the product of a developmental process deeply rooted in the links between individual and social history.

Knowledge to a constructivist is an individual construction; to the activity theorist it is a collective representation. This is not to intimate that constructivists deny the importance of the societal context, nor that there is no place for the individual in the Vygotskian viewpoint. Rather it is a shift in emphasis.

Saxe suggests of the Piagetian perspective:

- Social life is related to cognitive development as an external process, and the way sociocultural life may be deeply interwoven with the character of intellectual functioning is unanalysed.

In contrast, Bauersfeld calls activity theory a prototype of collectivist perspectives. A simplified overview of this perspective, provided by Bauersfeld is that learning is enculturation into pre-existing societal structures. This suggests a ready made world and knowledge, a notion for which activity theory is criticised. This enculturation is not a passive process. The individual develops through effective participation in activities. In contemporary research the term “appropriate” is used rather than “internalise” to emphasise the active role of the learner.

Radical constructivism, developed by Von Glasersfeld, has been criticised for studying:

- Human mental functioning as if it exists in a cultural, institutional and historical vacuum.

To its critics, radical constructivism presents a view of the human being as a closed system: “self-organising, self regulating, self-contained”. Communication is problematic in this approach with meanings “taken as shared” rather than shared. There have been attempts to integrate social aspects in accounts of the construction of mathematical knowledge. These add on to radical constructivist perspectives by acknowledging the “important but secondary” place of social interactions in knowledge construction. Lerman argues that adding the “social” to constructivism leads to incoherence. It fails to account for how people understand each other, or to explain the social dimension in a personal world.

Lerman proposes that the Vygotskian approach presents a different world view to the mentalism that underlies constructivist thinking, one in which:

- It is necessary to recognize the shift from a view of the autonomous cognizing subject constructing her or his subjectivity and knowing to one of the construction of human consciousness in and through communication.

Hence, the difference in thinking between Piaget’s and Vygotsky’s followers does not simply lie in the latter taking greater account of social interactions, as social constructivists do, anyway. Rather it is in acknowledging the primary sense in which subjectivities and positionings are constituted and reconstituted by the social events and cultural history surrounding the individual. To activity theorists, socially and culturally linked goals and needs are seen as integral to cognition, rather than as the “interference” of subordinate issues.

Ernest proposes that any form of constructivism retains portions of the radical constructivism metaphor of an:

- Evolving and adapting, but isolated organism, a cognitive alien in an hostile environment.

Hence the individual's cognition takes place in a private domain of experience. Transference from the public or social realm to this personal domain cannot be explained. This problem is not, however, restricted to constructivism. Davydov an important student of Leont'ev, postulates that the structural difference between individual and collective activity is also an unsolved problem of activity theory.

The two poles of thought represented by constructivism and Vygotskian approaches are major current theories which have in common a rejection of the transmission view of teaching and learning. They both focus on the actions of the individual in learning. Their points of difference have led to a multiplicity of models. Current approaches include: synthesising the two approaches superseding models and emerging connectionist theories of cognition or enactivism. One example of a middle position between individualism and collectivism is an "interactionist" perspective.

It takes the position that the culture of the classroom is constituted in social interactions among teachers and students. Another strategy has been to adopt complementary perspectives. Bartolini Bussi argues that rigid adherence to the principles of constructivism or to a Vygotskian perspective does not recognise the richness and complexity of the ideas of the founders. Moreover she feels that theoretical coherence should not take precedence over real life problems. Indeed Bartolini Bussi moves that such a pragmatic view is "deeply Vygotskian", as Vygotsky himself was concerned with pressing social and cultural issues, rather than theorising. Lerman presents a critique of this view, arguing that adding bits of one theory to another, or slipping from one to the other, ignoring the contradictions, or plastering over theoretical holes in each, do not do justice to the insights and coherence of either.

There is considerable debate between protagonists of Vygotskian approaches and those of other current theories. I believe that the usefulness of activity theory lies in its systemic approach. Activity theory posits a view of learning in which personal experiences, goals, subjective perceptions and sociohistorical factors are interwoven. Rather than focusing on separate facets of learning and context, activity theory implies a commitment to investigating the learning process as a "dynamic system of meaning" in which intellect and affect unite and through which society and the individual interact and evolve. This view of learning includes notions of growth and diversity.

SOME INFLUENCES ON THE THEORY OF ACTIVITY

In developing a Marxist psychology, Leont'ev drew on the work of many philosophers, such as Marx himself and Engels, and of psychologists, particularly Rubinshtein and Vygotsky. Leont'ev's orientation to Marxism is a critical element in his theories about human consciousness and cognition. He explained the

revolution brought about by Marx in the theory of cognition in terms of the role Marx ascribed to human practice in cognition. That is, Leont'ev stressed that to Marx cognition and activity were inseparable.

Leont'ev wrote:

- In reality the philosophic discovery of Marx consists not in identifying practice with cognition but in recognising that cognition does not exist outside the life process that in its very nature is a material, practical process.

Leont'ev concurred with Vygotsky who was convinced of the Marxian concept that the “human essence is constituted by social relations”. That is, awareness, thought and other higher psychological functions, arise and develop in the interactions among people and their ties to the world in which they live. In Marx' philosophy, the object of knowledge is to transform the world, not just to understand it. In Soviet education, these ideas were translated into attempts “to construct a new socialist man”. Both Vygotsky and Leont'ev built their psychology on a conception of Man developed by Engels and Marx.

This conception is expressed by Mellin-Olsen as follows:

- The conception is one of man as an acting person, at one time being both determined by history and determining it, being both created by society and creating it.

It was in this context of historical and dialectical materialism that Leont'ev considered activity as an object for psychology. Leont'ev's formulation of activity owes much to his many debates with Rubinshtein. Rubinshtein, who lived from 1889 to 1960 explored the ‘mind body’ problem stressing that activity is not only external behaviour but is inseparably linked with consciousness.

He expressed this in the formula:

- External causes act through internal conditions.

Leont'ev disagreed with Rubinshtein in that the latter considered that practical activity was the subject of study for psychology only to the extent that such activity included internal mental processes, such as perception or thinking. Leont'ev characterised this as a one sided view, in which mental activity is seen as directing physical activity, or external activity is viewed as dependent on psychological images. In Leont'ev's view, the “circle” of mental processes opens up “to meet” the external world of objects through external practical processes or activity. For example, bouncing a ball leads to a perception of its resilience.

To Leont'ev the function of activity is “transforming this reality into the form of subjectivity”. That is, activity enters psychology not as one of its elements, nor as an aspect of internal processes, but through its function—the function of linking the

individual's external and internal worlds. At the early stages of its development, activity must have an external form. Activity develops through reflection and regulation. Through processes of interacting with others and the environment, mental images and thoughts take place. According to Leont'ev these "deflect, change and enrich this activity".

Vygotsky's ideas and images permeate activity theory as a melody runs through a complex orchestrated score, with the harmonies, counterpoint, new melodies and even discordant notes, being provided by his students, mainly Leont'ev and Luria. It is therefore important for me to interpret Vygotsky's notions as they apply to activity theory in general and to my application of it in particular.

Vygotsky did not himself develop the concept of activity as a theoretical construct. However, he conducted empirical investigations based on the assumption of activity, emphasising the role of speech and semiotics in causing

Fundamental changes to the nature of the activity. According to Davydov and Radzikhovskii:

- The true methodological significance of Vygotsky's work consists of the assertion that activity is the explanatory principle in psychological theory.

This remark suggests that Vygotsky adopted Marx' approach to formulating a new psychology. In the last years of his short life, however, Vygotsky moved away from strict adherence to Marxist principles—at least this was the view of the Soviet authorities—resulting in his works being banned for many years in the Soviet Union. Some of Vygotsky's colleagues and students, including Leont'ev, went on to interpret and propagate Vygotsky's sociohistorical theory of psychology within a Marxist framework, linking individual consciousness and personality with social and practical activities.

OUTLINE OF LEONT'EV'S ACTIVITY THEORY

Wertsch, commenting on Leont'ev's exposition of the tenets of activity theory summarises three major original contributions of Leont'ev to the works of Vygotsky and other theorists. The first of these is the construct of activity itself. Secondly, Leont'ev presents levels of analysis of human activity, arguing that activity can be viewed from the perspective of the milieu or context in which it takes place, from the goal directed actions which make up the activity and from the operations which depend on the conditions under which actions take place.

Thirdly, Leont'ev replaces sign systems, which are central to Vygotsky's theories, with activity as the mediator between humans and their worlds. Thus an analysis of activity explains the dynamics of how humans relate to their physical and social environments.

Activity

Activity, as a construct, occupies a major explanatory role in the psychology that dominated the Soviet Union in the sixties and seventies.

The very process of living is described by Leont'ev as:

- The system of activities that succeed one another.

Activity refers to the functional unit of human behaviour that relates the individual to his or her social and cultural world. Leont'ev and his fellow activity theorists explain that humans understand their world and develop knowledge about it by acting purposefully in it. In turn this activity changes the world.

Leont'ev rejects "positivist" notions of activity which stress activity as purely adaptation to the external world. His main criticism of this perspective is that if psychology is limited to the concept of socialisation of individuals, the structure and transformations which link humans with their society will remain a mystery. To understand these links he posits that we must investigate activity—its structure, its specific dynamics and its various forms, both overt and cognitive.

The Structure of Activity

Leont'ev identified three levels of analysis of activity.

Further expansions were provided by Zinchenko and Gordon.

- The first level is concerned with the global aspect of activity. This defines activity as a unit of life mediated by reflection; a frame outlining the context in which the activity takes place, for example, play, formal education or work. This level identifies the socioculturally defined milieu in which the actions occur. At this level analysis is therefore concerned with the motivation underlying and engendering the actions, the "energising function" of the activity.
- The second level relates to the actions which make up and realise the activity: how the task was carried out. To Leont'ev, actions are always directed towards a goal. He did not acknowledge that we sometimes do things without a conscious reason. He postulated that there may be many intermediate or partial goals to be satisfied on the way to achieving the final aim. These intermediate goals are determined consciously and with regard to the social relations in which they are set. Leont'ev gives the example of individuals beating the bushes to scare out an animal which will be caught by other, strategically placed, members of the community. The actions of beating the bushes do not in themselves have direct relevance to satisfying hunger, the motive of the activity. It is the connection of these actions to those of others and to the main purpose of the exercise which explain the actions.

- As outlined by Leont'ev actions have an intentional aspect and an operational aspect and these are carried out to realise a conscious motive. The same motive can give rise to different goals and accordingly can produce different actions. Conversely the same actions can realise different activities. For example, a statistical procedure such as a "t - test" may be carried out by a student to get an answer, with little reflection about understanding the procedure while different goals may lead to the same actions being carried out but with the focus on the underlying rationale of the procedure.
- The means by which actions are carried out are labelled operations by Leont'ev. Operations are therefore components of actions. While actions are determined by the goals which they fulfil, operations depend on the conditions, especially the tools, which delineate the exact mechanisms for carrying out the action. Tools can be physical, or "extra-cerebral" for example, computers or calculators for carrying out statistical procedures. They can also be cognitive, for example an algorithm, followed mechanically in order to get a result. Leont'ev posits that it is the fate of operations to become automatic by their mechanisation. Operations, however, are inseparable from the actions and in turn the goals which they serve. They are under conscious control as part of the actions and, through these actions, the activity in which the individual is engaged. The issue here is that different conditions lead to different compositions of actions. Solving a linear algebraic equation, for example, may be performed on an operational plane if the student has practised the process many times but not if the student is a novice in algebra. This level of analysis is particularly pertinent to the analysis of learning Statistics where the aim of many students is to become familiar with, and so automate, processes and algorithms.

The implication of viewing activity from different levels is that these provide different vantage points for investigation. At the global level, Leont'ev distinguishes activities on the basis of motive and the object towards which they are oriented. This provides one vantage point from which to understand students' learning. Activities are comprised of actions which are determined by the goals impelling them. Hence the conscious goals or needs driving the actions provides another perspective for analysis. Actions, in turn, consist of operations where the notion of operation has to do with the routine automatic aspects of carrying out a task. This level of analysis, therefore, relates to the means or resources for carrying out the actions.

Dynamics

To Leont'ev, the problem of understanding the dynamics of activity, is one of discovering the relationships that connect the individual's behaviour with

physiological functions, “the work of the brain”. By this, Leont’ev is not proposing a quick course in neuro-physiology. Rather he suggests an indirect approach—investigating the functional development of the mechanisms in the brain as a product of activity.

This analysis must include an understanding of both phylogenetic development, that is, development which is sociohistorical or evolutionary, and ontogenetic development—the maturing of the organism. Leont’ev posits that higher order mental functions take place as a result of “mastering tools and operations”. These mental systems are instated by or generated by activity.

This means that mental images are not formed by the brain; they are the function of the brain. They are generated in the transition from the “extracerebral to the intracerebral sphere”. That is, there is no landing pad in the brain awaiting the arrival of images. It is by means of our actions, including mental actions such as reflection, that we transfer images from the external world to the cognitive sphere. Activity mediates between the environments surrounding humans and our internal domains.

Leont’ev stresses that activity is characterised, not by its units which are meaningless if studied in isolation, but by the systemic connections between the units and their transformations. That is, activity is not simply a sum of actions. Rather, the connections between the parts and the goal formation determine activity. The levels of activity are mobile or dynamic; actions can become activities in their own right. For example, driving a car is an activity if the person is learning to drive in order to pass a driving test.

It is purposeful, effortful action. The same actions—such as steering, braking, accelerating, may, however, be carried out as part of another activity, for example driving to work. Here the setting is work; the partial goal of the driving actions is to arrive at work—actions such as steering or braking, are the means of achieving this aim. Further, if the driver is experienced, the actions taken in driving may be automatic. They are now operations. However, in a difficult situation, such as a driver would experience in heavy traffic and wet conditions, conscious decisions will again regulate the actions, rather than a mechanical set of operations being performed.

The example illustrates that in the course of attaining an overall goal, activity may be split up into separate, successive actions which are consciously carried out with the help of operations which, in turn, may have been formed under different circumstances.

The opposite happens when the individual is no longer conscious of intermediate results—the overt actions and mental reflection merge together or are consolidated in carrying out an activity.

According to Leont'ev, investigating both these aspects:

- The breaking down of the activity and the integration of its actions and operations, can only be done by studying the links. These may be all internal, as in cognitive activities, but, more often, internal activity is implemented by external actions.

The word “activity”, as used throughout this thesis, refers to this framework. That is, a student’s statistical activity encompasses her actions within a specific context, her goals, and the resources available to her, whether technological or her own expertise.

THE ACTIVITY OF LEARNING STATISTICS

While activity may be viewed as an abstract construct, Leont'ev emphasises that in reality we always deal with specific activities, within a finite time, space and setting. His three levels of analysis provide three vantage points on a fundamental question for any investigation from the perspective of activity theory: the question of what an individual or group is doing in a particular setting.

In order to understand what a particular group of students is doing in learning Statistics, responses can be formulated in terms of each of these three levels. The first level concerns the cultural or historical milieu of the students’ actions. This is an account of students’ learning from the perspective of the global level of activity. To respond to the question at this level it is necessary to understand students’ actions in the institutional context—while studying a university course.

A university has its own well defined social practices. Students' interpretations of these practices are bound up with their perceptions of what is expected of them and will be fundamental to their actions.

According to Wertsch:

- An activity setting is grounded in a set of assumptions about appropriate roles, goals and means used by the participants in that setting.

This setting guides the selection of actions and choice of tools. It also determines the function of the activity. Wertsch explains that settings are not determined by the physical context but are created by the participants in the activity. Further, assumptions about the setting are often implicit, rather than consciously identified. Participants may not identify what organises their performance. An individual's understanding of the setting emerges as a "byproduct" of interacting with others in it.

To say that a student is engaged in the activity of learning a university subject, Statistics, simply tells us that the student is working in a particular socioculturally

defined setting. To understand activity at Leont'ev's second level of analysis one must look at the actions which, in his view, are defined by goals or partial goals.

In my view, goals are not automatic nor fixed in advance. They are tested by action and remain fluid throughout the process of selection and testing. This notion of goals as in flux - as being socially tested hypotheses - was expressed explicitly by one student whom I interviewed during her first year at university.

I've never really studied before this at all, and it's only been since last year that I actually applied myself to anything in academic terms. And so for me everything's just - what's the word... an experiment.

An experiment to see what works and what doesn't. Finally, a response to the question about a student's learning of Statistics can be formulated in terms of the tools and operations that the student has at her command. This is the third level of the activity of learning Statistics that must be investigated.

The availability of tools as mediating devices will partly be determined by the setting - for example what calculators are deemed appropriate for students to use. Tools and operations also depend on the student's personal history - her experiences, including the student's repertoire of skills, such as her ability to use a calculator or mathematical symbols. Affective elements are important as well.

If the student's memory of using a compass at school is linked to negative emotions, this tool will not be readily utilised. The tools or operations used by a student affect how successfully the student is able to carry out her intentions.

FRAMING THE RESEARCH QUESTION

Guided by activity theory and within the methodological framework outlined, I explore the qualitatively different ways students relate to their learning of a statistics course at university. Statistics, with a capital "S" refers specifically to the statistics component of the Psychology II course. Hence this usage immediately specifies the setting of the activity as university learning of a particular topic at a defined time and place.

The main research question which I investigate is:

- What are students' orientations to learning Statistics ?

I am interpreting the word "orientations" as signifying students' positioning of themselves with respect to the learning task. This question is important because, from the theoretical perspective I have outlined, students' orientations to learning Statistics are integral to the ways students engage with the learning task and hence relate to the quality of their emerging knowledge.

To investigate the research question I explore three interdependent aspects. Firstly, I investigate different facets of students' orientations to learning Statistics, including affective elements, students' conceptions of Statistics and their approaches

to learning the subject. Secondly, I look at the connections between students' orientations to learning Statistics and the outcomes of learning it, mediated by their activities. Thirdly, investigating this question intrinsically includes exploring the relationships between the students' perceptions and actions and the contexts surrounding their learning. For example, if a student's conception of Statistics is "algorithms", this is not a characteristic of the student or of the subject Statistics or of the educational institution.

It is a relationship between the student's way of experiencing Statistics and the contexts surrounding these experiences. From the activity perspective, how a student orients herself in the learning arena her actions and her evaluations of the learning task, develop together and coherently and, with their accompanying outcomes, are organised within and contribute to the wider sociocultural setting. A student's orientation to learning Statistics could be regarded as a particular mind set individually generated in response to her experience of a certain context.

My view of orientation is in contrast to this view of it as an individual and internal construction. Consistent with an activity theory framework, I regard a student's orientation to learning Statistics as inseparable from her actions to learn Statistics and as part of a wider and dynamic societal "system of activities". Statistical thinking cannot occur in isolation, in the head.

In learning Statistics, an individual is participating in a cultural practice even when she appears to be acting in isolation, such as doing examples or reading a text book. Further, the statistics that the student is studying has itself developed historically through interactions which are culturally founded. The methodology for statistical inference, for example, has been cultivated and improved by successive generations and continues to undergo major transitions as a result of current technology.

My interpretation of the activity of learning Statistics, drawing on Leont'ev's sense of the construct, refers to the actions a student takes to grapple with it—to engage, purposefully, with the problem of learning it. A student's engagement with the task of learning Statistics is expressed by both cognitive actions and practical actions. These actions are directed, not random, even if the student does not articulate her goals. By "doing" Statistics a student "makes" it "artistic, practical, creative or routine".

RESEARCH DESIGN AND APPROACH

The activity theory perspective suggests that a focus on teaching, unrelated to students' perceptions about their own learning and its context, is unlikely to be successful in changing outcomes. My approach focuses on the experience of learning Statistics at university from the point of view of the student. Consistent with my

theoretical framework based on the ideas of Leont'ev and Vygotsky, I explore the network of relationships between learners, the subject matter and context.

My investigation took place at a large and traditional metropolitan university, the oldest in Sydney. The participants were second year Psychology students, all of whom were required to study Statistics. Statistics is introduced in first year Psychology at The University of Sydney, but it is as a compulsory component of the second year course that it plays a major role, contributing one quarter of the final assessment mark. The instruments I used included participant observation, interviews and surveys. My project consists of two investigations.

Study One is entitled “Exploring Mature Students’ Learning of Statistics”. The context for this study was the Mathematics Learning Centre where I work. The participants in this study were of great interest to me as an educator concerned with ameliorating students’ difficulties with Statistics. Study Two is called “Understanding University Students Learning Statistics as a Service Course to Psychology”. In this study, I widened the context of my inquiry to include the general Statistics class. For my investigations, I drew on a triad of research tools—naturalistic inquiry, procedures based on the phenomenographic method and quantitative methods for describing data and exploring patterns and relationships. Among the instruments I developed was the Approaches to Learning Statistics Questionnaire.

PSYCHOLOGY STUDENTS AT THE MATHEMATICS LEARNING CENTRE

In Study One I utilise a naturalistic perspective to draw on the rich accounts of five students who were studying Psychology after many years away from the educational setting. My aim is to tell the story of these students in a way that is generalisable to others—that is, I try to uncover recognisable insights. I was in no way involved with the formal assessment of these students and worked very intensively and closely with them. Hence I was able to develop a close relationship with the participants of Study One and had more access to their perceptions and feelings than is usually the case for university educators in statistics. My analysis is based mainly on interview data, complemented by written expressions from various sources. The five participants were selected “purposively” for their range of experiences and attributes. As is often the case with qualitative research, the data for this study consisted of descriptions, direct quotations and excerpts, obtained by close psychological contact with those being studied.

The study is an example of action research in that my actions as a researcher were inseparable from those designed to assist the students in their learning of Statistics. As I have outlined in Gordon this means that the methodology for the study developed through the “action research spiral”.

They describe this spiral as recurring cycles of:

- Planning, acting, observing and reflecting, with each of these activities being systematically and self-critically implemented and interrelated.

VIEW OF PSYCHOLOGY STUDENTS LEARNING STATISTICS

Study Two was grounded in Study One and broadened the perspective on students learning Statistics. The participants of Study Two were Psychology II Students who took part in a survey during their Statistics lecture, near the end of the first semester. The survey was completed during 20 minutes of the lecture time and was the major source of data for this study. Other data for this study included assessment results and vignettes from interviews with students selected from those who agreed to contribute further to my research.

Background of Phenomenography as a Research Tool

One major focus of Study Two was to elicit students' conceptions of the subject matter, in the context in which they were studying it. To do this I adopted a phenomenographic approach. The term phenomenography was first used by Ference Marton to describe programmes of research which had the common aim of describing peoples' conceptions.

The results of phenomenographic analysis are categories of description of the qualitatively different ways students conceive of the phenomenon being investigated. This focus on describing conceptions is not the sole aim of the investigations in which phenomenography is used as a research tool. Rather it is learning and teaching that are being investigated based on the focusing of conceptions. Conceptions are the lens through which the phenomenographic researcher views learning.

Marton describes phenomenography as a method:

- For investigating the qualitatively different ways in which people experience, conceptualise, perceive and understand various aspects of, and phenomena in, the world around them.

Phenomenography was developed within the framework of education research at the University of Gothenburg, Sweden. It is concerned with the relations between people and the objects of their perceptions or content of their thoughts. Marton calls phenomenography a "research specialization", that is, a combination of a research orientation and a research approach to describing and comparing conceptions and understandings.

The research orientation emphasises the importance of description and the use of categories as forms of expressing the conceptions. The research approach is

characterised by the open explorative form of data collection and the interpretative analysis of data. Säljö, a forerunner in the development of the phenomenographic approach, comments that in more recent studies, the term “way of experiencing” is used in preference to the term “conception”.

This emphasises that:

- The prime interest of phenomenographic research is in finding and delimiting the variation in ways of experiencing reality.

Hence, in deriving categories of description for students’ conceptions of Statistics, I am attempting to find relationships between the students and the subject matter which express their ways of experiencing the subject, Statistics, as they were learning it. Svensson argues that underpinning the phenomenographic specialisation is an assumption that knowledge is fundamentally a “question of meaning in a social and cultural context”. Such an approach views phenomena systemically and avoids separating person and context.

As Säljö in an editorial of Learning and Instruction, concludes:

- Human experiences are inescapably cultural in nature, and learning and growth take place within cultural boundaries.

This view of the intertwining of culture, mind and action is consistent with a Vygotskian assumption that there is no duality between self and context; between thinking and acting. The phenomenographic view of knowledge is that it is relational, created through human thinking and activity which relates to the external world—a relation between thought and social and cultural life. Hence my choice of phenomenography as one of my research tools is consistent with the theoretical perspective with which I am framing this investigation.

The relational view of learning furnished by phenomenography has formed the basis of much of the research into student learning in higher education. Phenomenography has been fruitful in exploring students’ conceptions and understanding in a number of topics, including physics; literature interpretation; essay writing and computer programming. In summary, this research indicates that learners’ experiences should be considered as involving the ways students relate to the learning environment, their goals and intentions, as well as their learning strategies. My colleagues and I have found phenomenographic methods useful to explore the qualitatively different ways in which students experience learning mathematics. Two studies were conducted.

In the first study we investigated the conceptions of mathematics and approaches to learning it of students entering university. In the second investigation we explored these students’ conceptions of a fundamental mathematical concept, namely that of a function. Traditionally, phenomenographic studies are built around interviews. However, in these investigations, my colleagues and I extended previous research

by constructing categories from the written responses of a large number of students. This developed phenomenography as a research tool. In Study Two, I built on our previous phenomenographic research by looking at the variation in the way second year Psychology students conceived of the nature of the subject matter, Statistics. The phenomenographic perspective provided my basis for identifying categories of description of students' conceptions. These revealed qualitatively different ways of experiencing Statistics. In much research, the categories of description or variables are imposed on the data by an expert researcher.

In Study Two, in keeping with phenomenographic practice, the categories of description were constituted in relation to the data—from interpretations of the survey responses. This does not imply that I, as researcher, viewed the data free of ideas based on prior experience or theoretical orientation.

Indeed:

- The act of categorisation is by its very nature subjective.

Further, my research is deliberately set in the framework of activity theory. However, instead of characterising students' responses to the three open-ended questions in the survey by means of an established taxonomy, the categories emerged in the context of the study. By keeping the questions as general as possible, I tried not to shape students' responses. Rather I tried to explore the students' points of view. This enhances the ethnographic validity of this research, that is, the sense of the research in terms of the lives and awareness of the participants in it.

The phenomenographic method analyses meanings constituted within a particular context and content domain. My categories were derived in a particular setting. However, they and their structure as an organised set, may prove useful in contexts other than the one from which they emerged.

In accord with the phenomenographic approach:

- The categories of description are supposed to be replicable, but the way in which they were found is not.

Conceptions may be expressed in different forms of action but they are most accessible through language. Variation in conceptions, expressed by people, immediately brings in the cultural and social context in which these conceptions are reported. The students' reports on their ways of conceiving Statistics, although limited to the students' awareness and abilities in written verbal expression, provided me with a rich source of information for characterising these experiences. This experiential perspective is referred to as a "second order" perspective by Marton.

He contrasts this with phenomenology, based on Husserl's imperative to return to the essence of a phenomenon, through immediate experience and free from conceptual thought—a first order enterprise. Phenomenography is a perspective on

how things appear to people—how phenomena are experienced, rather than what they are “in reality” or whether or not such a reality can be described.

Phenomenography was derived from empirical and pragmatic research in education. Its commitment to philosophical foundations is therefore not always clear. The procedures defining its use are neither prescriptive nor indisputable. Indeed, Hasselgren and Beach argue that “there is no genuine consensus method of phenomenography”.

To them:

- Phenomenography is research which is simply concerned with how things are understood, the experiences of the process of formation of understandings at individual levels, and their distributions in specific collectivities.

While my way of applying this research tool is individual, I have tried to maintain the essence of phenomenographic research as a way of understanding the multiple realities of students. That is, my appropriation of Marton’s term signifies this approach. I view phenomenography as a research tool which bridges the gap between empirical, analytic methods, which are recognised by the research community, and students’ subjective awareness of their own diverse conceptions and experiences.

Introduction to Analysis of Students’ Approaches to Learning Statistics

I analysed students’ approaches to learning Statistics by means of a questionnaire, the Approaches to Learning Statistics Questionnaire. My questionnaire was modified from the Approaches to learning Mathematics Questionnaire which, in turn, was derived by my colleagues and myself from the Study Process Questionnaire. Biggs refers to three approaches to learning: deep, surface and achieving. He differentiated each of these into two aspects—the motive, or intention, and the strategy. Hence, in the Study Process Questionnaire the items are divided into those referring to motive or intention and those referring to strategy.

Each motive-strategy combination defines a distinct approach to learning—deep, surface or achieving. Early work by Biggs, on samples of students from universities and Colleges of Advanced Education, indicated that the achieving approach was equally related to the surface and deep approaches in tertiary students.

The surface and deep approaches, however, are referred to by Biggs as:

- Independent ways in which students may become involved in learning.

In this project I was concerned with deep and surface approaches to learning. Achieving approaches were of less theoretical interest to me and were not investigated. Considerable research has been done on the Study Process Questionnaire. For

example, a literature review on approaches to studying indicates that mature students seem more likely than younger students to adopt deep approaches to learning, while surface approaches decline with age. However, completion rates and possible bias in these studies, for example, in the postal returns of surveys in Biggs' investigations, renders this finding problematic.

Richardson also reviewed the literature on cultural specificity of approaches to studying in higher education. Investigations using the Study Process Questionnaire in countries as diverse as Australia, Nepal, Britain and Nigeria yielded a similar two factor structure for this questionnaire—one indicating a deep approach and the other a surface approach. The research also suggests that orientations towards understanding the meaning of learning materials, that is, deep approaches to learning, reflect a consistent agreement across different cultures with regard to the goals of higher education.

On the other hand, this research indicates that patterns of responses on the subscales measuring surface approaches to learning, are more distinctive to differing cultural contexts. Concern has been expressed about the factor structure underlying Biggs' differentiation of the Study Process Questionnaire into motive and strategy components. In my analysis of the Approaches to Learning Statistics Questionnaire I did not find evidence for a breakdown into intention and strategy factors. I therefore analysed the items of the ALSQ in terms of two subscales: one measuring a general surface approach and the other a deep approach to learning Statistics.

Biggs characterises a surface approach and a deep approach to an academic task by the following.

A surface approach is distinguished by:

- A view of the task as imposed, a demand to be met;
- A fragmented view of the task—parts are unrelated to each other and the task is unrelated to other tasks;
- Worries about the time taken by the task;
- A lack of recognition of any personal meaning in the task;
- Reliance on memorisation and ways of reproducing the details.

A deep approach reflects:

- Interest and enjoyment in the task;
- A search for underlying meaning;
- Efforts to make the learning personally meaningful—relating task to personal experience or to the real world;
- Holistic approach—relating parts of the task to each other and to other knowledge;
- Theorising about the task.

The surface approach and the deep approach, as defined by Biggs, correspond closely with the surface and deep levels of processing distinguished by Marton and Säljö. Later, Marton and Säljö referred to these as surface and deep approaches to learning. In contrast to Biggs, however, Marton and Säljö see surface and deep approaches as the opposite ends of a single continuum, rather than as independent ways of learning. Marton and Säljö showed that students would adopt one of two methods of processing information according to their intentions.

If their aim was merely to memorise and reproduce material, or, as Biggs puts it:

- To display the symptoms of having learned,

They would adopt a surface level of processing; if they wanted to maximise their understanding of the underlying meaning, they would adopt a deep strategy. Hence Marton and Säljö inferred a relationship between strategy and intention. What the student intends to gain from the learning determines the strategy used. In recent research, Marton, Watkins and Tang make the point that while a surface approach to learning is often associated with rote learning, this is not what characterises it.

- Rather, a surface approach is characterised by a focus on the learning material or task in itself and not, as would be the case for the deep approach, on the meaning or purpose underlying it.

Their ideas accord with Leont'ev's proposition that what distinguishes actions are the goals driving them.

INVESTIGATING INDIVIDUALS IN SOCIALLY SIGNIFICANT PRACTICES

My project is an example of what Chaiklin describes as “investigating individuals in socially significant practices”.

These are studies in a “yet-to-be-embodied” research tradition that:

- Try and develop an account of the actions of individuals participating in a societally significant practice while it is occurring, by an analysis that locates the practice in a social, societal and/or historical perspective.

Chaiklin proposes that many different theoretical perspectives and methods could contribute to such research. He summarises such projects as having five common characteristics, which I assert are fulfilled by my project.

- Firstly, these studies take concrete, meaningful, societal practices as the direct object of study. That is, the setting for the study is an actual example of human practice and would be so whether or not it was the object of study. In my research I have tried to get as close as possible to the participants and interpret situations which were as typical as possible for students learning Statistics.

- Secondly, the practice takes place in a recognisable societal institution, in this case an institution of higher learning.
- Thirdly, such studies have a definite theoretical interest. Insights into the practice of learning Statistics are important elements of my research but so are insights into and extensions of the activity theory framework in which I have interpreted this practice.
- Fourthly, there is the idea that knowledge and actions are social as well as individual. I draw on Vygotsky's and Leont'ev's idea of "co-knowing" to illustrate this notion—statistical knowledge is socially created and re-created through the consensus of practitioners. This collective development of knowledge is facilitated through tools, for example, by the easy and quick exchange of ideas through electronic media. In my university, Statistics is continually being transformed by each lecturer and committee involved in organising the curriculum and setting the examinations. Students come to know Statistics through interacting with peers and teachers, as well as through their own reflections and actions. Socially organised constraints and resources surround individual actions.
- *Finally, the particular practice selected for such studies has:*
 - Significant consequences for the people participating in these practices.

Learning Statistics can change the lives of those participating in this practice. In some cases, the outcomes could be instrumental in determining students' academic and career paths. For example, students' examination results in Statistics could determine whether they would attain a degree or be accepted into Psychology Honours. Learning Statistics can also powerfully affect students' personal development as was the case for some of the participants of Study One.

In this project I have tried to piece together practical and theoretical perspectives to contribute to the building of a research framework—to an understanding of the relations between theory and practice in education.

STATISTICS EDUCATION AT UNIVERSITY

"Statistics" said Jane, a mathematics student:

- Really fits my logic and it feels right. Maybe the men have finally invented a good mathematical study for a change.

The comment highlights the tension between knowledge as culturally endorsed and the individual's personal appraisal of it, a tension not always as agreeably resolved as in Jane's case. Statistical literacy and appreciation, particularly an understanding of data gathering, presentation and interpretation, are important components of undergraduate and graduate education in many fields. They are also essential for modern living in technologically developed countries.

Statistics is often a compulsory unit of university courses, such as Psychology, Economics, Business or a Health Science, because it is an important tool for analysing the "uncertainties and complexities of life and society". Despite this importance, many students in statistics courses are reluctant to study it.

Indeed, Cotts maintains that it is:

- Almost unarguable that the introductory statistics course is the most widely feared course on most university campuses.

This conviction is echoed in several studies.

RESEARCH IN STATISTICS EDUCATION

There has been considerable research into statistics education in the last thirty years. This interest in the teaching and learning of statistics is not only a part of the general growth spurt in mathematics education but is also a field of research in its own right. Four international conferences, the International Conferences on the Teaching of Statistics have been devoted to grappling with issues relating to statistics education.

Much topical literature concerns the teaching and learning of statistics at all levels of education. For example, in a special edition on teaching statistics of the Journal of Educational and Behavioural Statistics, Becker reviews 530 articles and dissertations which are documented on electronic databases such as the Educational Resources Information Centre. Almost all these articles (97%) were published after 1970 and about one third have appeared since 1990.

A bibliography on the available literature published between 1987 and 1994, concerning the teaching of probability and statistics, is provided by Sahai, Khurshid and Misra. This shows that the body of work being done in this area is extensive and growing.

Truran and Truran review Australasian research into the learning and teaching of stochastics, for the period 1992-1995, which reflects the current importance of probability, statistics and combinatorics to education in my region of the world. Electronically based journals such as the Journal of Statistics Education and Web discussion groups facilitate the extensive exchange of ideas and the development and distribution of research among participants in statistics education.

The quantity and scope of the published literature, as well as the ongoing discussion and research, is a strong indication of current interest in statistics education.

The literature and discourse concerns many topics. One important topic concerns teaching strategies. For example, Lan writes about self monitoring and Smith discusses the use of writing assignments in teaching statistics.

The role of computers, multimedia materials and other technological aids in teaching statistics is an area of increasing prominence. Individual differences, such as gender differences in learning statistics, have also been investigated. For instance, Clark proposes that female students prefer statistical questions which have a people-orientation. Preliminary results by Forbes however, suggest that, in statistical examinations in New Zealand, the form and type of examination questions, for example, whether questions involve essay writing or require using Calculus, are at least as important as their contextual embedding in determining gender preferences and performance.

As with any other field in education, what constitutes statistical knowledge and how to enhance the quality of students' learning of it, are key problems in statistics education. A major theme that recurs in the literature on higher education in statistics pertains to teaching and assessing statistics. There is general consensus in the community of statistics educators that reforms are urgently needed in the teaching of introductory statistics courses at university. Some university educators describe teaching activities and/or methods of assessment intended to address the problems - to make statistical concepts meaningful and useful - to relate statistics to the real world.

For example, Anderson and Loynes and Pfannkuch discuss what abilities and skills are needed by practising statisticians and how to teach these. Garfield Giraud and Keeler and Steinhorst describe new ways of teaching statistics using co-operative learning activities. Garfield and Hubbard present frameworks for developing assessment instruments and procedures which are appropriate for measuring students' understanding and applications of concepts in probability and statistics.

Many university educators report on the success of their statistics courses by describing enhanced performance and/or increased student satisfaction. However, as some researchers point out, little is known about how such courses would transfer to other settings. Becker concurs with this view. In her review of the literature and other resources on teaching statistics, she focuses mainly on statistics education at the university level. She reports that this literature is largely anecdotal, with less than 30 per cent of the reviewed articles describing the results of empirical studies. Hence, extensive information on instructional strategies and resources are available to tertiary educators in statistics, either in print or through electronic media. However, research empirically evaluating the teaching and learning of statistics is less copious. Further, and in stark contrast to the literature on mathematics education, there is a dearth of studies on the teaching and learning of statistics which are framed in terms of theories of education. The literature on teaching and learning statistics at the tertiary level tends to concentrate on the "knowledge craft" of the teachers.

A further and major area of research in statistics education concerns students' understanding of particular concepts in statistics and probability theory. This

research shows that many students have difficulties with and misconceptions about statistical ideas. Konold reviewed research showing that the intuitions of adults are at odds with accepted probability and statistical theory. Fischbein and Schnarch investigated the stability of students' misconceptions in probability across different age levels from grade 5 to college students. Surprisingly, they found three different outcomes: some misconceptions grew stronger with age, some grew weaker and one remained stable.

Vallecillos and Batanero presented a study on the persistence of conceptual errors in university students' understanding of levels of significance in tests of hypotheses. There are also parts on students' understanding and misunderstanding of concepts relating to probability and statistics in books on the teaching of statistics such as Green; Holmes; Hawkins, Jolliffe and Glickman. These attest to the importance of conceptual understanding as a goal of statistics instruction.

In summary, research on student learning in statistics shows that students have difficulties with statistical concepts and that they are often anxious about and have poor attitudes to learning statistics. The body of research on teaching and learning statistics is large, vibrant and growing. However, much of it still lacks the systematic methodology and theoretical foundations that are often of the most lasting value in any field of education. Further, a concern with describing teaching strategies or students' attitudes or their misconceptions, while indicating an awareness of the problems facing statistics education, does not offer a model for understanding the impasse—a first step towards alleviating it. My approach is to explore the issues underlying this impasse within a theoretical framework which relates students, their actions and the context.

3

Analysis of Students' Appraisals of Learning Statistics

This part outlines the method used to analyse the first open-ended survey question:

- Would you study statistics if it were not a requirement of your psychology course? Please give reasons for your answer.

As I specified the first part of the question was simply analysed in terms of whether the student answered “Yes” or “No”.

The reasons that students gave for their choice were categorised in the following way:

- I started with the categories that had been identified in my pilot study. However, I expected that differences would emerge in Study Two. The pilot study had been carried out three years earlier. A different lecturer taught Statistics then and the pilot study was conducted at the beginning of the academic year, so that students had less experience of Statistics than the participants in Study Two. Moreover my pilot study sampled not only Psychology II students but also students of General Statistical Methods. Nevertheless, many of the same categories were found to be useful for Study Two.
- Most students gave several reasons for their decisions. For example, some students who reported that mathematics was boring also believed that it was hard. I classified each portion of the student's response into one of the specified categories. If the student gave a reason which indicated a negative view, I assigned her a score of -1 for the appropriate category.

I assigned a score of 1 for favourable observations. If the student made no response in a particular category, a score of zero for that category was allocated. In this way students could have non zero scores in a number of categories.

- Each student scored either -1 , 0 or 1 for each of the categories. Hence the total number of favourable responses and unfavourable responses in any one category was equal to the number of students whose reported reasons were classified in that category.
- If the student's response did not fit into any of the categories identified so far, a new category was specified.
- When all 279 surveys had been classified, some of the original categories were found to be empty and dropped.

ANALYSIS OF STUDENTS' CONCEPTIONS OF STATISTICS

I based my analysis of students' conceptions of Statistics on the modifications of the phenomenographic method that were developed in earlier research by my colleagues and myself. As was the case in those investigations, the categories of description and their patterns of distribution are considered to be major results of Study Two. The phenomenographic analysis of the data on students' conceptions involved three stages. In the first stage the categories of conception were identified.

The second stage consisted of classifying the 279 surveys into these categories. In this process the categories were clarified and refined. In the third and later stage I checked each survey response to pick out any that I felt had been misclassified and submitted these to further examination and discussion.

Stage One: Identifying the Categories of Conception

The first stage in the analysis of the data was to identify a set of qualitatively different categories of description of students' conceptions of Statistics.

This involved the following procedure:

- An initial set of categories was identified by myself and another education researcher, Mr Peter Fletcher, experienced in phenomenographic research. This was achieved by our independently reading and classifying the entire set of 279 written responses to the open-ended question below:
 - What in your opinion is this statistics course about? Please explain as fully as possible.
- We two researchers then compared and discussed our initial categories and agreed on a draft set of categories and sub-categories.
- Together with a third researcher, we independently classified 30 selected responses in terms of this draft set of categories.

- The three of us compared and discussed the individual classifications for the 30 responses and agreed on a final set of clear statements for each category.

The categories were arrived at by negotiation and discussion. We looked at commonalities in the students' responses and differences between them.

Stage Two: Classifying the Surveys

All 279 responses were then classified into the identified categories by myself and my co-researcher, working independently. This classification was done in the following way.

- For each student the response to Question 3 was read in isolation to the rest of her survey.
 - What in your opinion is this statistics course about? Please explain as fully as possible.

An initial decision was made as to the category the response best fitted. I was mindful of the fact that, although I had phrased the question in order to elicit the student's own perception of the subject matter, some students were likely to interpret the question as asking about their perceptions of the teacher's view of Statistics, rather than their own awareness.

- Each of us re-appraised our initial decisions in the light of students' responses to the other open-ended questions, namely:
 - Question 1 Would you study statistics if it were not a requirement of your psychology course? Please give reasons for your answer.
 - Question 2 Think about the statistics you've done so far this year.
 - a. How do you go about learning it?
 - b. What are you trying to achieve?

In this way we amplified our understanding of each student's awareness and perceptions of Statistics and gained further insight into her way of experiencing the knowledge. We individually recorded a final category for each student's conception of Statistics by taking account of the student's overall responses to all three open-ended questions. The initial category that had been identified from Question 3 alone played no further part in the analysis, but was found to be very useful in the ensuing discussions between myself and fellow researchers in making explicit the reasons for the final categorisation.

- We then discussed all classifications and reached agreement on any that did not match. In this process of classification and discussion the categories themselves were further clarified.

That is, as Marton explains, the analysis:

- Is dialectical in the sense that meanings are developed in the process of bringing quotes together and comparing them.

Not only core meanings are important in specifying the categories, but, as Marton points out, “borderline cases” play an important part in delineating the categories. In accord with Marton’s phenomenographic method, the categories transcended the boundaries between students’ responses to different questions and also transcended the boundaries between individuals. That is, the students’ separate responses to different questions and their individual ways of expressing themselves were subsumed into general categories.

Stage Three: Triangulation and Checking

Triangulation on the analysis of students’ conceptions of Statistics was achieved by:

- Interpersonal agreement between at least two researchers;
- Interviewing selected subjects;
- Peer review. I presented my ongoing analysis at three research conferences, conducted approximately six months apart. In this way I obtained feedback on my ideas, methodology and findings as my study progressed.

After a period of some months I read through all the responses, one category group at a time. On the basis of the better understanding of the data now available to me, for example through interviews, I discovered a few responses that appeared to me to have been misinterpreted in earlier discussions. These were further discussed with my colleague and reclassified in some cases.

CONCEPTIONS OF STATISTICS

The focus of this part is the phenomenographic analysis of students’ responses to the three open-ended survey questions, in order to understand and categorise the students’ conceptions of Statistics. The three questions are reproduced below.

- *Question:* Would you study statistics if it were not a requirement of your psychology course? Please give reasons for your answer.
- *Question:* Think about the statistics you’ve done so far this year.
 - *How do you go about learning it?*
 - *What are you trying to achieve?*
- *Question:* What in your opinion is this statistics course about? Please explain as fully as possible.

Phenomenographic analysis is unlike content analysis. Both these analyses are interpretative and subject to the world view of the researcher. However, my analysis

of students' appraisals of learning Statistics, described in the previous part referred specifically to students' responses to the survey Question 1 and only to Question 1. The categories of conception were developed from the phenomenographic analysis and were inferred from what students wrote in response to all three open-ended questions. As advocated by Marton boundaries between students' responses to different questions were ignored. That is, although a student's response to Question 3 was important, it was her overall response to the three questions that enabled my colleague and myself to classify her conception of the subject, Statistics, into one of the categories we had formed.

Further, unlike the categories of students' reasons derived from the content analysis of the phenomenographic categories form a logical and empirical hierarchy based on inclusion. That is, except for the No Meaning category, which I will explain each conception category subsumes a conception or awareness of Statistics expressed in the previous categories.

OVERVIEW OF CATEGORIES OF CONCEPTION

Categories for students' conceptions emerged from the phenomenographic analysis. They are: No Meaning; Processes or Algorithms; Mastery of statistical concepts and methods; a Tool for getting results in real life and Critical Thinking. The following bar graph indicates the distribution of students' responses into the five categories. The percentages shown in Figure are out of 279, the number of students surveyed. Twenty nine students (10.4%) gave insufficient information for their responses to be classified into one of the Conception categories. These data will be treated as missing.

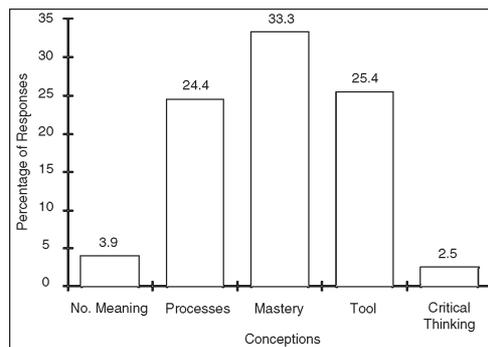


Fig. Distribution of Students' Reported Conceptions of Statistics.

DESCRIPTION OF CATEGORIES FOR STUDENTS' CONCEPTIONS OF STATISTICS

This part describes the qualitatively different categories for students' conceptions. A label for each of the categories is given below. Labels are followed by descriptions

of that category and a number of illustrative excerpts from students' written responses. I have indicated which parts of the quotes (if any) are excerpts from students' responses to Question 1 or Question 2 as part of my "audit trail".

No Meaning (N=11, 3.9%)

Students' responses indicating perceptions of Statistics as meaningless or unconnected to their goals in learning psychology, worthless, or set by the university as a means to confuse or "cull" less able students, were classified in this category.

Five of the responses classified in this category (with their code numbers) are reported below:

1. Trying to confuse me;
2. You tell me I just learn;
3. About 28 weeks;
4. I don't know. It is boring and pointless for my future;
5. It is about the Uni having something they can use as a means to assess our performance. I assume that Psychologists use computer programmes to do everything we have learned in a matter of seconds.

Hence this category of responses indicates a perception of Statistics as being without value or relevance.

Processes or Algorithms (N=68, 24.4%)

Responses were classified in this category if:

- The student's responses to the question consisted of a list of one or more statistical procedures;
- The student described Statistics in terms of processes or algorithms—mechanical ways of dealing with data.

Examples of responses listing procedures are:

- 151: Tabulating data;
- 272: Testing hypothesis;
- 259: Trying to find correlations to accept/reject null.

Examples of responses indicating a perception of the course as being about mechanical processes or coding are reproduced below. These indicate that a problem is entered and an answer or conclusion is produced via an algorithm.

- 128: Learning to manipulate and tabulate data;
- 115: The Lecturer's Black Box example (or analogy) of stats. "You don't have to understand how it works, just be able to get the right answer";
- 24: Operational level of understanding ie have number X ! get result Y;

- 267: Statistical results from experiments It's not necessary, considering computers do all the work;
- 226: Number crunching;
- 292: Interpretation of data using a set of formulae and rules w/o the use of a fully comprehensive why element.

In summary, this category, which I will refer to as the Processes category, is characterised by conceptions of Statistics as consisting of disconnected and mechanical techniques for solving classroom problems.

Mastery of Statistical Concepts and Methods (N=93, 33.3%)

This category includes the understandings described in the previous category—algorithms and technical processes, but, in addition, the responses indicate an awareness of conceptual material and interpretation. Responses were classified in this category if students reported their conceptions of Statistics in terms of competence in technical skills, knowledge of facts and understanding of underlying statistical concepts—as presented in class. Typical responses included some or all of the following: analysing or interpreting given data; coming to conclusions on the basis of decontextualised information; solving practice exercises. In short, reading and/or understanding statistical information as prescribed for assessment and in isolation from the rest of the study of Psychology. Excerpts follow.

- 129: Basic stats to give an overview of stats in psych. Adequate knowledge to do well in psychology;
- 290: The course is about teaching us how to understand and use the data we receive from experiments. I am trying to achieve a basic understanding of the material and concepts and an ability to work out the problems. This will hopefully lead to a good result at the end of the year;
- 248: To give us a broad feel of what statistics is about. To do the very best I can;
- 34: Teaching us general concepts about stats in the vain hope that as suggested, find it remotely interesting; a precursor for those intending to do Honours courses in psych. A mastery of the course; I realise that this will not be all that difficult to achieve so I feel that putting all my effort into stats would be disproportionate to the marks that I will achieve not to mention being completely unnecessary.

Students whose responses were classified in this, the modal category, expressed perceptions of Statistics as being about interpreting and understanding the set problems. As reported by these students, Statistics was viewed in terms of information to be accumulated and stored in order to meet the assessment demands in the subject.

The Mastery category differs qualitatively from the Processes category in that the former denotes a more conceptual and cohesive view of Statistics than the latter. However, both these categories express a view of knowledge as performance in the academic context. The next two categories identify a shift in the students' thinking—students' conceptions move from an exclusively institutional context into the wider world and society.

A Tool for Getting Results in Real Life (N=71, 25.4%)

Responses in this category refer to the use of Statistics in conducting research or to its use in society. While some of these responses specifically alluded to notions expressed in the previous categories—for example, algorithms and competence in analytical methods, a student's reported conception was only categorised as a Tool if it also included the idea of Statistics as an applied subject which could be used. It is noteworthy that not all students who thought statistical knowledge was applicable stated an intention to actually use that knowledge. Indeed only a minority (17 students, 6 per cent of the 279) of the 71 students whose conceptions were classified in the TOOL category indicated conceptions of the subject as being personally beneficial.

Examples of responses indicating conceptions of Statistics as a TOOL are listed in two groups: those who expressed the idea that the Statistics could be (but not necessarily would be) applied and those whose conceptions included the idea of personal purpose.

The following excerpts are examples of responses indicating that the subject could be used.

- 147: It is an attempt to give psychology students insight into stats and experimental method, to enable them to do psychological research if they choose to follow psychology as a career;
- 180: Teaching us the basics, as if continue with Psych, it is quite relevant and important in any research to understand it, so to apply it. I personally - no use for it, though it is useful;
- 70: It is about exposing and preparing Psychology students for research in psychology;
- 146: It is a useful course for people who intend to do experimental studies in Psychology, since it's the only way of collecting and analysing data in a systematic way. I don't see it as necessary in my future career.

The following are examples of a more personal, purposeful, view of Statistics as a tool.

- 169: Using statistics to apply it to experiments as suggested, use later on in careers in psychology. A practical course;

- 44: A basic framework of statistics that allows for easy reference in many other aspects of psychology. Without this course, the rest of the psychology course would have little value. Knowledge;
- 208: Giving us a grasp of stats so that when we are practising psych we can interpret our results.

Logically, a student who conceived of Statistics as a tool, would also be aware of the subject matter as pertaining to underlying concepts and methods which must be understood. Empirically, many students expressed both these notions. However, the awareness expressed in this category extends beyond the idea of knowledge as performance in assessment, signified in the previous two categories. The TOOL category designates a conception of Statistics as knowledge that could be applied to get results in real life.

A Way of Critical Thinking (N=7, 2.5%).

Responses were classified in the final category if they referred to Statistics as being about a (mathematical, scientific) way of critically evaluating findings, or organising, communicating and interpreting findings.

Only seven responses were classified in this category. These responses attest to an added awareness of Statistics, compared to that expressed in the previous category. The conceptions of the subject not only related to its use for getting results in the real world but also its providing a perspective on those results.

- 104: Stats is about methodology which is used as a comprehensive form of analysis to interpret and test theories and correlations psychologists create. Substantiated method. Statistics is structured mathematics and should be considered as a friend to psychology;
- 293: Understanding how numbers can provide evidence for or against some hypothesis you are testing. As a way of ensuring the validity and reliability of your own research methods. To *understand how numbers can be used to falsify data/conclusions*.

In this category Statistics is evidently viewed as a way of gaining insight into statistical thinking; an awareness of both the complexity and limitations of statistics as it is used in psychology or the broader world—a way of communicating. In summary this category expresses conceptions of Statistics as a basis for the scientific method.

DISTRIBUTION OF CONCEPTION CATEGORIES ACCORDING TO WILLINGNESS TO STUDY STATISTICS AND GENDER

Table shows the percentage of students in each category of conception, divided into students who reported their willingness to study Statistics (“YES” students) and those studying it only because it was compulsory to do so (“NO” students).

The final column summarises the overall frequency distribution for the participants in the five categories as shown previously in Figure. The modes for each row are in bold font, to highlight the structural shifts. The percentages shown are column percentages, that is out of 204, 71 and 279, respectively. They are rounded to whole numbers except where the percentage is less than 1 per cent.

Table. Number of “Yes” and “No” Students in Each Conception Category

Category (N=204)	“NO” Students (N= 71)	“YES” Students (*N=279)	Total
No Meaning	11 (5%)	0	11 (4%)
Processes	61 (30%)	7 (10%)	68 (24%)
Mastery	75 (37%)	17 (24%)	93 (33%)
Tool	36 (18%)	35 (49%)	71 (25%)
Critical Thinking	1	6 (8%)	7 (3%)
Unclassified conceptions	20 (10%)	6 (8%)	29 (10%)

Note: *Four students could not be classified as “YES” or “NO”.

Big differences in the categorised conceptions between the students willingly studying Statistics and those who were not. Over 70 per cent of the “NO” students were classified in the first three categories, compared to 34 per cent of the “YES” students. In particular, the modal category for the “NO” students was Mastery while for the “YES” students it was TOOL.

The differences in the frequencies for the “NO” and “YES” students were statistically significant in two categories: Processes and Tool. As can be seen, a substantially higher number of the “NO” students reported conceptions of Statistics in terms of mechanical processes or algorithms than the “YES” students. On the other hand, far more of the students who would evidently have chosen to study Statistics, as opposed to those who would not, reported their awareness of its applicability (Tool category). Further, only 2 of the “NO” students in the Tool category (1 per cent of the “NO” students) expressed conceptions of Statistics as a personally useful tool compared to 15 (21%) of the “YES” students. Statistical tests are inappropriate for the No Meaning and Critical Thinking categories as some cell frequencies are zero or one, but clearly the differences are substantial and are in the expected directions. These findings indicate strong links between willingness to study Statistics and conceptions of it.

Figure and Table show the gender differences in students’ conceptions of Statistics. The heights of the bars in the graph indicate the percentages of male and of female students (N=203) whose responses were classified into each of the five Conception categories. Gender information is missing for one student. Conceptions could not be classified in the cases of 12 males (16%) and 17 females. It would

appear that a number of students, particularly males, were unable or unwilling to articulate their thoughts in answer to the survey Question 3. This was an unfamiliar question and one to which students were asked to supply their own answer, rather than choosing from given alternatives.

The gender patterns are very interesting. In particular there appears to be a big difference between the proportions of males and females whose responses were classified in the Tool category. This difference between the observed and the expected frequencies for males and females in the Tool category was statistically significant. From this analysis it appears that far more females than males related Statistics to the world around them. However, in the small group of 7 students whose reported conceptions were classified in the Critical Thinking category, 4 were males (5.3% of the males) and 3 were females (only 1.5% of the females). While the Critical Thinking group is small (and statistical tests inappropriate) this does represent an important gender shift.

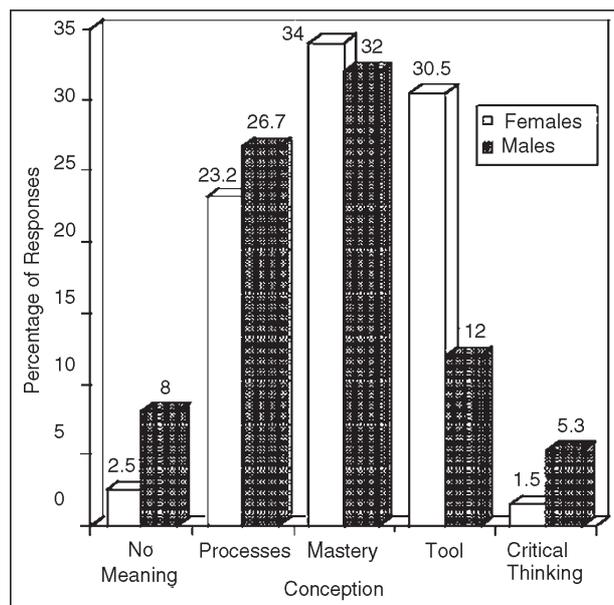


Fig. Distribution of Students' Reported Conceptions of Statistics According to Gender

The apparent anomaly between the proportions of females and males whose conceptions were classified in the Tool category compared to those in the Critical Thinking category led me to reassess the gender patterns in terms of the different conceptions recorded at the Tool level. A student's conception was classified in the Tool category if the response took one of two forms: either indicating that Statistics could be applied to get results in real life or suggesting that Statistics was seen as personally relevant—a tool that was currently useful or potentially beneficial for

that student. Table summarises the distribution of students' reported conceptions of Statistics according to gender, including the sub-division of the

Tool category: This table shows that of the 62 females whose conceptions were classified at the Tool level, only 12 expressed some personal commitment to using Statistics. The males, however, were divided almost equally into the two sub-categories of the Tool classification. Five of the 9 males in the Tool category (that is, 6.7% of the males) expressed the idea that Statistics was personally relevant. All 7 students classified at the Critical Thinking level reported conceptions of Statistics as relevant to their concerns or future lives. In summary, 24.6 per cent of the females (50 females) and 5.3 per cent of the males (4 males) reported on Statistics as a general tool (but not a personal tool) that could be applied to get results in real life. However, only 7.4 per cent (15) of the females compared to 12 per cent (9) of the males reported Statistics as personally relevant—either as a Tool or a way of Critically Thinking which they actually intended to use or were already using. Hence, while more females than males indicated an awareness of the utility of Statistics as a tool in the real world, these findings suggest that in most of the females' minds this tool was destined to remain in the “tool kit”.

Table. Number and Percentage of Male and Female Students in Each Conception Category

Category	Female Students (N=203)	Male Students
No Meaning	5	6
Processes	47 (23.2%)	20 (26.7%)
Mastery	69 (34.0%)	24 (32.0%)
Tool (General)	50 (24.6%)	4
Tool (Personal)	12	5
Critical Thinking	3	4
Unclassified conceptions	17	12 (16%)

- One student did not provide gender information.
- Modes for each category are shown in bold font.

Additional information about males' and females' conceptions of Statistics as a “real life” tool was provided by their responses to item 4 of the Approaches to Learning Statistics Questionnaire. This item is reproduced below. There was no statistically significant difference between the mean item score for females and that for males (2.6) on this item. Females, it seems, did not relate Statistics to the world around them more than males did.

My interpretation of the apparently paradoxical results concerning females' awareness of Statistics as a tool is that females, more than males, internalised their teachers' reasons for including Statistics in the curriculum of Psychology II. That is, females were more likely than males to express conceptions of Statistics

according with the institutionally endorsed meaning of Statistics—as important and integral to psychology—rather than reporting conceptions based on their own concerns alone.

APPROACHES TO LEARNING STATISTICS

In this aspect of Study Two I am concerned both with the constitution of the Approaches to Learning Statistics Questionnaire for gauging deep and surface approaches to learning Statistics and the characterisation of students' learning by means of scores on its Deep and Surface Scales.

THE APPROACHES TO LEARNING STATISTICS QUESTIONNAIRE

The ALSQ consists of 18 of the 28 items completed by students in the survey. Initially the 28 items were based on the Study Process Questionnaire and the Approaches To Learning Mathematics Questionnaire. Consistent with these questionnaires, even numbered items are considered to indicate deep approaches to learning Statistics, while odd numbered items are considered to indicate surface approaches to learning Statistics. The following data analyses was done using the software package SPSS.

Scale Reliabilities

Initial analysis was carried out on all 28 items completed by the students. I used the Cronbach alpha coefficient, a common indicator of the internal consistency, on the two scales consisting of odd and even numbered items respectively. The alpha coefficient indicates the extent to which the items in the scale “agree” with each other. That is, it is a way of assessing the scale's reliability, indicating the extent to which the items are consistent.

The inter-item correlation on the deep approach items indicated that internal consistency would be increased by omitting items 6 and 12. A number of students wrote on the survey that they did not understand item 12, so perhaps this is the reason for its poor correlation with other deep approach items. Item 6 consists of two ideas and I believe that some students agreed with one or other portion of the item, rather than with the item as a whole.

I defined the Deep Scale for the ALSQ as the scale consisting of the following 12 items: 2, 4, 8, 10, 14, 16, 18, 20, 22, 24, 26, 28. This scale yielded $\alpha=0.86$, indicating a high level of internal consistency. This coefficient compares favourably with internal consistency results obtained by Biggs with samples of university students on the Deep Approaches Scale of the Study Process Questionnaire, which ranged from 0.65 to 0.81. It is also similar to the two values of Cronbach's alpha obtained on two successive occasions, about six months apart, on the Deep

Approaches Scale of the Approaches to Learning Mathematics Questionnaire. Scales indicating surface approaches to learning have consistently resulted in lower reliability than those denoting deep approaches in previous research. My reliability analyses indicated that the maximum internal consistency on a scale indicating surface approaches to learning Statistics would be achieved by using a Surface Scale consisting of the following six items: 5, 7, 13, 21, 23, 27. For this scale, $\alpha=0.70$. This value is in the middle of the range of Cronbach alpha coefficients cited by Biggs on the Study Process Questionnaire, but lower than the alpha coefficients (0.78, 0.77) obtained on our two trials of the Approaches to Learning Mathematics Questionnaire. By restricting the number of Surface Scale items to six, I narrowed the construct of a surface approach. Students who gained high scores on the six items were evidently concerned with uncritically memorising details, as presented by their teachers, in order to satisfy the demands of assessments.

From this point on, I will refer to this construct as a surface approach to learning Statistics as it is similar, though not identical, to the construct developed by Biggs and is consistent with the interpretation of a surface approach to learning given by Marton, Watkins and Tang. My Approaches to Learning Statistics Questionnaire is the questionnaire consisting of two scales - the Deep Scale, consisting of the twelve items and the Surface Scale consisting of six items, as described.

Item Factor Analyses

Justification for the items of the ALSQ to be divided into two scales, each denoting a different approach to learning Statistics, was provided by factor analysis. A principal components factor analysis was carried out to explore the structure of the relationships among the eighteen items which make up the Deep and Surface Scales. This was followed by a varimax rotation. Four factors were identified with eigenvalues greater than 1. These eigenvalues are 5.34, 1.39, 1.43 and 1.26.

The aim of factor analysis is to account for as much of the variance as possible with a solution which is both interpretable and economical. The four factors which I extracted accounted for 57.3 per cent of the variance. Factor 1 links items from the Deep Scale which mainly indicate that students find learning Statistics interesting. Factor 2 links items from the Deep Scale which suggest that students seek personal meaning from their learning, while items that load highly on Factor 3, again from the Deep Scale only, indicate that students adopt a cohesive approach to learning Statistics, relating it to other material. I have interpreted these factors as Find Interesting, Seek Personal Meaning, and Relate to other Material. As the fourth factor links items from the Surface Scale only, I have interpreted it as Adopt surface Approach. Some overlap was found among the first three factors, all of which show high positive loadings of items from the Deep Scale, but there was no overlap with items from the Surface Scale.

Table summarises the rotated factor matrix. The items have been ordered so that the six items which make up the Surface Scale are shown first, followed by the twelve items which make up the Deep Scale.

Loadings smaller than 0.44 and negative loadings are omitted in the table in order to clarify the structure. Decimals are correct to two places and decimal points have been omitted.

Table. Rotated Factor Matrix on Items of the Also

Item	Factor 1: Find Interesting	Factor 2: Seek Personal Meaning	Factor 3: Relate to Other Material	Factor 4: Adopt Surface Approach
5				
7				
13				59
21				44
23				57
27				79
2		75		
4			80	
8		44	46	
10		71		
14	77			
16			64	
18	47	62		
20	79			
22	85			
24		48		
26	56			
28			74	

Since there was no overlap among the items loading positively and highly on Factor 4 (the Surface Scale items) and the items loading positively on the other three factors (the Deep Scale items) a two factor solution seemed reasonable. The two factor solution after varimax rotation is shown. The two factors account for 42.5 per cent of the variance and have eigenvalues of 5.33 and 2.32.

Decimals are correct to two places with decimal points omitted. Negative loadings and loadings smaller than 0.2 are omitted in the table. The factor analysis shown in Table with two factors extracted, supports the structure of the ALSQ I proposed above. That is, the six items I classified as representing surface approaches

loaded positively and highly on one factor, and the twelve items classified as representing deep approaches to learning Statistics loaded positively and highly on another, separate, factor.

Table. Principle Component Factor Analysis With two Factors, Using Varimax Rotation

Item	Factor 1: Deep Approach	Factor 2: Surface Approach
5		70
7		55
13		68
21		54
23		48
27		66
2	61	
4	48	
8	45	
10	61	
14	76	
16	64	
18	76	
20	74	
22	65	
24	67	
26	68	
28	46	

STATISTICS FOR DEEP AND SURFACE SCALES

Each item on the ALSQ has a possible score of between 1 and 5 with high scores indicating that the student usually adopted the approach to learning Statistics suggested by that item. On average, students had considerably lower scores on the Deep Scale than on the Surface Scale. Table shows that the average item score for the Deep Scale was a low 2.19, compared to an average Surface Scale item score of 3.43. This substantial difference between the item means for the Deep Scale and Surface Scale is statistically significant.

Moreover, for the vast majority of the surveyed students (214 students, 77%) the average item score on the Surface Scale exceeded the average item score on the Deep Scale. This indicates that over three quarters of the students adopted surface approaches to learning Statistics more frequently than deep approaches.

Table. Descriptive Statistics on Deep and Surface Scales

	Mean	Median	Standard Deviation	Cases
Deep Scale	2.19	2.08	0.68	267
Surface Scale	3.43	3.5	0.81	270

Females had statistically significant, higher scores, on average, than males on the Surface Scale of the ALSQ ($t=2.98$, $p<0.01$). The item mean for females on this scale was 3.53 (standard deviation 0.76, $N=196$) while males attained an average of 3.18 (standard deviation 0.90, $N=73$).

On further analysis I found that while the mean item scores were higher for females than for males on all six items of the Surface Scale, these gender differences were greatest (at least 0.5) and statistically significant ($p<0.01$) on items 5, 13 and 27. This suggests more concern about assessment and a greater reliance on the authoritative view of Statistics by females than males. Average scores on the Deep Scale do not differ significantly for males and females. However, on two items of the Deep Scale: item 20 and item 22, differences are statistically significant ($p<0.05$). On these two items males scored on average somewhat higher than females (0.3 or less) although the means for both sexes were low on these two items - at most 1.8. Both of these items are concerned with the level of interest in Statistics. In general, the lowest average item scores were on the five items loading positively and substantially on Factor 1 of the Deep Scale - Find Interesting. The mean item score on these five items was only 1.67 (with standard deviation 0.69, $N=269$). A few students even indicated on their survey papers that had a rating lower than 1 ("only rarely") been available for these items they would have chosen it. The most frequent reason cited by students, in response to the first open-ended survey question, was they found Statistics uninteresting. Mean item scores on the other two subscales of the Deep Scale were also low: 2.44 and 2.67 respectively. On average, the students expressing reluctance to learn Statistics ("NO" students) scored substantially lower on the Deep Scale and substantially higher on the Surface scale of the ALSQ than those reporting that they would have chosen to study Statistics ("YES" students). Table shows the different means and other descriptive statistics for "YES" and "NO" students. The differences between the means on the Deep and Surface Scales are statistically significant.

Deep Scale

Table. Descriptive Statistics for "Yes" and "No" Students on and Surface Scales

	Mean	Standard Deviation	Cases
"Yes" Students	2.56	0.64	69
"No" Students	2.06	0.64	194

SURFACE SCALE

	Mean	Standard Deviation	Cases
“Yes” Students	2.89	0.68	71
“No” Students	3.64	0.77	195

Given that most of the participants of Study Two viewed the task of learning Statistics as imposed—a demand to be met which lacked personal relevance—it is to be expected that they would tend to adopt surface approaches to learning it. Most did not want to learn Statistics. It is therefore unlikely that they would strive to make the learning personally meaningful, interesting, or cohesive—the hallmarks of the deep approach. The statistics for the Deep and Surface Scales are in the predicted direction. This supports the validity of the Deep and Surface Scales in the sense of substantiating the sense and recognisability of these results. What each scale purports to denote is credible. The structure of the ALSQ fits with a qualitative analysis of students’ approaches to learning Statistics.

PERFORMANCE IN ASSESSMENTS

The final mark for Statistics is the average of the following four components: the class mark, based on “open-book” tests or quizzes, and the examination mark for semester one and, similarly, the class mark and examination mark for semester two. These tests and examinations are not available for reproduction in my appendices as they are kept confidential from students and teachers and similar versions are re-used from year to year. For this reason I was also not able to inspect the tests or examinations.

From my discussion with the lecturer of Statistics it appears that the assessments involve problem solving which aim to test students’ conceptual understanding of the content. The student shows her full working in the “open-book” class tests. The two multiple choice examinations include problems involving calculations and questions for which no calculations are required. About half the questions (less in the first semester) are embedded in contexts related to psychology, such as problems concerning memory or reaction times; the others test skills and techniques. The (raw) means on the four assessment tasks for the whole Psychology II class were: 58 per cent; 50.6 per cent; 62.7 per cent and 53.1 per cent respectively, yielding an overall average of 56.1 per cent (with standard deviations 24%, 20.4%, 21.6% and 22.5% and overall standard deviation 22%). The final examination in semester two was completed by 340 Psychology II students. The minimum pass mark for Statistics is 40 per cent.

The following table, summarises the means and standard deviations of the surveyed students on the four assessment tasks and on the final mark in Statistics (calculated by averaging the marks on the four components for each student). All marks are unscaled (raw) and are expressed as percentages correct to one decimal place. These averages are higher for the participants of Study Two than for the Psychology II class as a whole. Although a matter of conjecture, it is possible that the students who did not attend the Statistics lecture during the week the survey was completed, were, in general, less engaged with the learning task than the participants of Study Two, who were at least present. Table also shows that the participants of Study Two performed, on average, considerably better on the “open-book” class tests than on the multiple choice examinations in both semesters.

Table. Descriptive Statistics for Surveyed Students’ Performances on Assessment Tasks

Variable	Mean (%)	Standard Deviation (%)	Cases (N)
Class Tests, Semester 1	60.3	23.5	250
Examination, Semester 1	53.0	20.1	246
Class Tests, Semester 2	63.9	21.5	238
Examination, Semester 2	54.7	22.5	234
Final Statistics Mark	58.3	18.5	222

On the whole students performed consistently on the four components of the assessment. High positive correlations were found between students’ marks on the class tests and examinations for both semesters. The Pearson’s correlation matrix is shown in Table. All correlations are statistically significant.

Table. Pearson’s Correlation Coefficients for Assessment Tasks in Statistics

	Class Tests, Semester 1	Class Tests, Semester 2	Examination, Semester 1	Examination, Semester 2
Class Tests, 1	1.00			
Class Tests, 2	0.67	1.00		
Examination, 1	0.64	0.58	1.00	
Examination, 2	0.62	0.64	0.61	1.00

The following finding explodes the myth that ability in the general area of Psychology and prowess in Statistics are mutually exclusive. There was a strong correlation of 0.62 ($p < 0.01$) between students’ final mark in Statistics and their overall marks on the other areas of Psychology II (excluding Statistics). Interestingly, there was a substantial and statistically significant, positive correlation between students’ expected grades in Statistics (Fail, Pass, Credit, Distinction or High Distinction) reported and their final marks in the subject. Students’ expected grades

in Psychology II also correlated positively and statistically significantly with their actual performances, although less strongly.

Males outperformed females in Statistics achieving a final mean score of 64 per cent (standard deviation 18%, N=55) compared with the females' mean of 57 per cent (standard deviation 18%, N=166). This difference was due mainly to the superior performance of the males in the multiple choice examination in semester one (statistically significant, $t=3.2$, $p<0.01$). While the males obtained a mean score of 60 per cent on this assessment task, the females' average was only 51 per cent. No statistically significant differences were found between the sexes in the other three assessment tasks in Statistics nor in the students' results in the non-statistical components of Psychology II. Finally, students who expressed their willingness to study Statistics ("YES" students) performed far better, on average than the "NO" students in Statistics on all four assessment tasks. Table summarises these differences.

Table. Performance of "Yes" and "No" Students on Assessment Tasks

	Means for "YES" Students		Means for "NO" Students	
Class Tests, 1	70%	(19%, 65)	57%	(24%, 181)
Class Tests, 2	73%	(15%, 65)	61%	(23%, 170)
Examination, 1	59%	(17%, 65)	51%	(20%, 178)
Examination, 2	63%	(21%, 63)	52%	(22%, 168)

Standard deviations and number of cases shown in parentheses. Percentages rounded to whole numbers. Differences between means statistically significant, $t>2.9$, $p<0.01$. The mean final mark in Statistics for the "YES" students was 66 per cent (standard deviation 14%, N=60). This was considerably higher than the mean of 55 per cent attained by the "NO" students (standard deviation 19%, N=159). The difference between the means was statistically significant ($t=4.1$, $p<0.01$).

However, no statistically significant difference was found between the means of these two groups on final performance in Psychology II excluding Statistics (mean for "YES" students: 67%, mean for "NO" students: 66%). This suggests that motivation to learn Statistics, rather than general ability or effort, was the factor most implicated in the different average performances on Statistics for these two groups of students. In summary, students' increased motivation to study Statistics was reflected in considerably better performances on all assessment tasks.

ILLUSTRATIVE EXTRACTS FROM INTERVIEWS WITH TWO STUDENTS

I have tried to capture some general patterns in students' conceptions of Statistics and approaches to learning it from the survey responses of the participants of Study

Two. However, such responses were limited by students' willingness and ability to express themselves in writing and were, by necessity, brief. Hence, the richness and diversity of individual experiences were lost. The following extracts from interviews with two students capture some of the individual complexity lost in the previous analysis. I firstly report on each student's survey responses and secondly on the interview data.

Table summarises the survey data and marks in Statistics of the two students. Neither student would have chosen to study Statistics, had it not been compulsory. Initially, both students' conceptions were classified as Mastery. However, in Colin's case this categorisation was tentative, as his written responses were very brief and somewhat cryptic. After analysing his interview data this classification was changed to Critical Thinking. As indicated by their scores on the ALSQ, Ruth and Colin adopted very different approaches to learning Statistics. Neither student did well on the Statistics assessments.

Table. Summary of Data for Ruth and Colin

	Ruth	Colin
Choice	No	No
Concept	Mastery	Critical Thinking
Deep Scale (Mean Item Score)	1.7 (Z=-0.8)	2.8 (Z=0.8)
Surface Scale (Mean Item Score)	4.7 (Z=1.5)	2.8 (Z=-0.7)
Age	19 years	45 years
Mark in Statistics	50%	*40%

Note: *Colin's final Statistics mark and his marks on the class tests are missing from my data. However, he scored 40% on each the two multiple-choice examinations.

RUTH

In her survey Ruth wrote the following responses to the three open-ended questions.

- No, I am no good at maths
- Trying to memorise formulas and trying to understand/apply concepts and formulas
- Pass the course
- Teaching us how we find data in psych and extending our ability to solve problems.

Hence, although Ruth expressed some preoccupation with applying formulae, her responses also suggested an awareness of Statistics being about conceptual understanding and examining data. I interviewed her in order to try and clarify this awareness.

Interview with Ruth

Ruth's plans were to be a "counselling psychologist". When I asked how Statistics fitted into her plans, her response indicated that, on the whole, she thought studying Statistics was pointless and irrelevant to her future.

She said:

- A little bit in, perhaps, research. And maybe, possibly, a little bit with working with certain individuals—working out where they fit in the scale of the population. But a lot of it doesn't seem to fit for me. It seems—extra—only necessary if you want to be really heavily into doing things, research and that. For example, when we do a distribution and we have to find the variance and we have to find the number of people in it, and all that sort of thing. It seems so pointless, because if I do a test—if I do an experiment, I'm going to know that. And this manipulation seems to be a little bit pointless. We're never going to have to use it again.

I asked Ruth how she was going about learning Statistics?

Her answer indicated a high reliance on rote learning:

- I try and understand. But if I can't, I go back to rote learning. I'm trying to understand more, but basically I always fall back to rote learning. I just write it out one hundred times or so until I know the formula backwards. Sometimes I might practice using it, but very seldom. It's usually only trying to get it to stick in my head that I can know it.

Ruth's aim was to pass the examinations. However, she indicated that she also hoped also to gain some knowledge and perspectives which would go beyond the immediate examinations.

- I was hoping that in the exams that would be what we'd be asked. That sort of thing. That at least I'd have remembered something, that it would stay there. But other than that, it's not doing anything.
- I'd like to understand it for next year. I don't want to have wasted time. To have nothing to show for it. And have no added knowledge or no added systems of doing things. It would be nice to have learned some logical ways—some logical methods. But it would be nice to pass the exams. Just that.

Ruth had bad memories about learning mathematics at school.

- I didn't hate it, but I couldn't understand it and it frightened me, generally. Got the frozen fear reaction and couldn't understand it at all. And then the teacher I had from year ten to year twelve. He was a male teacher. He would say it once. And he would get very impatient. And in the end I just stopped asking because it was hard and it was embarrassing to ask

all the time. He was very good at maths but he was a perfectionist. And he expected us to do that too. And I'd fail exams and I wouldn't want to go and ask.

I asked what in particular had given her trouble in mathematics.

She replied:

- Concepts, mainly concepts. But also some of the symbols and the formulas. I would not know how to use them at all in a test situation. And it left a very bad impression. This particular formula was really bad because every time I looked at it I failed.

However, she did not feel the same way about Statistics.

- I relate to it a bit differently. The environment's a bit different which is better. Most of the tutors I feel comfortable with. And the way they explain things is more basic—not expecting that you know—which is a lot easier. And the Statistics, too isn't on the same level. It's not as frightening as year twelve maths. It doesn't have a lot of the concepts that used to really frighten me. The things that gave me the frozen fear reactions.
- It's more trying to understand. It's more trying to give an understanding rather than just answers. It's not just the answer on the page. It's understanding how you get to it... You can write down and explain that you've understood it. Instead of using things like $P(\text{OBS} | H_0)$ —that sort of thing. You can say that you understand rather than just having to use formulas.

Hence, as in her survey, Ruth indicated an awareness that in addition to involving procedural knowledge, understanding Statistics also involved interpreting and communicating ideas. I tried to probe what Ruth meant by “understand”. Ruth explained that by understanding she meant feeling confident and being able to communicate her understanding.

She knew that she had understood it:

- Generally when I can explain it to someone else. And also when I can sit down in a situation, away from all my notes and stuff and feel reasonably confident. I don't get frightened, I don't get thrown off. And I get the right answer. It may take me time but I don't get lost. I don't get lost! I tend to do that in tests—just mill around.

Ruth felt constrained by her fear of tests and examinations and the lack of time to get on top of the work.

- Generally, especially in the last exam I had, I'll see the question on the page and—there's just a feeling that there's something missing. For example, I'll know how to do a certain thing using Z scores. But there's no Z score there. And it frightens the life out of me. I spend most of the time trying to figure that out and then realise that I didn't need it anyway.

So I wasted my time and I just wandered around doing something that wasn't really beneficial to finding the answer. That generally is what happens.

- Generally, I just try to get the formulas straight in my head. I practised using formulas this time. Sometimes, if it's a really simple test, I will practise a lot. Examples and using formulas, trying to find things in the formula. But when it gets more difficult, I usually revert back to just trying to learn the formula without understanding.
- It's difficult. Because for all the subjects we have reading to do. And also the Statistics course itself. When we have a test we also have a tutorial scheduled, so we'll get a sheet and we'll just have to go over it in our spare time. Sometimes I don't have time for that. So it means that I'm not getting as much practice or even as much explanation because of the amount that's jammed in. And also all my other work.

I asked what she would do differently if she had more time. She said this:

- I think I'd start reading the text the night before the lecture. Getting a grip on that. And possibly doing more of the examples from the text book. More of the practice questions from the tuts (tutorials) too. If I had more time. I may even go back and listen to my lecture tapes over and over.
- Just to reinforce it. To get it into my head more than once. To get the reinforcement. And also, I'd be able to pick up if I didn't understand something. Sometimes in a lecture she'll say something that will confuse me. But by the time I go back to it the confusion's gone and I've forgotten what the question was. And if perhaps I'd read it the night before (rather) than after the lectures, it would be easier to deal with that problem straight away. Instead of it coming up in an exam situation where I really didn't understand.

It seemed that Ruth hoped to gain a mastery of the concepts and ideas from the Statistics course.

- Hopefully an understanding of Statistics. And also the ability to—a system where I can work things out for myself. Where I don't always have to go back to a formula or a book. I should be able to work things out without necessarily having to stop every three seconds to figure out where I'm at.

The interview with Ruth substantiated much of what she had written in her survey concerning her appraisal of learning Statistics, her conception of it and her approach to learning it. Ruth, clearly, would have preferred not to study Statistics given a choice. Her conception of Statistics appeared to fit best in the Mastery category, although it was a borderline case. Had I been ranking students' responses within this category, hers would be at the "lower" end. Ruth's description of her

aims and strategies strongly indicated that she usually adopted a surface approach to learning Statistics. There was also little indication of the engagement, interest or cohesive approach associated with deep approaches to learning. The interview data were consistent with her high score on the Surface Scale of the ALSQ and her low score on the Deep Scale.

FINDINGS OF STUDY ONE

BACKGROUND AND ATTAINMENTS OF THE PARTICIPANTS

The five students came voluntarily to the Mathematics Learning Centre hoping to overcome what they saw as difficulties or disadvantages that would affect their learning of Statistics. Alice wrote on her enrolment form that she had no mathematical skills or background, while Norman expressed the view that he was out of practice; it had been seventeen years since he last did any mathematics. Sandra indicated on her form that she required further explanation and repetition of tutorial material to aid her in understanding and clarifying the concepts. She also hoped to increase her confidence in her ability to understand Statistics. Hettie displayed considerable distress at the beginning of the academic year.

She wrote that her reason for enrolling with the Centre was that she found:

- The statistics component of Psych. II very intimidating, almost incomprehensible!

A lack of confidence was also demonstrated by Ernest who wrote on his enrolment form:

- I feel that I need all the help I can get.

The assessments in Statistics completed by the five students consisted of one tutorial test or quiz and one examination in semester one and a quiz and examination in semester two. The tutorial tests were open book tests in which problems involving statistical analyses were posed. The examinations at the end of each semester took the form of forty multiple-choice questions. The scores on these four components were equally weighted to obtain the final mark for the year in Statistics.

Table provides evidence of the exceptional nature of this group. The table summarises the level of mathematics studied at school by the five students, the final grades obtained by them in Statistics, their grades in the non-mathematical components of second year Psychology and their final grades in Psychology II. As can be seen from this table, these students achieved success in their attainments for Psychology II.

As is often the case for older students, life experiences, coupled with high motivation, disciplined study habits and effective communication skills, helped these students in their study of psychology. Their lack of preparation in mathematics,

however, meant that considerable difficulty was experienced by the five in Statistics. This was especially the case for Alice and Hettie who had not studied algebra at all.

THE STUDENTS' PRIOR CONCEPTIONS OF MATHEMATICS AND STATISTICS

The students' reports of their initial expectations about Statistics were based on their prior beliefs about statistics. These, in turn, were generated by experiences which related to mathematics or statistics. Alice conceived of mathematics as "a whole heap of figures". In the Attitudes Questionnaire completed for me during the Statistics bridging course before the first semester began she described herself as "bored and frustrated" by mathematics at primary school.

She wrote that the experiences that led to this attitude were:

- Bad teaching leading to a lack of comprehension and a mother who constantly said that she had no 'head for figures' so was not surprised that I didn't either.

Alice had worked as a caterer, so she would have had to do a certain amount of work with figures. I asked her in the interview whether that had given her any trouble.

She replied as follows:

- *No, but There were two of us Doing it and we Used to say: 'Okay, you've got two hundred people, you allow a quarter pound of beef per person.' So you just multiplied that out, and rang the butcher. But that's really simple stuff.*

Alice evidently expected Statistics to be difficult and anticipated that she would have to manage on her own, rather than with the support she enjoyed in her real life problem solving. In addition, she thought of Statistics as a mysterious subject, having no connection to her experiences.

She said that in her day statistics was not taught in school.

- It practically didn't exist. It was something the government did. Every now and again they took a census. In those days there were no surveys about what brand of coffee you drank. I didn't come up against it until I came here. When I first saw the word 'statistics' in the psychology book, I just blacked it out—I thought I'd worry about it when I came to it.

Norman stated that he had liked mathematics at school, on the whole, and in the bridging course Attitudes Questionnaire reported that he was initially:

- Reasonably looking forward to it though my priorities in life don't include maths.

His conception of mathematics was shaped by a confident attitude to arithmetic and his interest in philosophy.

He wrote:

- There is maths which is simple numbers perhaps and maths which is concepts. Now I like maths which is numbers, I always add up numbers in my head in supermarkets, things like that. I like to play with numbers.

In the interview I pressed him for a definition of mathematics.

He replied:

- It's a discipline or science concerned with numbers and quantification, perhaps. I do philosophy and I'm aware that maths is arguably being used to explain everything in the universe. I like the subject on that level—it's interesting, rational, abstract.

Hence, for Norman, studying Statistics held no terror. He was comfortable with mathematics at any level, whether concrete or abstract, and viewed it in terms of a game to challenge the mind. Sandra, like Alice, separated formal or school mathematics from the mathematics she used in her everyday life. She replied to my interview question: "What is your concept of mathematics, your personal view?"

As follows:

- It's simply working with numbers, it's putting quantities into numbers so that you can arrive at answers to particular problems.
- In my business I had to know how much money was coming in, how much money I was spending. That's really maths. That's what I think of as maths—everyday maths. I suppose I think of it as different levels of understanding. There's the everyday maths, which I can get by with very nicely, which is practical maths, and then there seems to be more esoteric areas, like calculus and so on, which I really don't know anything about at all.

Sandra reported in the Attitudes Questionnaire that at school she was bored and confused by mathematics. She attributed this to having gone to fourteen different schools, in different countries, where the educational systems did not match. Her perception of Statistics, as expressed in this questionnaire, was that it was "useless and dull". She initially appraised the Statistics lecture notes as "daunting" and described herself as "resistant" to learning Statistics. Hettie, despite her business skills, was extremely anxious about studying Statistics. Looking back on her initial feelings about learning Statistics, she said this in the interview.

- I had accounting skills from running a business, so I was not completely innumerate. In second year, from day one, when we got the handout, I was panicked - by the algebraic equations, everything.
- This was what scientists, astrophysicists do, not what I could do.

These four students appeared to base their assumptions about the learning task facing them on their school experiences. Mathematical activities in school were

considerably more distant in time than the mathematical problem solving they had addressed in the context of their work. However, they identified school mathematics as being the closest to the current task of learning Statistics. As indicated by the quotes, Norman faced the challenge of Statistics with equanimity.

The three female participants of this study, on the other hand, indicated that their competence in using mathematics in the setting of life skills was not translated into confidence in the environment of university education. Their comments show that they expected their university course to be an intimidating, mysterious and difficult subject, unrelated to the life skills they had developed. These observations on attitudes to mathematics in different settings complement the research of Lave; Lave, Murtaugh and de la Rocha; Rogoff and Gardner and Scribner.

They found that the setting of the mathematical task determined the success of the individuals using the mathematics. Adults in the context of practical or job-related tasks successfully developed a range of methods to solve problems, while similar problems in the arena of school arithmetic were tackled with considerably less success. From the theoretical perspective that I have developed, affective and cognitive aspects of learning are congruent with the contexts surrounding them and are inseparable from them. Ernest could relate to mathematics only when he perceived it to be concrete and personally relevant.

Asked for his beliefs about mathematics he replied as follows:

- I think it's awfully important because it is the only way we can measure something, consistently. That's what I like about mathematics.
- I did algebra. I could never concentrate on that; geometry the same thing. Arithmetic I didn't mind at all, but the moment it became more abstract, the moment symbols entered the scene -
- Without a teacher who could relate it to the practical usefulness of it, he lost me.

Ernest, unlike the other students, related Statistics to the statistical knowledge he applied in his everyday life, rather than to school mathematics.

- As a hobby for years, I have followed the races. I look at the percentages. I like the idea of comparing my percentages with those that the bookmaker has on the board, and at that level I have always dealt with statistics.

The students' prior beliefs about Statistics related to their experiences of mathematics and statistics. These were connected with two kinds of mathematical activities: mathematics or statistics as an activity in a practical setting, either work or recreation, and mathematics as an activity in the setting of formal education. While all the students experienced the former activity as useful and manageable, only Norman expressed a positive view of abstract mathematics or school mathematics.

Leont'ev's theory of activity poses three different levels of analysis. The first level pertains to the setting—which defines the type of activity, for example work or education. For Alice, Hettie and Sandra, perceptions of the arena for learning Statistics related mainly to their schooling, separated from the practical settings in which they had experienced mathematics. The students identified the activity of learning Statistics, on the broadest level, by its institutional setting. Their prior conceptions of Statistics were that it would be like school mathematics.

They also expected to experience problems learning it, notwithstanding their proven abilities in the vocational world. Norman and Ernest positioned themselves more favourably with respect to learning Statistics than did the three female students. They related the activity of learning Statistics to arenas in which they were challenged or had experienced statistics as relevant.

GOALS AND ACTIONS: THE EFFECT OF CONTEXT

In the activity framework all learning is regarded as goal directed. The examples below illustrate that while all five students were set the same task of learning statistics as part of their psychology course, they produced differing goals in the process of participating in the activities. The features of these emergent goals were linked to the socioculturally defined contexts of their instruction. Alice summed up Statistics as “incomprehensible but necessary”.

Initially, as she indicated on the Attitudes Questionnaire her aims regarding Statistics were:

- To get a grip on it at least to a basic level of understanding.

At the end of the year, her goals concerning the Statistics she had studied related to her conception of it as a tool for research.

In the interview she explained to me:

- I know I'm not going to be able to read numbers and understand experimental papers and I'm not going to be able to do my own work without it. I need it. I'll probably work on case histories as opposed to large samples. Ultimately I'm interested in memory area - brain damage, so I won't be working on large quantities of people. I might be working on, say, motor bike victims as opposed to people who have held their breath under water too long - they've suffered the same damage, but why is this so? That interests me enormously. It would be simple statistics that I'll be doing.

She hoped that when she wanted to apply it, she would be able to do so, but expressed concerns about the theoretical nature of the subject matter:

- I'm hoping that some of that stuff will be instantly recognisable. Now whether they make it more practically theoretical instead of simply

theoretical, maybe that's going to help. I would rather be faced with a hundred coffee beans to play with than a lot of figures. I can't really explain it, but working it out on paper doesn't seem to me to have any relevance.

Before the academic year commenced, Norman evidently intended to make use of the Statistics he would be learning.

He wrote in the Attitudes Questionnaire that his goals were:

- To learn enough statistics to become an effective psychologist.

During the year, however, he accorded priority to short term goals.

His actions were directed to fulfil his evaluations of the institutional requirements:

- I have a very pragmatic approach to university, I give them what they want. Arguably if I could guarantee enough knowledge to get full marks in the tutorial test and the stats exam and know that I forgot it all completely afterwards, I'd almost go for that course, because that's what they want. I really do like knowledge for knowledge's sake, but my main motivation is to pass the course.

Sandra's account reflects a more far-reaching and personal perspective on her academic learning than that suggested by Norman's comments.

Already working in a crisis clinic, she aimed to get the required qualifications in psychology, as she would get better pay and was:

- Not comfortable doing crisis counselling as a non-professional—as much for my clients as for myself.

Her explanation of what she had gained so far by studying Psychology indicates personal development and an enhanced view of the world around her.

She said in the interview:

- While a lot of course material is not relevant for counselling, a lot of the attitudes that you learn are important. A sense of professionalism in your approach, not a knee-jerk reaction to things, but sitting back and assessing it. The course teaches you to take many theories in and assess the different theories—not what is right and wrong but hold many different theories in mind at once. And sit back a bit more. People who haven't had that training... they're more of a knee jerk reaction.

Sandra achieved the identical high grade in Statistics to Norman but in contrast to his instrumental approach, her actions were characterised by a search for meaning:

- It's almost like two separate things in the Statistics course we've just done. You could have actually just got the steps and maybe not understood why you were doing

For Hettie, Statistics lacked relevance to her vocational objectives.

She said:

- Some statistics is essential but it's of very little use to to people doing counselling—to me personally.

Hettie reported that she had put in three or four hours a week on Statistics and that it was too much time for the "bits" that she might require.

She commented that:

- If there had been no assessment, I simply would not have put in the time or effort.

In the second semester Ernest wrote in the Statistics Course Survey that he was more motivated to learn mathematics now than at school because he could see "its importance and application".

He elaborated on this in the interview as follows:

- Related to the study of psychology, I could see very much the importance of it, because it relates to experimental results and what else can you do with them if you can't quantify them? So you need quantification, and maths is the only method we have, the only instrument we have for quantification.

His goals concerning the function of statistics in his future were instrumental:

- Apart from knowing that we need it as an instrument to measure things - beyond that my interest doesn't go. I would never become a statistician. If I ever work as a psychologist, I would either be a social psychologist, I would be a writer, or possibly even a clinical psychologist, dealing with people. And then whatever I needed in the way of statistics as an auxiliary to the work I was doing, I would of course make sure that I could control. But I wouldn't pursue it as an end in itself. Purely as a means to an end.

Goals are not produced by individuals in isolation but are influenced by social interactions, institutionalised practices and personal needs. In universities such as this one, a system has developed over time. Learning activities situated in universities are bound by the resources and conventions of this system, in particular, assessment. For some students, such as for Norman or Hettie, goals may be subordinated primarily to the requirements of assessment. For others, such as for Ernest and Alice, instrumental goals for using statistics in their future careers may not be congruent with the theoretical nature of academic learning. It seems that even students such as Sandra, whose goals in learning Statistics did serve educational objectives, may act in accord with these objectives in spite of, rather than because of, their perceptions of what is required in the university setting.

APPROACHES TO LEARNING STATISTICS

I outlined my perspective on surface and deep approaches to learning Statistics, drawing, in particular, on the work of Biggs; Marton and Säljö and Marton, Watkins and Tang.

This perspective and research on learning in higher education suggests that in surface approaches to learning the student's attention and actions are centred on the task as an end in itself - on reproducing knowledge under assessment conditions. It suggests, too, that in deep approaches, the student focuses on meaning and understanding.

The approach adopted by a student is not fixed and unvarying but is constituted within a particular spatial and temporal context and content domain. The students' comments show that their approaches to learning Statistics were affected by personal factors, such as level of interest and perceived competence in learning Statistics, as well as by their prevailing perceptions of the context, particularly perceptions of time constraints and assessment demands.

Alice sought external clues to help her appraise the material:

- In the lectures I was sitting watching him go through the overheads of our notes and if he said: 'This is very important', I would underline it and if he said: 'Don't worry about these pages', then I wouldn't worry about those pages. I assumed the man knew what he was doing because he wrote the notes!

Alice wanted to understand and use the concepts. However, her difficulties with the mathematics and her perceptions of time constraints and assessment demands strongly inhibited her actions.

She said:

- I thought if I could grasp the basic concepts I would be able to apply it to my exams - but I couldn't. There was something missing and I think it was my comprehension rather than their teaching.... It's in a different language. I don't have a problem with languages - it must be the figures, Sue, I can only assume it's figures. I think the whole subject is really difficult! I just know I haven't understood it.
- I find that reading, say, a book on cognitive processes has logical progression and the material gets more and more in depth. Now Statistics probably does exactly the same thing, but I find that sort of book almost impossible to read, because of the things in stage one which I stumble over. I'm not the sort of person who can skate over the top and think: 'Oh yes I won't worry about that!'. I have to get that straight before I can get to the next thing. And that holds me up.

- Given enough time, I can do all those things, but put me in a situation where I'm pressured. Ask me to write an essay about it and give me six weeks - no problem. Give me sixty minutes, and I have to do it step by step, so I run out of time.
- My essential problem is that I can't generalise from what I know to some other problem. In the 't- test' I did the working on the computer and came up with the right answer. I was totally thrilled with that. That was simple, but I had three weeks to work on that. You put me in an exam and give me five minutes to answer ten questions - and I'm history.

Alice wrote in the Statistics Course Survey that the most difficult thing about learning Statistics was "coping with figures and symbols". This difficulty may have been ameliorated if she had interpreted Statistics in her functional language. However, she evidently defined the learning activity in terms of project management. In this setting mistakes are seen as costly. This perception prevented her from deciphering

The mathematics. She did not dare convert it to more intelligible and transparent terms:

- I don't translate from maths terminology because one has to learn the terminology to put in for exams, so I may as well learn it right away, instead of translating to English and back. I'm terrified of doing that. I'd rather learn the technical terms first up, then make it simple, and then have to put it back into technical language.

Alice's study notes, written to summarise and revise Statistics, reflected a focus on the operations and algorithms rather than on a conceptual understanding of the content. She wrote in the Statistics Course Survey that her way of learning a mathematical topic was by "repetition". In the interview she reiterated this rote learning approach, reporting a perception that what was required was the memorising of details.

- You can't express yourself with this, you have to express what you are taught. The underlying concept is not such a problem but they don't ask you conceptual questions. If you started to be creative with it you'd run into the most appalling trouble - go off at a tangent. I'd never go outside what's in the book.

Hence Alice's actions were strongly constrained by her understanding of what was appropriate to do in the setting. For Vygotsky and the activity theorists following him, the cultural, historical and social contexts for all activity are of primary importance.

The comments quoted above reflect the relation between individual actions and the institutional arena surrounding them. On the level of more immediate social

interactions, Alice's reports of her experiences testify to Vygotsky's view that working in the "zone of proximal development", that is, mastery with the help of more capable others, precedes independent mastery.

- I was working with Norman and Sandra - every Sunday night, almost the entire year. We went back over the previous week's lectures and tutorials, and went over it again and again and again, with the help of Sandra's husband who understands statistics. I can do all test things with the others around a table, we can get them right.

Norman reported adopting a surface approach to learning Statistics yet he achieved a high degree of success in the assessments:

- I just wanted to pass the course. Practice and repeat is the key. You have to have the basic understanding of when to apply the test, and that is almost formula. They are not looking to see if you critically appreciate because the test questions are very similar to the tutorial questions. Compare the test question to the tutorial question, if they're the same, apply the same formula.

Norman found the multiple-choice examinations harder than the class tests because of the speed with which each question had to be answered.

For these, too, he relied on superficial clues, rather than: understanding.

- To get away with doing it in one and a half minutes a question—anything less than knowing it really, really well—you were in trouble. I had to guess. A lot of multiple-choice questions are really tricks. If two of them are similar, then usually it's one of them.

Norman's comments raise the question of what the assessments in Statistics actually measured. Despite Norman's perceptions of the superficial quality of learning required in the context of academic learning, the social context provided by his working regularly with Sandra and Alice, resulted in a deeper approach.

- I invariably picked up some understanding anyway. Compared to Sandra and Alice. When I worked with the others as a group then I would try to do more of the understanding.

Hence institutional norms and social interactions mediated the relations among students' goals, their actions and the outcomes of those actions. In Norman's case the different approaches he adopted to learn Statistics and the quality of the ensuing knowledge as he reported it, were interwoven with the social settings surrounding his actions. As in Alice's case, engagement with the task of learning Statistics, that is activity in Leont'ev's sense of the word, was associated with direct, interpersonal interaction.

Together, Norman, Sandra and Alice created an interactive learning environment very different from the traditional lecture-tutorial settings in which they mostly

studied Statistics and in this environment their activities were directed at attaining a conceptual understanding of Statistics. Sandra's actions reflected her intention to achieve what Skemp calls a relational understanding of the subject matter. In Skemp's terms this means to understand mathematical concepts and topics in ways which inter-relate whole areas, are intrinsically motivated and serve as a basis of further and deep exploration of new topics and concepts. This construct accords with the view of deep approaches to learning that I have expressed so far. Sandra's notes summarising her study of Statistics indicated her intention to gain a relational understanding of Statistics. In these notes, she began each new part with an overview of what she saw as the purpose and ideas underlying that topic.

Sandra reported her conception of learning mathematics by explaining that mathematics is:

- Something that you learn by increments, by degree—a gradual accretion of knowledge.

Her concern that she would not be able to understand Statistics led Sandra to take action in a determined and methodical manner to overcome difficulties and fulfil her goal of understanding:

- I worked through my lecture notes at the same time as the lecturer did. I just wanted to get a broad brush stroke, a picture and then more detail with the 'tuts'. I went to three tutorials, one at the beginning of the week, one in the middle and one at the end. Each time it became a little clearer. By the third time I was feeling on top of it. And then I was coming here twice a week as well. And I was working with Norman and Alice and my husband as well. We worked through examples for hours, our 'tut' sheets, to learn how typical these things are, to understand.

Like Alice, Sandra also did not have the confidence to pursue a broader study of Statistics than that presented in class:

- I stayed very much with my lecture notes, while with other subjects I did a lot more reading of texts, which would have given me more understanding.

Sandra, like Alice and Norman, indicated the importance of social interactions to her learning of Statistics. She wrote in the Statistics Course Survey, in second semester, that her way of learning Statistics was with assistance at the Mathematics Learning Centre getting:

- Repeated explanation, where I feel free to ask questions, in a comfortable, supportive atmosphere; working through examples—talking about it.

It therefore appears that Sandra's initial grappling with the concepts of Statistics took place when she interacted with others—her teachers, colleagues or husband. This accords with the activity theorists' viewpoint that collective external activity precedes individual internal activity.

Sandra's comment shows that working collaboratively on Statistics helped her to overcome some of her anxiety:

- I didn't work a great deal on my own, although I did at the end. I had to go through it on my own—but I felt frightened working on my own.

Sandra reported an increase in confidence during the year. *She noted in the Statistics Course Survey that:*

- It is possible to learn stats successfully.

However, in this survey, she also expressed the view that she needed a better understanding of concepts and how to apply them in differing situations, adding:

- Also I need to learn to work faster.

This indicates her perception that a deep understanding of the concepts was necessary but not sufficient to perform well in assessments. This perception is well substantiated by empirical evidence. Sandra's perseverance led ultimately to a high grade in Statistics but in the examination she had to constantly fight against her own resistance.

- I had this constant overwhelming desire to put down my pen and say:
- 'I can't be bothered carrying on with this!'. It was very difficult.

Hettie wrote in the Statistics Course Survey that her main reaction to Statistics was "Panic!". So intimidated was she that she spent many lectures and tutorials in tears. She was torn between wanting to be accepted into the Honours stream, for which a minimum grade of a Credit in Psychology II was required, and her inability to come to terms with Statistics, an important part of the course for assessment purposes.

In a conversation with me early in the year, she described graphically her feelings during Statistics lectures:

- When he put all that stuff on the board, I just froze. I was like the rat I'd been observing in the laboratory earlier on. I just curled up in my seat and froze in terror.

A shift in her attitude took place in the latter half of the first semester when we discussed her goals for Statistics. We decided that even if she only attained twenty per cent for Statistics in the examinations, she could still meet her aim of getting a Credit for Psychology II, due to high grades, so far, in its other components. By lowering her goals to what she felt was realistic, she was able to make a fresh start. Freed from the paralysing anxiety she had experienced up to then, Hettie started to work through the notes and examples systematically, understanding it at her own level and in her own functional language. The outcome in first semester was a Credit for the multiple-choice exam and a pass in the tutorial quiz—well above the proposed twenty per cent.

- *Hettie likened having someone explain statistics to her to having: Someone describe a taste—not very meaningful.*

The strategy she developed, with considerable pain, entailed acting systematically and energetically—engaging with the subject matter.

- Initially I wrote lots of notes which were not helpful because I did not understand what was going on, I just wrote down formulas. It took halfway through the semester before I systemised things and sat down—with your solutions and worked out the tutorial exercises. That is what overcame the phobia about it. For me it's not as though it can be explained. It's great to have a solution there. But you really need to take every little bit and break it down, every equation and break that down and understand what it is, and actually do it yourself.

The skills Hettie was trying to develop were related to understanding the underlying concepts rather than merely learning algorithms.

She felt that in view of the use of computers time was better spent:

- On the concept of it, the meaning of it. Not the complicated mathematical process.
- I wonder if we need to learn how to manually work out things we are never manually going to work out. More in the tutorials than the lectures, they often present the concept of what it is, and give some kind of practical illustration of what it is rather than the mathematics of it. I think that's more useful in view of the use of computers.

Hettie realised that a very disciplined approach to studying Statistics paid off.

In the Statistics Course Survey she wrote that her way of learning it was to get an overview of the concepts, then:

- To work through it myself—every step.

It seemed to me that she conceived of learning Statistics as struggling to land a large fish. *She said:*

- Stats more than anything else in psychology pays off from some attention, some time—serious time not just read about it. Reading about statistics doesn't do anything for me. I don't retain it. Read it—and five minutes later it's gone. It doesn't hook in to anything that is in your mind. The only thing it will hook into is the tutorial exercise you did last week. When you've actually done it. Its not a thing that's not graspable—it's just a thing I had to grapple with and put in some time.

In this description of how she grappled with learning Statistics, Hettie illustrates the essence of what Leont'ev means by activity—effortful and purposeful behaviour, which included overt actions and cognitive actions—reflection, making connections.

In the Statistics Course Survey, Ernest reported that, unlike Hettie, he did:

- Appear to absorb more through reading.

He described an holistic way of learning Statistics, writing that he preferred:

- A clear handbook to explain the issues involved,
And, in contrast to Alice,
- Plain language presentations into symbolic formulation.

Ernest expressed a strong desire to adopt a deep approach to learning. Despite this, his actions were constrained by his perceptions of the pressures of the academic setting. His comments bear out observations by Entwistle and Ramsden that students can perceive a conflict between grades and learning and that they:

- Speak of using strategies to get good grades at the expense of understanding the material.

In the interview Ernest explained his perceptions as follows:

- I must admit, because of the time factor involved, I always had in mind that interest might come later, but now you've got to get things ready for the tutorial test and later the exam. I would have avoided pursuing it beyond the immediate requirements out of fear that it would possibly confuse me and overload the circuits. They go through a tremendous load. The content is so that you can't deal with all that content in a qualitative sense. You can only do it in a quantitative sense.
- I'm interested in learning theory, we did it as part of our psychology course, and to me a fascinating person was Betty. She always claimed that she was completely helpless, that she didn't understand it. And we more or less agreed on difficulties before the lectures. And yet she did extremely well in Statistics, got a High Distinction. So I thought: 'Well, I seem to have the same problem with the material, and yet she manages to overcome this, she gets good results and I don't. Why is that?'
- And I can only think of an answer that it's a matter of how our minds work. I tend to make a synthesis of things, I want to understand them. I'm a deep thinker, put it that way, while other people simply seem to work at a more superficial level, and take it in and remember it and reproduce it. And I can't do that, you see. To me it first has to be digested. I am an internaliser and I feel that Betty and others like her are externalisers who therefore have a greater facility of doing it quicker, while I take much longer. But I feel that I get a deeper understanding.
- For Statistics, I think maybe a lot of people just have the facility of learning that quickly. They don't feel the need like I do to relate it and to internalise it and therefore their brain obviously has a limited function

which it can perform quicker, than if you want to look at all the circuits - as to where its leading. Look at the overall picture - that can slow you down. So that's my theory.

Ernest's last comment attests to an all too often reported paradox that:

- Institutions often appear to discourage the very things that, officially, they are committed to foster.

In particular, for students who are not comfortable with, or facile in, assessment driven learning, it appears that perceptions of the university educational system can obstruct actions directed towards high quality learning.

THE STUDENTS' SELF REGULATIONS AND EVALUATIONS OF LEARNING STATISTICS

The view that activity is goal driven is central to Leont'ev's theory. The connection between a student's goals and her actions is self regulation. It is on this account that recognising a student's interpretation and evaluation of the learning task is important to understanding that student's activities. Self regulation of thought is explained by Semenov as being on two planes. As described earlier the reflective or "intellectual plane of thought" designates how the subject monitors and controls the ongoing cognitive activity, while the "personal plane of thought" refers to the degree to which the problem solver evaluates success in personal terms.

In Semenov's words:

- A subject does not simply solve a problem: the process is, at the same an act of self realization.

Hence, these metacognitive processes of monitoring and evaluation are paramount in defining the activity. Alice wrote in the Statistics Course Survey in the second semester that she had achieved:

- A gradual increase in confidence and some glimmerings of understanding.

However, at the end of the year she expressed frustration at her inability to achieve her goals:

- I don't like having this area of weakness in the overall course, when the other areas are so strong. It annoys me that I can't grasp it, I'm an intelligent person—why can't I get it?

Alice's evaluation of her performance was evidently based on her grades, as in a different setting, where no external authority was judging her, she demonstrated confidence in her ability to understand statistics:

- When I'm reading a newspaper or magazine, now, I don't skip the statistics, I can actually read it and understand it. I don't just accept what someone writes—I question it. Someone phoned to do a survey. I

asked him how many people he intended to survey. He was taken aback and asked why. I said: 'If you are going to survey ten people I'm not going to bother answering your questions. It's going to be nonsense!'

This account was in sharp contrast to her response at the beginning of the year to a question in the Attitudes Questionnaire on reactions to everyday situations involving mathematics, such as reading surveys and statistics in magazines and newspapers. At that time she had written: don't read stats in newspapers!

Hence Alice's actions relating to her evaluation of her own statistical competence depended on the context in which she was making those evaluations. Norman's plans for his future were in the academic field.

His goals were:

- To be an academic psychologist, do a Phd, do counselling as well, or a counselling psychologist.

He reported in the Statistics Course Survey that he found it difficult:

- Getting a grip on concepts that I had never thought about in everyday life.

I asked him in the interview whether he would continue to study statistics in third year, if he had the choice. His reply indicated that the challenge of overcoming his difficulties seemed to mediate against purely instrumental goals in learning statistics:

- I don't know. Its not clear cut. I would lean to not doing it, but wouldn't be too certain about the idea. Even if I knew I'd never need it. It's one of those things that when you could do it it's great. I really liked it when the answers come out.
- If my mother, instead of a psychologist, had been a mathematician, I'd be into math. I do quite like abstract ideas. Similar sort of learning—the curiosity to know and explain something via numbers and equations. I can see if that was a strong feeling with me I would find it fascinating. Read a paper by someone who tried to mathematise thinking—pages and pages of equations to explain how human beings think. It sank without a trace but I could see an interest on those sort of levels. If I had an interest not in people but in numbers it would be fun manipulating equations. Same learning style, I'd think about it more often.

Sandra felt that her learning activity had resulted in personal development:

- By the end of the year I thought, it doesn't really matter how I go in this exam. I'm not going to let the exam mark dictate to me my knowledge. Because I knew I had a better grasp at the end of the year and I really felt that if I was doing experimental work I could work out what to do with my stats.

- It felt very good, it felt a lot like growing up. All my life it felt like I had this dark secret:— that I felt really stupid about this area. I'd cover it up so no-one would know. It really felt like growing up.

Hettie's gradual awareness that she was capable of learning Statistics produced a sense of achievement:

- I wouldn't choose to go on with statistics, because it's not an area where I get very good marks, and in the end that does matter. It's one of those things that when you get a bit of a handle on the fundamentals, then you've got something to build on—so it doesn't intimidate me. In fact I get this strange sort of satisfaction out of doing the tutorial exercises now. It's like a puzzle. While I'm actually doing it, I quite enjoy doing it. It really bolstered my self confidence. You might recall—I used to weep. I found it very stressful and I was absolutely certain that this was beyond my capabilities.
- It disciplines you in a particular way I think, because it's a field of inquiry not connected to your normal life; it exercises a part of my mind that I normally would not have. And it has increased my confidence quite a lot.

Hettie had thus developed her metaknowledge about the process of learning Statistics to include an awareness of her capabilities and a sense of how to allocate her cognitive resources. Ernest acted on his need to understand, but expressed the idea of a conflict between university education in practice and deep approach to learning:

- To me its very important how a subject is presented. It's always the case that the degree you can identify with it is the degree it arouses your interest. It's really intellectual curiosity because even during the holiday, when most students would have thrown their books in one corner, I have been pursuing those things that we simply didn't have time to pursue during the year.
- I really found that I was never quite happy with Statistics. I felt that if I had been in charge of giving that course I would have approached it in a different manner. I would have made it more interesting, I would have related all those different tests to what they were meant to do. The notes immediately went into formulae, rather than what this test does.
- Once I see the logic of it, then I have no problems with it. But if they don't deal with that logical function then immediately I start questioning the need for it. Like at school, when the guy was droning on about algebra, even more so for geometry, I said to myself: 'I don't think I'll ever need that in my life' – and I lose interest.

- All they can possibly say in defence of their way of teaching is that the intellectually curious student may still find it a useful base to depart from and to develop, evolve from. What they overlook is that a lot of the people who are not so interested, who do not have this native interest in the subject—they will not get it because of the way they teach. If they taught it in a more interesting way—if they taught people to think about it, rather than to repeat it.... We do nothing to arouse this intellectual interest apart from making them exam smart and certainly with young students, all they talk about is what is needed for the exam.

While the rhetoric surrounding teaching at university emphasises making resources available to learners, it is the student's metacognitive awareness that plays a central role in determining how these resources are used. On the "reflective plane" self regulation provides the links between what is to be learned and how it is learned.

Norman, for example, regulated his approach according to whether he was carrying out his goal of just passing the course or of helping his friends make sense of the lecture notes. On the "personal plane" of regulation the resources available to students are evaluated in terms of personal interests, perceptions of self-capabilities and attitudes. Ernest's self judgement of his performance was based on his own objectives as well as his appraisal of the instructor's requirements.

In his own words:

- I want my questions to be answered. When I was the age eighteen, nineteen, twenty, I wouldn't have worried about the deeper significance of it either.

In quantitative terms the outcomes of learning Statistics for the five students can be assessed by their grades: simply that three passed and two obtained distinctions. As the comments show, however, it is students' goals in their sociocultural contexts that provide the criteria against which students qualitatively evaluate the outcomes of their learning. Sandra's satisfaction at her personal development or "growing up", Hettie's increase in confidence and Ernest's disappointment at what he perceived as a requirement for students to repeat suitable portions of the course, rather than to think about it, are some of the qualitative evaluations that emerged from the data.

Marx summarises the product of learning as follows:

- Knowledge is the result of the subject's active intervention in the process of changing reality.

The mature participants of this study were aware of the meaning of their own experiences and environment and this awareness was at the core of their learning.

DEVELOPMENT OF THE APPROACHES TO LEARNING STATISTICS QUESTIONNAIRE

The Approaches to Learning Mathematics Questionnaire and the Approaches to Learning Statistics Questionnaire were derived from the two scales of the Study Process Questionnaire which denote surface and deep approaches to learning. While the Biggs' scales purport to investigate approaches to studying in general, the Approaches to Learning Mathematics Questionnaire investigates students' approaches to learning mathematics, as a generic field of study. That is, in the Approaches to Learning Mathematics Questionnaire, the wording of Biggs' deep and surface scales was changed to refer to approaches to learning mathematics, rather than to studying in general.

My Learning Statistics Questionnaire from which the items of the ALSQ were selected, was modified from our Approaches to Learning Mathematics Questionnaire by changing "mathematics" to "statistics" in the items. The Learning Statistics Questionnaire refers to students' approaches to learning Statistics—as a particular subject studied for Psychology II. Hence the three questionnaires: the Study Process Questionnaire; the Approaches to Learning Mathematics Questionnaire and the ALSQ represent a progression—each focusing and particularising the constructs of interest in previous investigations.

The Learning Statistics Questionnaire completed by the Psychology II students contains 28 items on approaches to learning Statistics. The 14 odd numbered items were derived from items in the previous questionnaires indicating a surface approach to learning and the 14 even numbered items were derived from the scales denoting deep approaches to learning. For each item a choice of responses numbered 1 to 5 was provided. The lower end indicates that the student "only rarely" adopts this approach when studying Statistics, while the upper end indicates that the student "almost always" does so. Hence, a student's score on each subscale signifies how usual it was for her to adopt the specific approach to learning Statistics.

I carried out item factor analyses and scale reliability analyses in order to determine the structure and internal consistency of the items. As a result of these analyses the ALSQ was defined as consisting of 18 items, twelve making up the Deep Scale and 6 items constituting the Surface Scale. Scale validity of the ALSQ is indicated by relationships with other variables such as willingness to learn Statistics.

ETHICS

This study was approved by the University of Sydney Human Research Ethics Committee. In order to ensure that I fulfilled my ethical obligations to the students and academics participating in my research I addressed the following issues.

Voluntary Participation

Survey

In the case of the survey, I invited students to participate both verbally and in writing. I explained the purpose of the research and how their responses would be used.

Students who did not wish to complete a portion of the survey, or indeed the whole survey, were at liberty to desist. A few students omitted to give their Student Identity Number and one person refused to complete the survey. No pressure was brought to bear on them.

Interviews

Only students who gave their written consent to be interviewed were contacted by telephone. All interviews took place on a face to face basis and were audio taped. Hence the participants were able to see when the tape recorder was running, and I invited them to switch the recorder off at any time if they so wished.

I asked students to sign a consent form. I also signed this form assuring the student of confidentiality and explaining again the purpose of the research. During the interview each participant was given the opportunity to ask any questions and discuss any difficulties relating to Statistics. Some students took this opportunity to ask questions relating to the course content, the assessments or my research. Students were offered full editorial rights over the transcript of their own interviews. None opted to take advantage of this offer.

Disclosure of my Aims

I informed all participants of my aims: in writing, on page one of the survey, on the interview consent form, and verbally. Teaching staff were invited to discuss the research with me at various stages of preparation for the project and analysis.

Guarantee of Confidentiality

All students and staff participating in my research were guaranteed confidentiality. False names are used throughout. As recognition of students by staff members close to them is impossible to prevent, no excerpts from students' interviews were published during the year the students were in Psychology II.

Opportunity to Complain of any Ethical Misconduct

Students were given written information as to whom any complaints or reservations about any aspect of their participation in this research could be addressed.

Taking Account of Power Structures

As a staff member of the Mathematics Learning Centre, I have no input whatsoever over students' grading and am not involved with tests and examinations in any way. Similarly I have no authority over other academics. My job is to assist students at their own behest with any subject at The University of Sydney which involves elementary level mathematics and statistics. Students and teachers were invited to assist me by participating in this research.

DILEMMAS

- My first dilemma concerns the invidious " $p < 0.05$ ". What does this mean for a non random sample? I am not trying to generalise to some population—my sample is from a hypothetical and undefined population, perhaps of students' responses at different times. Further, statistical tests of significance do not answer the interesting and relevant question: "Is there a low probability that the results occurred by chance?" or more precisely "What is the probability that the null hypothesis is true given the results I have observed?" Instead they answer the far less critical converse question, namely: "What is the probability of getting the observed results assuming that the null hypothesis is true?". Hence my use of these tests does not make my results more credible. They cannot be used to evaluate the educational significance of the result nor to ensure trustworthiness, in the positivist sense of reliability or replicability. I am using these tests simply as flags, signalling that something may be worth qualitative interpretation and investigation or suggesting directions for future research. Statistical significance is important if it converges with educational significance, or signals an anomaly.
- My second problem concerns the contextualising of phenomenography. As I pointed out earlier phenomenographic categories are "clean" categories in the sense that they ignore the boundaries between an individual's responses to different questions and they also "abandon" boundaries between individuals. The categories become generalisations in which idiosyncratic diversity and contextual specificity is lost. Yet each person's responses are embedded in her personal history as well as the context in which the response is made. I can only acknowledge this paradox and suggest that development of phenomenographic methods is needed to take into account personal and contextual divergence in the categorisation of conceptions.
- Are students in a position to assess their own perceptions, especially in a situation where there is limited time? If they had the surveys to take

home and think about, their responses would surely have been very different. On the other hand, did the spontaneity occasioned by students responding immediately to a question result in more honest responses?

CONCLUSION

The aim of research is to illuminate the phenomena under investigation. To do this, a spectrum of methodologies is available to the researcher. Methodologies are not defined by the types of data collection or analytic techniques deployed but by the purpose of the investigation. In this research my aim was to understand students' orientations to learning Statistics from their own perspectives, taking into account the context of their responses. The research tools I used depended on the questions I wanted to answer. In Study One these required exploration, rich description and qualitative interpretation. In Study Two, the questions required a more systemic analysis, involving categorisation of concepts, distributions, patterns and relationships. By using a variety of methods of data collection and analysis I have endeavoured to shed light on some aspects of the complexity of learning Statistics.

EDUCATIONAL RESEARCH IN STATISTICS

ISSUES FOR EXPLORATION IN RESEARCH

The acknowledgment, in the education literature, of the prevalence of students' misinterpretations of key statistical concepts leads me to question how statistical thinking is embedded in academic settings. That is, how do students experience statistical reasoning in the academic setting and how does this reasoning relate to that of working statisticians in practical situations? According to one statistician the components of statistical thinking are: understanding the dynamics of the real world problem, moving towards a statistical model and using statistical tools.

If students in a university statistics course are not provided with experiences enabling them to understand the relationship between the statistical model and the "real life" situation, they may not be adequately equipped to use the statistical tools with which they are presented and so may be unable to appreciate the statistical reasoning process. For example a lack of understanding about variation could lead students either to trust implicitly their own intuition about data, without attempting to use statistical reasoning to evaluate the findings more critically, or to distrust universally any statistical statement—without the means to assess its reliability. It is important for me in this investigation to understand how students' concepts of statistical knowledge relate to the contexts in which they apply this knowledge. The ways that students experience learning statistics are also likely to contribute

to the difficulties that many students have with the subject and to their objections to studying it. How students understand statistics is related to how they interpret it in the context in which it is presented.

This is an aspect of students' learning of statistics which has received scant attention in the research literature and, in my experience, is rarely accorded importance in the teaching of statistics courses in higher education. Skills and facts are easily identified in the design and assessment of statistics courses at university. However, students' conceptions of the subject matter as a whole, approaches to learning it and their perceptions and beliefs are rarely evaluated in any formal sense. These aspects of students' learning of Statistics are major topics for exploration in my project as it is a prime postulate of my research that these are critical dimensions of students' emerging statistical knowledge.

In learning Statistics, a student's thinking and problem solving is accompanied by affective elements: feelings, beliefs, desires and attitudes which will affect how long she will persist with a task or a problem, how easily distracted she is likely to be, how long she will remember facts and skills and other important factors which can facilitate or hinder her cognition. Affect is therefore of importance and interest in my investigation which seeks to understand learning Statistics from the activity theory perspective. In this framework, affective elements are not extraneous or secondary to intellectual processes but indivisible from them.

Vygotsky describes this inseparability of intellectual processes and affective elements as follows:

- Thought itself is engendered by motivation, *i.e.*, by our desires and needs, our interests and emotions. Behind every thought there is an affective-volitional tendency, which holds the answer to the last 'why' in the analysis of thinking. A true and full understanding of another's thought is possible only when we understand its affective-volitional basis.

Hence, the affective components of students' cognitive processes give those processes their "attitudinal colour". Statistics is included in the curricula of many disciplines at university in order that students may use it and appreciate its relevance to their chosen fields. In Western countries, statistical thinking is bound up with technology, commercial concerns and other matters of cultural importance. The social interests and preoccupations of a culture are not, however, automatically assimilated by individuals, but are monitored.

Students regulate their thinking and actions according to their evaluations of a learning task. What is culturally accepted may be personally abhorrent. There may even be a conflict between studying statistics and a student's perception of her own self realisation or values. For example, in the following survey response one student expressed the idea that real psychologists don't do mathematics.

She wrote:

- I don't even see the point. In psych why must maths infiltrate itself??? Studies have shown that those who have high maths abilities have low or poor communication and perception skills—shouldn't psychologists be exceptionally perceptive and able to communicate well? It seems that if there aren't silly numbers to justify things then they aren't plausible in our computer/maths/science promotive society.

Leont'ev makes an important distinction between meaning and personal sense, which relates to conflicts such as the one expressed by this student. To Leont'ev, meanings are connected with the reality of the outside objective world, the life of society. Leont'ev calls them the “crystallization of social experience”. Personal sense, on the other hand, is connected with the reality of the person's own life and motives. That is, personal sense involves the incorporation of socially constituted meanings into the psychology of the individual.

Personal sense, according to Leont'ev “does not have its own ‘supraindividual’, ‘nonpsychological’ existence”. Sometimes, there is a mismatch between societal and personal meaning. According to Leont'ev, it is affect that signals to the individual the fit between the two.

Lerman argues that the valuing of decontextualised, intellectual processes, divorced from personal and social elements, is expressive of oppressive discourse. It is this privileging of abstract thought, such as academic mathematics, that is disempowering for some students. Sierpinska and Lerman refer to the vested interest mathematicians have in maintaining the status of mathematics in society. This idea was passionately expressed by a participant in my pilot study for Study Two.

She wrote:

- Maths is an exercise in agony, because the people who teach it make one feel as though maths belongs in a higher plane of evolution. Even though the number system is for everyone, and the concepts are there for everyone, the feeling that you do not deserve to know anything runs rampant. Maths, in short, is a lofty pain and a real headache to study.

In summary, the issues that I am concerned with in this project relate to the ways that students orient themselves to and interpret the task of learning Statistics and to how personal dimensions and individual actions are linked to the wider social, institutional and cultural arenas surrounding them.

4

Approaches to Research Methodologies in Adult Education Training

In order to have a fruitful discussion on the methodologies of training, it is necessary to identify certain other aspects *viz.*, training ‘for whom’, ‘why’ and ‘for what’. Only then will arise the question ‘how’. Since the participants of this seminar are drawn from various agencies—Government, semi-government and voluntary—engaged in training, social service or welfare activities, solely or partly, there cannot be any uniform approach. However, one thing is common. All are interested in the progress and welfare of the community, the upliftment of the downtrodden and deprived sections of the society and implementing developmental activities in the respective areas.

The common aim of training should hence be equipping the personnel to take up welfare activities in an effective way. This can be through the provision of adult education programmes *viz.*, adult literacy, non-formal education for the dropout, vocational training, rural development and self employment schemes, etc. Popularising scientific and technological advances among the masses and inculcating reading habits among them form other areas of work. This dichotomy has to be kept in mind while thinking of the ‘how’ of the training of cadres. The ‘how’ will very depending on the category of personnel involved *viz.*, full time paid workers, part time paid workers, volunteers, social workers, etc. Though there are commonalties, a uniform type of training cannot suit all these. The background involvement, experience in the field, chances of sticking on to the field, etc., are

factors to be considered in the preparation of training strategies. Another point to be clarified is the 'why' of the training. In the preparation of teachers we now use the term 'teacher education' instead of 'teacher training'. It is argued that only animals and birds can be trained and not men and women. Training can, however, take place in mechanical fields such as physical training, pilot training, type writing, etc. Only if similar situations and environment are anticipated, can we train people to act in the same way. In the case of human beings, it is rather difficult. What is possible is some kind of orientation or preparation or guidance for the successful discharge of one's duties. That too has to be attempted scientifically and wholeheartedly.

Training is generally of two categories: (1) pre-service. *i.e.*, training imparted prior to one's entering a job or profession so as to equip him sufficiently and (2) in-service *i.e.*, on the job training to revamp the abilities or reorient a person to the desired goals in the light of changes or trends in the profession or to keep oneself abreast of the times. There will be marked difference in the planning, organisation, conduct and evaluation of these two programmes. Not only duration and content will differ but difference will exist in the aims and objectives, resource personnel and materials, approach, outcome, etc. When the personnel involved in any ongoing programme have to be reoriented to the changed trends and objectives, refresher training programmes are launched on a massive scale within time limits to cover all the different levels of functionaries.

The three major phases of any training programme are planning, implementation and evaluation. All are equally important and deserve special attention in all its innumerable aspects. Prospective trainees have to be oriented to the programme sufficiently early and to the extent possible background reading materials have to be supplied prior to the starting of the programme. A tentative programme schedule can be drawn up for discussion with the participants, immediately on arrival with a view to making necessary changes in response to their expectations, background and experiences. The trainers and resource persons will also have to be brought together for necessary briefing in order to avoid possible duplication, difference in interpretation and consequent confusion and monotony among the participants. Field work, practical sessions, group and individual assignments, etc., require adequate planning as also the provision for interaction among the participants and talent shows. Necessary records and documents should be procured in sufficient number. A reference library is a must. Emphasis should be on participatory approach and not on stereotyped lectures and demonstrations. Newer techniques have to be experimented with adequate preparation, feedback and follow up. For the success of any training programme a combination of theory and practice is needed. Frequent evaluation by participants and consequent changes in approach and programme must be the policy to be adopted in any good training programme.

Micro teaching is one of the modern techniques that could be effectively tried in any training programme, especially of the formal type. In teacher education programmes, this has been found very useful, but in the non-formal sector this cannot be of that use due to the flexibility of the approach and diversity of content and personnel. A shortened programme (in duration, no. of participants and content area) with possibilities of repetition, review, revision and resultant refinement is the crux of micro teaching.

Team teaching is another approach possible in training programmes. Instead of a single person handling a subject through lecture, discussion, demonstration, etc., a team of experts well versed in the subject, and having mutual understanding and qualities of adjustment take part in this. This ensures integrated approach which is essential for the success of development-oriented programmes. The members of the team should have prior discussion on the areas each one has to cover and an agreement should be reached so that any member can interfere in the presentation if some additional point has to be made or clarifications are needed. Whenever areas or topics of an interdisciplinary nature are tackled, this approach will be very useful.

Role play is yet another modern technique very effective with the masses. Purposive enactment of 'roles' by different individuals to enter into fruitful discussions on topics of vital importance is the crux of the technique. The 'actors' need not necessarily be prefixed; they can emerge spontaneously and participation of trainees will be maximum in this case. Different persons can try different roles so that resultant discussions will vary and can lead to appropriate decisions. Dramatisation is different from role play in that the latter is spontaneous and oriented towards identified problems requiring immediate solution. Need reduction and problem solving should result from any developmental and welfare programme whether it is educational or not and here role play can be a successful technique. The 'street drama' form yet another approach.

Discussions-leaderless and with leader as well as planned and spontaneous-can enlist group activity and feeling of participation among the trainees. Small group discussions help in persuading even the introverts to speak out. So in every training or seminar ample opportunities should be provided for group discussions, preferably small group sessions followed by plenaries. These should help the trainees acquire the necessary abilities to organise, demonstrate, evaluate and follow up discussions on their own.

Brainstorming and buzz sessions are also of great value in training programmes. This will help to ensure participation of all the members of the group. Practical sessions should be given appropriate provision in any training programme. We need theoretical and practical orientation. Planning things at the top without trying

to understand the feelings of the masses is a major drawback in our country. People are interested in doing armchair researches; but they often hesitate to go to the field. Unless one goes to the field, he cannot have a clear picture of the situation; he can't establish rapport with the people without a proper dialogue. So every one interested in social or welfare work, has to gain adequate mastery in surveying, collecting data, recording the same, tabulating, interpreting, and communicating as also establishing proper human relations. The way to win the support and confidence of the people has to be found out. An understanding of adult psychology, an idea of their needs and problems, aspirations, behaviour patterns, etc., together with approaches for motivating them and sustaining their interestes is essential for any trainer and hence should form a part of any training programme for key, middle level and grass root level functionaries.

Preparation and use of teaching learning materials, improvisation of teaching aids, procurement of materials should find a place in the training schedule. Evaluation of the entire training as a programme (process) or a product is also essential for future guidance. The technical jargons used by various agencies differ considerably and hence require discussion. For higher level training, supervision, administration, finance, etc., should also form part of the total programme. Initial and final inventories to be administered on the trainers need to be prepared. Necessary publicity before and after the training will enthuse public interest, opinion and even criticisms which are all needed. There can only be a common frame of reference and not a uniform pattern for the training of cadres. Naturally there can't be any one methodology. Salient features of all good ones have to be integrated fruitfully to make the programme a real success.

TEACHER

In education, a teacher is a person who provides schooling for others. A teacher who facilitates education for an individual student may also be described as a personal tutor. The role of teacher is often formal and ongoing, carried out by way of occupation or profession at a school or other place of formal education. In many countries, a person who wishes to become a teacher at state-funded schools must first obtain professional qualifications or credentials from a university or college. These professional qualifications may include the study of pedagogy, the science of teaching. Teachers will have to continue their education after they receive their degree from a college or university. Teachers may use a lesson plan to facilitate student learning, providing a course of study which helps cover a standardized test curriculum.

A teacher's role may vary between cultures. Teachers teach literacy and numeracy, or some of the other school subjects. Other teachers may provide help or certain education instruction in craftsmanship or vocational training, the Arts, religion or spirituality,

civics, community roles, or life skills. In some countries, formal education can take place through home schooling. Informal learning may be assisted by a teacher occupying a transient or ongoing role, such as a parent or sibling or within a family, or by anyone with knowledge or skills in the wider community setting. Religious and spiritual teachers, such as gurus, mullahs, rabbis, pastors/youth pastors and lamas may teach religious texts such as the Quran, Torah or Bible.

PROFESSIONAL EDUCATORS

Teaching may be carried out informally, within the family which is called home schooling or the wider community. Formal teaching may be carried out by paid professionals. Such professionals enjoy a status in some societies on a par with physicians, lawyers, engineers, and accountants. A teacher's professional duties may extend beyond formal teaching.

Outside of the classroom teachers may accompany students on field trips, supervise study halls, help with the organization of school functions, and serve as supervisors for extracurricular activities. In some education systems, teachers may have responsibility for student discipline.

Around the world teachers are often required to obtain specialized education, knowledge, codes of ethics and internal monitoring. There are a variety of bodies designed to instill, preserve and update the knowledge and professional standing of teachers. Around the world many governments operate teacher's colleges, which are generally established to serve and protect the public interest through certifying, governing and enforcing the standards of practice for the teaching profession. The functions of the teacher's colleges may include setting out clear standards of practice, providing for the ongoing education of teachers, investigating complaints involving members, conducting hearings into allegations of professional misconduct and taking appropriate disciplinary action and accrediting teacher education programmes. In many situations teachers in publicly funded schools must be members in good standing with the college, and private schools may also require their teachers to be college peoples. In other areas these roles may belong to the State Board of Education, the Superintendent of Public Instruction, the State Education Agency or other governmental bodies. In still other areas Teaching Unions may be responsible for some or all of these duties.

PEDAGOGY AND TEACHING

In education, teachers facilitate student learning, often in a school or academy or perhaps in another environment such as outdoors. A teacher who teaches on an individual basis may be described as a tutor. The objective is typically accomplished through either an informal or formal approach to learning, including a course of study and lesson plan that teaches skills, knowledge and/or thinking skills. Different

ways to teach are often referred to as pedagogy. When deciding what teaching method to use teachers consider students' background knowledge, environment, and their learning goals as well as standardized curricula as determined by the relevant authority. Many times, teachers assist in learning outside of the classroom by accompanying students on field trips. The increasing use of technology, specifically the rise of the internet over the past decade, has begun to shape the way teachers approach their roles in the classroom. The objective is typically a course of study, lesson plan, or a practical skill. A teacher may follow standardized curricula as determined by the relevant authority.

The teacher may interact with students of different ages, from infants to adults, students with different abilities and students with learning disabilities. Teaching using pedagogy also involve assessing the educational levels of the students on particular skills. Understanding the pedagogy of the students in a classroom involves using differentiated instruction as well as supervision to meet the needs of all students in the classroom. Pedagogy can be thought of in two manners. First, teaching itself can be taught in many different ways, hence, using a pedagogy of teaching styles. Second, the pedagogy of the learners comes into play when a teacher assesses the pedagogic diversity of his/her students and differentiates for the individual students accordingly. Perhaps the most significant difference between primary school and secondary school teaching is the relationship between teachers and children.

In primary schools each class has a teacher who stays with them for most of the week and will teach them the whole curriculum. In secondary schools they will be taught by different subject specialists each session during the week and may have 10 or more different teachers. The relationship between children and their teachers tends to be closer in the primary school where they act as form tutor, specialist teacher and surrogate parent during the course of the day. This is true throughout most of the United States as well.

However, alternative approaches for primary education do exist. One of these, sometimes referred to as a "platoon" system, involves placing a group of students together in one class that moves from one specialist to another for every subject. The advantage here is that students learn from teachers who specialize in one subject and who tend to be more knowledgeable in that one area than a teacher who teaches many subjects. Students still derive a strong sense of security by staying with the same group of peers for all classes. Co-teaching has also become a new trend amongst educational institutions. Co-teaching is defined as two or more teachers working harmoniously to fulfill the needs of every student in the classroom. Co-teaching focuses the student on learning by providing a social networking support that allows them to reach their full cognitive potential. Co-teachers work in sync with one another to create a climate of learning.

CONCEPT OF TEACHING SKILLS

“Teaching constitutes activities that are designed and performed to produce change in student behaviour.” Komisar has pointed out that various specific activities included in teaching are introducing, demonstrating, citing, reporting, confirming, questioning, elaborating, etc., which may be considered as constituent skills of teaching. In simple words, teaching constitutes a number of verbal and non-verbal teaching acts like questioning, accepting student responses, rewarding, smiling, movements, gestures, etc. These acts in particular combinations facilitate the achievement of objectives in terms of student growth. A set of related teaching acts or behaviours performed with an intention to facilitate students’ learning can be called a teaching skill.

‘Teaching skills are specific instructional techniques and procedures that a teacher may use in the classroom’. The Asian Institute for Teacher Educators has defined teaching skills as ‘specifically those activities of teaching that are especially effective in bringing about desired changes in students’. Mc Intyre and White have defined the term teaching skills as ‘a set of related teaching behaviours which in specified types of classroom interaction situations tend to facilitate the achievement of specified types of educational objectives’.

Teaching Skills

You have already understood the concept of a teaching skill.

Introducing a Lesson

When one introduces a stranger to you, your reactions towards him/her or your responses during the conversation with him/her depend upon the introductory statements that are made about him/her.

Similarly, when a teacher introduces a lesson or a unit, he/she gives a brief introduction about the lesson or the unit, in order to draw the students’ attention to it. Generally, an introduction to a lesson includes what the teacher does with or without the help of the students upto the stage of stating the aim of the lesson. Teachers differ from each other in the way they introduce a lesson. Studies have shown that the students’ learning of the new lesson or unit largely depends on the way the lesson is introduced. A teacher must possess the necessary skill to introduce a lesson or unit in an effective manner. The components of the skill of introducing a lesson are:

- Desirable behaviours:
 - *Using previous knowledge*: The previous knowledge refers to knowledge already possessed by the students. If any new knowledge is to be added to the previous knowledge, there should be a logical continuity between

them. New knowledge should also be relevant to previous knowledge of students. When we present new knowledge to the students, we have to bring their previous knowledge to their conscious level.

- *Using appropriate devices*: Here, ‘device’ refers to the technique that a teacher uses while introducing a lesson. Such devices can be:
 - a. Use of examples
 - b. Questioning
 - c. Lecturing describing narrating
 - d. Story telling
 - e. Dramatisation
 - f. Audio-visual aids and
 - g. Experimentation. The appropriateness of the use of each of these devices depends on its suitability to the maturity level, age level, grade level, interest, experience of the students and also on the lesson to be taught.
- Undesirable behaviours:
 - *Lacking in continuity*: Continuity refers to the sequence of ideas or information being presented. While introducing a lesson, continuity breaks when the statements made for questions asked by the teacher are not logically sequenced.
 - *Making irrelevant statements*: A statement or a question which a teacher makes while introducing a lesson, is said to be irrelevant when it is not related to the aim of the lesson. Such statements or questions do not contribute to the effectiveness of the skill in terms of establishing rapport with the students. Sometimes such statements also confuse the students.

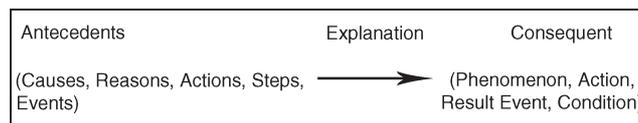
Explaining

In our day to day life you find persons explaining some idea or phenomenon by going deep into the matter with appropriate examples, logically organising the ideas, using certain non-verbal gestures, etc. You also find persons who cannot explain clearly. They jumble up ideas. They not only confuse the audience but also get confused themselves. This is because they do not present ideas in a logical sequence.

In classrooms right from grade I through higher grades, a teacher explains ideas and concepts. It is a most commonly used skill and is the essence of instruction. When a student does not clearly understand the ideas which his/her teacher tries to convey, he/she generally asks for an explanation. A teacher is said to be explaining when he/she is describing ‘how’, ‘why’ and sometimes ‘what’ of a concept, phenomenon, event, action or condition. Explanation can also be defined as an activity to bring about an understanding in someone about a concept, principle,

etc. Explanation involves filling up the gap in one's understanding of the new phenomenon by relating it to his/her past experience. Thus, explanation depends on the type of the past experience, the type of the new phenomenon and the type of relationships between them.

In a classroom, an explanation is a set of interrelated statements made by the teacher related to a phenomenon or an idea, in order to bring about or increase understanding of the students about it. While giving explanation, we generally explain causes of the phenomenon, reasons for the action, various steps involved in arriving at the particular result, or various events that have occurred earlier resulting in the event being explained. All such causes, reasons, steps, events, etc., are called 'antecedents'. Such antecedents result in the phenomenon, event, result or action. Each of these is known as a consequent. Thus an explanation involves giving antecedents to a consequent, which can be diagrammatically presented as follows:



There are various techniques through which we can explain an idea, phenomenon, etc. They are question-answer technique, use of audio-visual aids or by making certain related statement concerning what we have to explain. Sometimes we use all the techniques simultaneously to make explanation more effective. To summarise, the desirable teacher behaviours for effective explanation should include, using only relevant statements, having continuity in statements, using vocabulary which the students know, being fluent in speech, avoiding vague words and phrases, using beginning and concluding statements and testing students' understanding by putting a few questions.

Questioning

Questioning is an important teaching skill that a teacher must learn. A teacher needs to put meaningful questions to the students during the teaching-learning process. You may be curious to know more about 'meaningful questions'.

Let us try to know what makes a question meaningful by considering:

- Structure,
- Process, and
- Product of questioning

Structure refers to the grammatical aspect and the content part of the question.

Various criteria for a well structured question are:

- Grammatical correctness,

- Conciseness,
- Relevance, and
- Specificity.

Increasing Student Participation

You must be aware that when a student participates in the learning process, His/her learning becomes more effective. A student is said to participate when He/she takes active part which is observable by responding to what the teacher asks for, by contributing his/her own ideas related to the topic being taught by the teacher or by reacting to others' ideas in the classroom. Student participation is an observable behaviour of students and includes responding and initiating. When a student is listening to the teacher he/she is not participating, because listening behaviour of the student is not observable.

Student participation in the classroom is essential for the following reasons:

- Students are more attentive towards the lesson when they are participating.
- Students' urges of social recognition and social acceptance are satisfied.
- There will be better understanding on the part of the students when they participate.
- A teacher can evaluate his/her teaching, that is, whether it is being effective in bringing about learning or not.

Skill of increasing student participation involves integrating the various components of the skill, namely, creating set, questioning, encouraging student participation and pausing in such combinations and proportions so as to maximize student participation.

These components are explained below:

- *Creating Set:* 'Set' in a class room may be defined as mental readiness on the part of the students before learning any task. If the students have to participate in the classroom discussion, they should be mentally ready, emotionally as well as cognitively. This can be done by posing to students a problem or situation which they discuss with the help of the teacher.
- *Questioning:* A question is a stimulus in the classroom that elicits student participation in terms of student response. You are aware that a good question is well structured, *i.e.*, precise, direct and grammatically correct. It is also put with proper tone modulation and made audible to all the students. To increase student participation the teacher should:
 - Avoid repeating questions,
 - Avoid answering his/her own questions, and
 - Avoid asking a number of questions.

- *Encouraging Student Participation:* In order to encourage student participation, we use two types of behaviours— verbal and non-verbal. Sometimes we may use both simultaneously. When the student gives the correct response we may say ‘yes’, ‘correct’, ‘very good’ and such other expressions. We may repeat student response to encourage. We may nod, smile-and sometimes pat the student who has responded. When the student gives a wrong response, we may say ‘think again’, ‘it is good that you have attempted’ and such other expressions. When the student has not given any response, we may say ‘come on’, ‘try’, etc.
- *Pausing:* Pausing can be defined as deliberate silence introduced by the teacher during classroom interaction so as to increase student participation. When the teacher pauses, the students are stimulated to participate. Pausing should be accompanied by non-verbal cues which would elicit more student participation.

Providing Reinforcement

You know that all the students need social approval for their behaviour. When they are answering or responding in the class, they are eager to know whether their answers or responses are correct or not. When the students come to know that the answers given by them are correct, they feel happy and get encouraged. Thus, their participation in the class increases. In such a situation, we say that the student’s behaviour of responding correctly is ‘reinforced’ or strengthened. In other words, it may be said that there is positive reinforcement in the student’s behaviour. In providing reinforcement important points to be remembered are as follows:

- Positive reinforcement means strengthening of desirable behaviour. It increases student participation in the class. Positive reinforces are those behaviours of the teacher which encourage students to participate more and more. ‘
- Negative reinforcement means weakening of undesirable behaviour. It decreases students’ participation in the class.
- Negative reinforces are those behaviours of the teacher which discourage the students to participate. Skill of reinforcement involves more and more the use of the positive reinforces and decrease the use of negative reinforces so that the students participate to the maximum.
 - In positive verbal reinforcement the teacher gives positive reinforcement through various verbal (with words) expressions. The teacher makes encouraging remarks such as ‘that’, ‘good’, ‘right’, ‘yes’, ‘correct’, ‘excellent’, ‘well done’, ‘continue’, etc.
 - Positive non-verbal reinforcement occurs when the teacher wants to reinforce positively a desired student response. The teacher may use

certain non-verbal (without words) expressions like nodding of head, smiling, moving towards the responding student, keeping eyes on the student, writing the response of the student on the blackboard or any other non-verbal action indicating pleasure at the student's response.

- Negative verbal reinforcement interferes with the learning of the students. It affects learning negatively and decreases the motivation of the students. We should avoid giving this type of reinforcement. The teacher should avoid discouraging expressions such as 'you are not good', 'wrong', 'non-sense', 'incorrect', 'stop it', 'do something else', etc. The negative remarks of this type should be avoided if the students are to participate more in the class.
- Negative non-verbal reinforcement is given by using such behaviours as moving away from the responding student, keeping eyes on the student with discouraging looks, hard and disapproving stares, not looking at the responding student, tapping foot impatiently and walking around, etc. The teacher should be conscious of such behaviours and avoid them as far as possible if the skill of reinforcement is to be used effectively.

CHARACTERISTICS OF EFFECTIVE TEACHING STRATEGY

For educational communication to be effective, a proper teaching strategy needs to be adopted. The selection of suitable teaching strategy depends upon the task, context and the teacher's discretion.

Nonetheless, a good strategy:

- Captures and maintain interests;
- Interprets the concepts clearly;
- Encourages critical thinking;
- Applies the learning in problem-solving; and
- Stimulates self-learning.

For this, it is important to select and organise the material taking into consideration learners' abilities, interests and psychological factors into mind. The sequencing of information, *i.e.*, moving from familiar to unfamiliar, simple to complex, general to specific and concrete to abstract needs to be done. Utilisation of illustrations, audio-visual aids, humour, questions use of exercises and assignments for continuous assessment increases the level of interest of students. Short, active responses during the course of the listening facilitate a greater degree of attentiveness and active participation by children.

Communication for Enhancing Children's Competencies

Communication enables development of listening and speaking skills for acquiring new concepts. While planning suitable tasks we need to bear in mind the age level and the interests of the children. The same activity can be varied for different age groups.

While planning suitable listening speaking and comprehension activities for learners, the following questions need to be raised:

- What type of listening activities actually go on in real life?
- What are the particular difficulties likely to be encountered by learners when coping with them?

We would like our children to go through activities which equip them to deal with real life situations effectively. In order to do this we have to create situations in the classroom which are as close to real life as possible.

To do this, we might need to look at:

- *Environment clues:* These include the facial expressions, posture, eye-direction, proximity, gesture and tone of voice of the speaker. In addition, related noises, visual materials such as illustrations, diagrams or maps may be deliberately introduced to make the listening experience as close to real life as possible.
- *Communication in real life:* Communication is interrupted by various stimulus such as person, action, visuals, happenings, etc., in the environment. In real life, stretches of heard speech are broken up by being spoken by different people from different directions. Even when there are long periods of seemingly uninterrupted discourse-talks, instructions, anecdotes, etc., these are often broken down into smaller units by the physical movement of the speaker - pauses, audience reaction, changing environmental clues. More formal stretches of speech - lectures, broadcasts, reports are usually less interrupted.
- *Formal/Informal communication:* It is necessary to draw a distinction between formal and informal communication used in most spontaneous conversations. You would have noticed a range of formality, stretching from the extremely formal (speeches, lectures), to the fairly formal (news reading), to the fairly informal (television interviews), to the very informal (gossip, conversations, phone chats). As teachers, you need to be aware of these aspects to identify the special characteristics of speech that go with the degree of formality for effective communication.

There is a distinct difference between the auditory effect of a piece of spoken prose and that of informal conversation. The former is characterised by a fairly even pace, volume and pitch. Spontaneous conversation, on the other hand, is jerky,

has frequent pauses and overlaps, goes intermittently faster and slower, louder and softer, higher and lower. Hesitations, exclamations, emotional reactions of surprise, irritation or amusement are bound to cause uneven and constantly changing rhythm of speech. Informal speech also contains a lot of colloquial terms, which are often spontaneous. The listener needs to develop some skills to identify the characteristics of this kind of speech. The message of a piece of spontaneous talk is delivered much more slowly, with a lot of repetition and irrelevant talk, than that of a rehearsed or planned speech.

In addition to preparing the activities keeping real life aspects in view, you can use variety of occasions in classroom to impart the skills of listening for:

- Main ideas,
- Important details,
- Sequence of events.

In this context, let us discuss two types of problems that have been identified to be most resistant for instructions:

- *Overuse of preferred information:* Many pupils tend to ignore important information and rely excessively on the facts that appeal to them. Their attention has to be consciously drawn to other relevant facts.
- *Lack of comprehension monitoring:* Many pupils tend to understand narratives, descriptions and explanations one fact at a time, without being able to evaluate the facts or see inconsistencies in the facts. They need to be given several such tasks, initially as reading tasks, where their eyes can move back and forth to detect inconsistencies. Later similar tasks can be given as listening task. The stories they have heard, the places they have visited, the home environment, the programmes they have been listening to on television all provide the backdrop against which they are able to view and give meaning to the various sounds. You can specifically develop tasks which will help children to improve some particular aspects of their listening. Efficient, active attentive listening needs to be taught at all grade levels.

Teacher-Pupils' Communication

Different types of communication serve different purposes. We can utilise these effectively to facilitate teacher-pupils' communication.

Interpersonal Communication

The teacher who values good rapport with children takes time to listen to children. This is where the student and the teacher have a real opportunity to grow and to

change together. Generally, teachers say eighty per cent of the words in classroom. S/he may try to maximize informal interactions this would increase interaction amongst students.

Endless repetition can be avoided by challenging children to listen carefully. If additional clarification is required, the children should be encouraged to help each other. New topics, instructions and activities need to be planned carefully to correlate with the child's attention span. Variety adds interest, renewed enthusiasm and better listening opportunities in the classroom. They should not become tedious, boring or overwhelming. You also need to reward and commend good behaviour.

Sincere statements to the class at appropriate times might include:

- I appreciate your attention to what was taught.
- I can tell by your answers that you're listening carefully for main ideas.
- I see that you stopped what you were doing to be ready for these directions.

Individual statement of appreciation and observation are always prized by children. Honest, non-judgemental, positive feedback is a reward highly valued by students. These type of comments are quite different from empty praise. It specifically tells students what the teacher values in their task or behaviour. Children will often follow the teacher's example by commenting on good listening by their peers.

Group Communication

Teacher-pupils communication and peer-group interaction falls under group communication. Teachers' skill in organisation and conduction of interaction leads to various outcomes such as sharing of ideas, opinions, information, settlement of differences, problem-solving and so on. Children talk and listen better in informal settings rather than in formal, impersonal settings such settings need to be created. The length of time for which children can attend to any communication depends in part upon the interest span and amount of time children of a given age can remain physically inactive. The duration of group activities needs to be carefully planned. To stimulate attentive listening, children need to be motivated. Teacher can use the skill of stimulus variation during communication, such as change in speech pattern (change in tone, volume or speed) of communication can make communication more effective and useful. Interest can be created through a range of post-listening activities which allow children to give personal expression to what they hear - through asking questions, dramatisations, or expressing their ideas with paper, paint and clay. Before beginning a story, the teacher might say, "when I finish the story, let's see if you know what happened to the Rabbit?" Or she may stop occasionally to ask questions that test attentiveness, as "why did the mangoes fall off the tree?" Opportunities to talk over what they listened to or to repeat important points increase the retention of material and give purpose to listening.

MICROTEACHING

Microteaching is a training technique whereby the teacher reviews a videotape of the lesson after each session, in order to conduct a “post-mortem”. Teachers find out what has worked, which aspects have fallen short, and what needs to be done to enhance their teaching technique. Invented in the mid-1960s at Stanford University by Dr. Dwight Allen, micro-teaching has been used with success for several decades now, as a way to help teachers acquire new skills. In the original process, a teacher was asked to prepare a short lesson (usually 20 minutes) for a small group of learners who may not have been her own students.

This was videotaped, using VHS. After the lesson, the teacher, teaching colleagues, a master teacher and the students together viewed the videotape and commented on what they saw happening, referencing the teacher’s learning objectives. Seeing the video and getting comments from colleagues and students provided teachers with an often intense “under the microscope” view of their teaching. Micro lessons are great opportunities to present sample “snapshots” of what/how you teach and to get some feedback from colleagues about how it was received. It’s a chance to try teaching strategies that the teacher may not use regularly. It’s a good, safe time to experiment with something new and get feedback on technique.

Techniques

Since its inception in 1963, microteaching has become an established teacher-training procedure in many universities and school districts. This training procedure is geared towards simplification of the complexities of the regular teaching-learning process. Class size, time, task, and content is scaled down to provide optimal training environments. The supervisor demonstrates the skill to be practiced. This may be live demonstration, or a video presentation of the skill. Then, the group members select a topic and prepare a lesson of five to ten minutes. The teacher trainee then has the opportunity to practice and evaluate her use of the skills. Practice takes the form of a ten-minute micro-teaching session in which five to ten pupils are involved

Feedback

Feedback in microteaching is critical for teacher-trainee improvement. It is the information that a student receives concerning his attempts to imitate certain patterns of teaching. The built-in feedback mechanism in micro-teaching acquaints the trainee with the success of his performance and enables him to evaluate and to improve his teaching behaviour. Electronic media gadgets that can be used to facilitate effective feedback is a vital aspect of micro-teaching.

LANGUAGE SIMPLIFICATION FOR NEOLITERATES

Post-literacy and follow-up measures are highly essential to retain the level of literacy among the neoliterates and to prevent them from relapsing into illiteracy. However much an adult learner is motivated to acquire the skills of literacy and numeracy, it has to be followed up carefully to sustain their interest and create reading habits among them with a view to ensuring a learning society. It has been alleged that even among the educated, reading habits are deteriorating; not to speak of teachers most of whom depend upon their own lecture notes and prescriptions of the good old days. Even in Kerala, where there is a good library movement with a network of more than 4000 rural libraries, it has been reported that there are not many readers, who really read standard books. Novels, short stories, dramas, etc., are liked by people but not scientific, technological and reference books. So good reading habits have to be inculcated among the neoliterates through properly directed and guided reading. For this appropriate books are needed.

Who is a Neoliterate?

Any one who did not or could not make use of the available educational opportunities, on time, and who at a later stage acquired the skills of reading and writing through formal, informal and non-formal approaches, can be said to be a neoliterate. He/She was hitherto unable to read and comprehend the printed or written word but can, now, with fluency or with difficulty, read and understand the print media. A neoliterate can be described as one who has acquired the ability to read and write his or her mother-tongue, rather late *i.e.*, after acquiring adulthood or even in old age. The reading speed and power of comprehension might differ from person to person and appropriate reading materials are needed for them.

Are there Reading Materials for Neoliterates?

Yes. There are. In most of the Indian languages and in English. But many have confused neoliterate literature with children's literature and hence most books that we find in the market are not meant for the target groups. Books for neoliterates should have certain specific qualities and hence should form a separate category.

The Government of India organised competitions for the neoliterate books with a view to ensuring the production of books of quality that would attract the neoliterate adults. By now, a cadre of neoliterate writers have emerged in Kerala, thanks to the attempts of the Kerala Grandhasala Sanghom and KANFED (Kerala Association for Non Formal Education and Development). Nearly 100 books have

been produced by the Sanghom and KANFED has to its credit more than double this number. Both the agencies published books for neoliterates not as a business concern but as service.

The established booksellers and producers (including the SPCS—Sahitya Pravartaka Cooperative Society) have yet to enter the field. The Award winning neoliterate books also do not possess high standards as only few dare to submit their scripts for scrutiny and not many are aware of the competitions, though 23 years have passed since the system was introduced. In Malayalam we have about 400 books which are classified as neoliterate books, of which at least half the number are worth that categorisation. Others need thorough revision. Not only books, but pamphlets and periodicals are also there addressed to the neoliterates. The ‘Saksharakeralam’ weekly published by the Sanghom for 5 to 6 years (not now) and ‘KANFED `News’ published by KANFED since 1978 are worth mentioning. A monthly wall newspaper ‘Nattuvalicham’ published by KANFED serves not only neoliterates but the elite as well, as a conscientising piece of immediate use and attraction. But the regular newspapers and periodicals are yet to start setting apart a column at least for the neoliterates.

Qualities Expected of Neoliterate Books

The following are some of the general guidelines:

- Neoliterate books should deal with their immediate surrounding needs, aspirations, etc. They should easily attract the attention of the reader and tempt him to read more books.
- The vocabulary should be in accordance with that of the neoliterates and the style of presentation, simple. Small sentences with familiar words should be preferred. The narration should be interesting. Unfamiliar objects and situations should be illustrated. Care should be given in avoiding factual errors in the books.
- The books should convey the message of better living and social progress. Taboos and superstitious beliefs have to be rooted out gradually through appropriate measures. Conversational style and familiar situation have to be preferred.
- The books should be graded according to the vocabulary content, etc., and readability, from the point of view of the learner. All neoliterate books need not be of the same difficulty level. There should be books on Science and technology, occupations, places of importance, legal aid to the poor, health and hygiene, democracy and citizenship, etc., besides stories, travelogues, biographies, etc. Folk songs, abridged versions of epics, etc., may also be attempted.

- The format and lay put should be designed properly to attract the neoliterates. Convenient size of the book and use of bold types facilitating easy reading should be preferred. The number of pages may range from 24 to 60.

A neoliterate book should be such that at first sight one should be tempted to take the book and examine it, read it at a stretch and read it again and again till it is fully comprehended.

The cover, paper, illustration, etc., are all contributory factors; but major emphasis should be on the content and presentation.

CAEE Workshops on Neoliterate Literature

The Centre for Adult Education and Extension (CAEE) with the support of its Extension wing, the Literacy Forum organised a series of workshops during 1980 and 1981 for evolving criteria for the preparation and evaluation of neoliterate books.

The workshop has recommended the following criteria:

- Group I—Relevance of the content, Relationship of the theme with the neoliterate, type of letters used, length of sentence, simplicity of language, sequence of ideas, style of presentation, reality, values, message.
- Group II—Mode of presentation, evidences, propriety of examples, possibilities of expansion, printing.
- Group III—Clarity, truthfulness and number of illustrations, size of the book, paper used, column used, cover, lay out, preface and cost of the book.

The 25 categories listed above are given a maximum weightage of 5 (first 10), 4 (for the next 5) and 3 (for the last 10) respectively if the quality is rated as 'good'. For an 'average' response, one point less and for a 'poor' response, one more point less was suggested yielding a maximum of 100 points and a minimum of 50. In the grading of the neoliterate books using the above criteria, the following categorisation has also been recommended by the workshop.

Scores	51—60	Poor
•	61—70	Average
•	71—80	Good
•	81—90	Very good
•	91—100	Excellent

The workshop which evaluated 60 neoliterate books selected at random could find only 10 per cent as 'excellent' and another 15 per cent "very good". These criteria were effectively used in the evaluation of a series of 'Science Cream' books

published by the Kerala Shastra Sahitya Parishad, which could identify 10 books for bulk purchase by the Development department for post literacy and follow up work.

KANFED organised evaluation workshop involving neoliterate writers for grading their publication and improving the quality of the books. Though there are plenty of books, they have yet to be scientifically screened.

Qualitative Improvement Needed

On a perusal of the neoliterate books published in Malayalam by various agencies, and the award winning neoliterate books, one is tempted to comment that qualitative improvement is an urgent necessity. Though the books are mostly prepared in workshops and scrutinised and edited by special committees, flaws are not few in many respects. The authors have their own style of writing which can be pruned only to a limited extent. Hence it becomes necessary to evolve norms regarding the language to be used in books for neoliterates. Here it lies the significance of the present seminar.

How to Simplify the Language?

Different writers mean different things while using the term ‘simple language’—so many the length of sentence is the major factor. To some others, the vocabulary matters much. Familiar and often used words are preferred by most writers. This they do to simplify the language. Compound and complex sentences make comprehension difficult for the neoliterate. I however doubt whether such sentences can be completely avoided. In science and technology it requires special ability to bring down the technical aspects to the level of the neoliterate. Many have succeeded in this area as well.

There is a tendency to count three alphabets as one word. It is doubtful whether this can be applied to neoliterate literature? The State Institute of Encyclopaedic Publications. The State Institute of Languages, etc., have come forward with this ‘three alphabet-word’ formulae. Simple words which are frequently used by the illiterates have many more alphabets. Hence this restriction, I feel, is applicable to neoliterates.

Length of sentence can be a criterion, especially in the neoliterates series. Colloquial terms make comprehension easier for the particular group but not as a whole. In print form generally acceptable and understandable words and phrases are to be preferred.

Conversational style and narrative approach will be more appealing to the neoliterates. Even highly technical knowledge can be simplified using familiar situations. Dialogue of ordinary style can evoke keen interest among the readers.

Certain simple expansions of joy, fear, exclaim anxiety surprise, etc., also can be attempted. Idioms and proverbs of local use can make things clear easily instead of giving long, scientific explanations. Comparisons with local conditions and specifics also may be attempted. The neoliterate adults are rich in experience. What they lack is the ability to read and write. If properly motivated, they will not hesitate to read anything presented to them, even if it is difficult to pronounce and comprehend.

Suggested Procedure for Preparing Neoliterate Books

Through a survey among the prospective readers, areas and topics of interest have to be identified first. A perusal of such a list will help one to fix up priorities in line with financial and allied matters.

Announcements inviting scripts from writers, be given in the radio, press, etc. The respondents may be assigned topics or titles of which the script should be made ready before a specified date. A workshop of all script writers may be convened at a suitable place with adequate number of resource personnel. The participants may be grouped based on fields or subjects. Each script writer may be asked to read his script while others listen and comment on the language, expression, style, etc. Constrictive criticisms are needed and the writer may be given chance to defend his viewpoints. Each writer has to pass through this ordeal and then comes the revision process.

The writers rewrite the script based on the suggestions and once again present the same before the group for approval. Having approved the scripts go to a scrutiny committee for editing, illustration, publishing, etc. The publishing concern has to look for the design, format, type, colour, cover, etc., as well as quality of paper and printing beside pricing.

The question of language simplification comes at the workshop level or even when directions or guidelines are issued to writers of neoliterate books. These cannot be a uniform pattern for all Indian languages, but certain common guidelines can be evolved such as the ones suggested in the previous section. Any book produced for neoliterates should not wait for a reader. It should be in great demand. Readers should come in search of the book. Let us see how best we can ensure this.

5

Education: A Primary Catalyst for Transformation

MEANING OF EDUCATION

Education in the largest sense is any act or experience that has a formative effect on the mind, character or physical ability of an individual. In its technical sense, education is the process by which society deliberately transmits its accumulated knowledge, skills and values from one generation to another. Etymologically, the word education is derived from educare “bring up”, which is related to educere “bring out”, “bring forth what is within”, “bring out potential” and ducere, “to lead”.

Teachers in educational institutions direct the education of students and might draw on many subjects, including reading, writing, mathematics, science and history. This process is sometimes called schooling when referring to the education of teaching only a certain subject, usually as professors at institutions of higher learning. There is also education in fields for those who want specific vocational skills, such as those required to be a pilot. In addition there is an array of education possible at the informal level, such as in museums and libraries, with the Internet and in life experience.

Many non-traditional education options are now available and continue to evolve. A right to education has been created and recognized by some jurisdictions: since 1952, Article 2 of the first Protocol to the European Convention on Human Rights obliges all signatory parties to guarantee the right to education. At world level, the United Nations’ International Covenant on Economic, Social and Cultural Rights of 1966 guarantees this right under its Article 13.

AIMS AND OBJECTIVES OF EDUCATION

The importance of aims and objectives of education is recognised by all the educational, professional, political, non-political and religious associations, organisations and groups at various levels in their memoranda, letters and brochures. It is said that education without clear cut aims is like a rudderless ship. The following comparisons emphasise this point fully well. Every pilot has a route-chart and set timing of landing at predetermined destination. There is constitution or set of Principles and traditions through which a country is governed Similarly, there should be properly defined and declared principles, aims and objectives of education or the basis of which policies and programmes of education have to be formulated to achieve the set goals without wasting scarce energies and resources in chasing the wild goose.

It is generally felt that our educational system has not followed the desired aims as a result that it does not produce ideal citizens in the country. It has followed, rather a narrow aim of preparing individuals for livelihood, as mentioned in one of the documents received from an organisation. The main reason of failure of educational system is that it basically stands on, pre-independence system. The main Objective of its products was how to take degree and to earn money and to be careerist without consideration of ethical values and national spirit. On the other hand, it has also been pointed out that it is unreasonable to criticise educational system alone because it is based on the other subsystems accepted by us. On the one hand we are developing and cultivating the British given economy, judicial system and system of administration and parliament, and on the other we are decrying and Criticising the education system which merely fulfils the needs of the British systems that we are propagating. As pointed out in a memorandum of an association, “the main defect of the old. education policy, is that it had completely ignored the Indian culture and the interest of the masses of India and have left them economically too backward and socially too fragmented to articulate their miseries....” The aims and objectives of education, suggested in the documents, include individual as well as social aims, with emphasis of social transformation aiming at reconstructing society to make it modernised, productive, participative, and value oriented nation committed to its constitutional obligations.

INDIVIDUAL DEVELOPMENT

Development of an individual - physically, mentally and spiritually is well known aim of education.

Objectives related to this aim of individual development have been expressed in various ways in the memoranda:

- Developing physical and mental faculties

- Acquiring the capacities of understanding, appreciation and expression through word and act, are the fundamental aims of education
- Aim of education should be to make children self- confident and self dependent, and to make them strong physically and mentally
- Education is meant to develop every child's character, personality and culture and as much knowledge as the child can assimilate not merely memorize.

The best expression of complete development of an individual and the harmonious development of personality.

The policy should be directed to the aim of enlightenment of head and heart; illumination of consciousness for allround development of individual personality. Education should enable a human being to attain the greatest possible harmony, internal and external, spiritual and material, for the fullest possible development of human potentialities and capacities.

SOCIAL AND NATIONAL DEVELOPMENT

Social, aim of education is equally important because an individual lives in society and has his obligations towards his nation. There is a realisation that, "The present education system does not yield required results mainly because it is divorced from the real social content and social goals".

It has, therefore, been suggested that education should be able, to discharge its natural functions and must correspond to its structure, goals and content in the interest of national development and social progress. It has also been suggested in this connection that students from young age should be made aware of the social responsibility cast on them.

At the same time, there are certain constitutional commitments, which are intimately related to this aim.. We as the citizens of the republic, are constitutionally Committed to democracy, social justice, equality of opportunity, secularism and above all to a welfare state. It has, therefore, been suggested that, "Educational policy and educational programme should clearly reflect these commitments".

The objectives of developing a sense of national identity, unity and patriotism are advocated by many associations. It is pointed out that the national objectives of planning and programmes and development with special emphasis on popular participation and the national problems that we face in different fields should. be taught at relevant stages. Individual and social aims of education are not contrary to one another. In fact they are complementary to one another. The following view strikes a balance between individual and social aims of education. The purpose of education should be the development of the fullest possible capacities and potentialities physical and spiritual of a 'total man'. It should make a man capable of earning his livelihood reasonably

well to enjoy a happy and secure life while making effective contributions to the society and national effort of making India strong# advanced and prosperous.

RELATING EDUCATION TO THE LIFE, NEEDS AND ASPIRATIONS OF THE PEOPLE

As is well known, the existing system of education is largely unrelated to life and there is a wide gulf between its content and purposes and the concerns of national development.

For instance,

- The educational system does not reflect the supreme importance of agriculture which is neglected at all stages and does not attract an adequate share of the top talent in the country; enrolment in the agricultural faculties of universities is extremely low; and agricultural colleges are comparatively weak and underdeveloped;
- The main task before the nation is to secure rapid economic development. If this is to be successfully accomplished, education must be related to productivity. The present system is too academic to be of material help in increasing national wealth;
- The schools and colleges are largely unconcerned with the great national effort at reconstruction and teachers and students generally remain uncommitted to it. They are often even unaware of its principles and very rarely have opportunities to participate in its programmes;
- Instead of promoting social and national integration and making an active effort to promote national consciousness, several features of the educational system promote divisive tendencies; caste loyalties are encouraged in a number of private educational institutions; the rich and the poor are segregated, the former attending the better type of private schools which charge fees while the latter are forced, by circumstances, to attend free government or local authority schools of poor quality; and - at a time when the need to cultivate a sense of moral and social responsibility in the rising generation is paramount, education does not emphasize character-formation and makes little or no effort to cultivate moral and spiritual values, particularly the interests, attitudes and values needed for a democratic and socialistic society.

There is hardly any need to multiply such instances. The nature of the transformation needed in our educational system is generally recognized. What we wish to emphasize is its urgency. Traditional societies which desire to modernize themselves have to transform their educational system before trying to expand it,

because the greater the expansion of the traditional system of education, the more difficult and costly it becomes to change its character. This truth has been lost sight of and, during recent years, we have greatly expanded a system which continues to have essentially the same features it had at its creation about a century ago. In our opinion, therefore, no reform is more important or more urgent than to transform education, to endeavour to relate it to the life, needs and aspirations of the people and thereby make it a powerful instrument of social, economic and cultural transformation necessary for the realization of our national goals. *This can be done if education is related to productivity;*

- Strengthens social and national integration; consolidates democracy as a form of government and helps the country to adopt it as a way of life;
- Hastens the process of modernization; and
- Strives to build character by cultivating social, moral and spiritual values.

All these aspects are interrelated and in the complex process of social change, we cannot achieve even one without striving for all.

EDUCATION AND PRODUCTIVITY

India is in transition from a society in which education is a privilege of a small minority to one in which it could be made available to the masses of the people. The immense resources needed for this programme can be generated only if education is related to productivity so that an expansion of education leads to an increase in national income which, in turn, may provide the means for a larger investment in education. Education and productivity call thus constitute a 'rising spiral' whose different parts sustain and support one another.

The link between education and productivity can be forged through the development of the following programmes which should receive high priority in the plans of educational reconstruction:

- Making science a basic component of education and culture;
- Making work-experience an integral part of general education;
- Vocationalization of education, especially at the secondary school level, to meet the needs of industry, agriculture and trade; and
- Improvement of scientific and technological education and research at the university stage with special emphasis on agriculture and allied sciences.

SCIENCE AS A BASIC COMPONENT OF EDUCATION AND CULTURE

A basic distinction between traditional and modern societies is the development and use by the latter of science-based technology which helps modernization of

agriculture and the development of industries. In a traditional society, production is based largely on empirical processes, experience, and trial and error, rather than on science; in a modern society, it is basically rooted in science.

The electrical industry was probably the first to become science-based; next came the chemical industry; and now, in industrialized countries, agriculture is fast becoming a branch of applied science. This close interlocking and interdependence between science and technology is a characteristic of the contemporary world. In recent years, several countries have been able to raise their GNP very rapidly because of their investment in basic science, technology and education. We are at a crucial stage in the process of development and transformation; and in this context the role of science is of the utmost importance. Science education must become an integral part of school education; and ultimately some study of science should become a part of all courses in the humanities and social sciences at the university stage, even as the teaching of science can be enriched by the inclusion of some elements of the humanities and social sciences. The quality of science teaching has also to be raised considerably so as to achieve its proper objectives and purposes, namely, to promote an ever deepening understanding of basic principles, to develop problem-solving and analytical skills and the ability to apply them to the problems of the material environment and social living, and to promote the spirit of enquiry and experimentation. Only then can a scientific outlook become part of our way of life and culture.

It is necessary to highlight this last point which is sometimes underestimated. Science strengthens the commitment of man to free enquiry and to the quest for truth as his highest duty and obligation. It loosens the bonds of dogmatism and acts as a powerful dispeller of fear and superstition, fatalism and passive resignation. By its emphasis on reason and free enquiry, it even helps to lessen ideological tensions which often arise because of adherence to dogma and fanaticism. Although it is largely occupied with the understanding of Nature at present, its development is tending more and more to help man to understand himself and his place in the universe. In the developments that we envisage in the future, we hope that the pursuit of mere material affluence and power would be subordinated to that of higher values and the fulfillment of the individual. This concept of the mingling of 'science and spirituality' is of special significance for Indian education.

WORK-EXPERIENCE

As another programme to relate education to life and productivity, we recommend that work-experience should be introduced as an integral part of all education—general or vocational. We define work-experience as participation in productive work in the school, in the home, in a workshop, on a farm, in a factory or in any other productive situation.

In our opinion, all good and purposeful education should consist of at least four basic elements:

- ‘Literacy’ or a study of languages, the humanities and the social sciences;
- ‘Numeracy’ or a study of mathematics and the natural sciences; work-experience; and
- Social service.

In the present educational system, most of the time is taken up with the first, although even in this limited sphere, the attainments are not appreciable. The second is still quite weak and needs a great deal of emphasis. But the third and fourth have been almost totally absent till recently and need to be highlighted—the former mainly for relating education to productivity, and the latter as a means of social and national integration. The need to include work-experience as an integral part of education is to some extent inherent in the very nature and organization of formal education. Traditionally, an individual grew up in society through participation in its activities, and work-experience formed the bulk of his education.

While this method had several advantages, its weakness consisted in that it was not essentially dynamic and forward-looking and tended to perpetuate traditional patterns of behaviour. Formal education, on the other hand, tended to withdraw the child temporarily from participation in community activities and to train him, in an artificial environment for his anticipated future role in society. This created a cleavage between the world of work and the world of study. This defect is particularly conspicuous in our system of education which tends to strengthen the tradition of denigrating work and alienates the students, particularly the first-generation learners, from their homes and communities. The introduction of work-experience is intended to overcome, to some extent, these weaknesses and to combine the advantages of the formal and informal systems of education. Work-experience is thus a method of integrating education with work. This is not only possible but essential in modern societies which adopt science-based technology.

In all traditional societies, an antithesis between education and work is usually postulated, partly because the techniques of production are primitive and do not necessarily require formal education, special skills or high intellectual ability, and partly because the work is generally manual, low-paid, akin to drudgery and confined mostly to the uneducated ‘lower’ classes. As against this, education is generally the privilege of the upper classes who are interested, not in working for a living, but in the cultivation of interests which may help them in the enjoyment of life. The educated elite thus become largely parasitical in character and the real productive workers—at a low level of efficiency, generally—are the unlettered peasants and artisans. The complex techniques of production adopted in modern societies, on the other hand, require higher forms of general or technical education and a

comparatively higher level of intellectual ability. High talent is required for research in technology, and even at the lower levels of work, brains become more important than physical strength. The traditional resistance of educated persons to engage themselves in productive work tends to disappear because, with the adoption of the new technology, work in industry or on the farm becomes more productive and remunerative and ceases to be looked down upon socially.

The educated person thus becomes an important source of production and the uneducated person, an unproductive burden on society. This process, which has already started in our country, needs to be accelerated and therefore the inclusion of work experience as an integral part of all education acquires an urgent significance. The need to provide some such corrective to the over-academic nature of formal education has been widely recognized. In the curricula of most contemporary school systems, particularly in the socialist countries of Europe, a place is found for what is variously called 'manual work' or 'work-experience'. In our country, a revolutionary experiment was launched by Mahatma Gandhi in the form of basic education. The concept of work-experience is essentially similar. It may be described as a redefinition of his educational thinking in terms of a society on the road to industrialization. In addition to being an effective educational tool, work-experience can, in our view, serve some other important purposes. It can help to make the distinction between intellectual and manual work less marked as also the social stratification based on it.

It could make the entry of youth into the world of work and employment easier by enabling them to adjust themselves to it. It could contribute to the increase of national productivity both by helping students to develop insights into productive processes and the use of science, and by generating in them the habit of hard and responsible work.

And it might help social and national integration by strengthening the links between the individual and the community and by creating bonds of understanding between the educated persons and the masses. In providing work-experience, every attempt should be made to link programmes realistically to technology, to industrialization and to the application of science to productive processes, including agriculture. This 'forward look' in work-experience is important for a country which has embarked on a programme of industrialization.

In a well-organized programme, work-experience, at least from the higher primary stage, should also result in some earning for the student-either in cash or in kind. This would meet, to some extent, the expenditure which the students have to incur on their education or on their maintenance while at study. The amount of this earning will naturally increase as the students go up the educational ladder and it becomes possible to organize work-experience in a manner that would enable

them to 'earn and learn'. The ultimate objective should be to move towards a situation in which the education of a student is not held to be complete unless he participates in some type of work-experience in real-life conditions and earns some amount, however small, towards his own maintenance. This will also help to develop in him values which promote economic growth, such as appreciating the importance of productive work and manual labour, willingness and capacity for hard work, and thrift. We realize that this is no easy task. But it will pay adequate dividends in the long run.

VOCATIONALIZATION

Another programme which can bring education into closer relationship with productivity is to give a strong vocational bias to secondary education and to increase the emphasis on agricultural and technological education at the university stage. This is of special significance in the Indian situation. where, as we have pointed out, the educational system has been training young persons so far mostly for government services and the so-called white-collar professions. The introduction of practical subjects in secondary schools so as to divert them into different walks of life was first recommended, as far back as in 1882, by the Indian Education Commission.

But little or no effective action was taken to implement the recommendations and even today the enrolment in the vocational courses at the secondary stage is only nine per cent of the total enrolment, which is among the lowest in the world. Even at the university stage, vocational education was mostly ignored throughout the last century. The Calcutta University Commission pointed out that the great majority of university students about 22,000 out of 26,000- pursue purely literary courses which do not fit them for any but administrative, clerical, teaching and legal careers.

About fifty years later, we find that the overall picture has improved only slightly and the proportion of students at the university stage enrolled in all courses of professional education is only 23 per cent of the total enrolment. Our proposals on this subject are discussed elsewhere. But it may be briefly stated here that we visualize the future trend of school education to be towards a fruitful mingling of general and vocational education-general education containing some elements of prevocational and technical education, and vocational education, in its turn, having an element of general education. In the kind of society in which as suggested, be living in the coming years, a complete separation between the two will not only be undesirable but impossible. We also expect a considerable expansion of professional education at the university stage, especially in the agricultural and technological fields.

IMPROVEMENT OF SCIENTIFIC AND TECHNOLOGICAL EDUCATION

For the planned development of the national economy we need a large-scale expansion of enrolment in engineering and agriculture, and at the postgraduate level, in pure science subjects. The increase has to be several times the present enrolments. The quality of education and research needs a radical improvement.

DEVELOPMENT OF HUMAN RESOURCES

These difficult, complex, significant and urgent problems are all interdependent, and the shortest and most effective way to their solution is obviously to make a simultaneous attack on all fronts.

This will have to be attempted through two main programmes:

- The development of physical resources through the modernization of agriculture and rapid industrialization. This requires the adoption of a science-based technology, heavy capital formation and investment, and the provision of the essential infrastructure of transport, credit, marketing and other institutions; and
- The development of human resources through a properly organized programme of education.

It is the latter programme, namely, the development of human resources through education, which is the more crucial of the two. While the development of physical resources is a means to an end, that of human resources is an end in itself; and without it, even the adequate development of physical resources is not possible. The reason for this is clear. The realization of the country's aspirations involves changes in the knowledge, skills, interests and values of the people as a whole. This is basic to every programme of social and economic betterment of which India stands in need. For instance, there can be no hope of making the country self-sufficient in food unless the farmer himself is moved out of his age-long conservatism through a science-based education, becomes interested in experimentation, and is ready to adopt techniques that increase yields.

The same is true of industry. The skilled manpower needed for the relevant research and its systematic application to agriculture, industry and other sectors of life can only come from a development of scientific and technological education. Similarly, economic growth is not merely a matter of physical resources or of training skilled workers; it needs the education of the whole population in new ways of life, thought and work. Robert Heilbroner describes the journey to economic development undertaken by a traditional society as 'the great ascent' and points out that the essential condition for its success is human 'change on a grand scale'.

He observes: 'The mere laying of a core of capital equipment, indispensable as that is for further economic expansion, does not yet catalyse a tradition-bound society into a modern one. For that catalysis to take place, nothing short of a pervasive social transformation will suffice; a wholesale metamorphosis of habits, a wrenching reorientation of values concerning time, status, money, work; and an unweaving and reweaving of the fabric of daily existence itself.' These observations are applicable to advances on the social, political and cultural fronts as well.

EDUCATION AS INSTRUMENT OF CHANGE

If this 'change, on a grand scale' is to be achieved without violent revolution there is one instrument, and one instrument only, that can be used: EDUCATION. Other agencies may help, and can indeed sometimes have a more apparent impact. But the national system of education is the only instrument that can reach all the people. It is not, however, a magic wand to wave wishes into existence. It is a difficult instrument, whose effective use requires strength of Will, dedicated work and sacrifice. But it is a sure and tried instrument, which has served other countries well in their struggle for development. It can, given the will and the skill, do so for India. This emphasis on the social purposes of education, on the need to use it as a tool for the realization of national aspirations or for meeting national challenges, does not imply any underestimation of values for the individual. In a democracy, the individual is an end in himself and the primary purpose of education is to provide him with the widest opportunity to develop his potentialities to the full.

But the path to this goal lies through social reorganization and emphasis on social perspectives. In fact, one of the important principles to be emphasized in the socialistic pattern of society, which the nation desires to create, is that individual fulfillment will come, not through selfish and narrow loyalties to personal or group interests, but through the dedication of all to the wider loyalties of national development in all its parameters. This direct link between education, national development and prosperity which we have emphasized and in which we deeply believe, exists only when the national system of education is properly organized, both qualitatively and quantitatively. The naive belief that all education is necessarily good, both for the individual and for society, and that it will necessarily lead to progress, can be as harmful as it is misplaced. Quantitatively, education can be organized to promote social justice or to retard it. History shows numerous instances where small social groups and elites have used education as a prerogative of their rule and as a tool for maintaining their hegemony and perpetuating the values upon which it has rested. On the other hand, there are cases in which a social and cultural revolution has been brought about in a system where equality of educational opportunity is provided and education is deliberately used to develop more and more potential talent and to harness it to the solution of national problems. The same is even more true of the quality of education.

A system of university education which produces a high proportion of competent professional manpower is of great assistance in increasing productivity and promoting economic growth. Another system of higher education with the same total output but producing a large proportion of indifferently educated graduates of arts, many of whom remain unemployed or are even unemployable, could create social tensions and retard economic growth. It is only the right type of education, provided on an adequate scale, that can lead to national development; when these conditions are not satisfied, the opposite effect may result. Judged from this point of view, it becomes evident that the present system of education, designed to meet the needs of imperial administration within the limitations set by a feudal and traditional society, will need radical changes if it is to meet the purposes of a modern democratic and socialistic society—changes in objectives, in content, in teaching methods, in programmes, in the size and composition of the student body, in the selection and professional preparation of teachers, and in organization. In fact, what is needed is a revolution in education which in turn will set in motion the much desired social, economic and cultural revolution.

The main concern of this Report is to identify the major programmes that can bring about this educational revolution which has three main aspects:

- Internal transformation so as to relate it to the life, needs and aspirations of the nation;
- Qualitative improvement so that the standards achieved are adequate, keep continually rising and, at least in a few sectors, become internationally comparable; and
- Expansion of educational facilities broadly on the basis of manpower needs and with an accent on equalization of educational opportunities.

It is with the first group of the programmes, namely, the transformation of the system to reflect the needs and aspirations of the Indian people.

EDUCATION AND SOCIAL AND NATIONAL INTEGRATION

Social and national integration is crucial to the creation of a strong, united country, which is an essential pre-condition for all progress. It has a varied content—economic, social, cultural and political—and its different facets are closely interconnected. To make this social and psychological revolution possible, it is necessary to deal with the short-term problems facing the country in this field, particularly in regard to the growing and dangerous symptoms of social disorganization. These express themselves as the widening gulf between the rich and the poor, the privileged and the unprivileged, the urban and the rural, the educated and the uneducated. They are

reflected in the general weakening of the feeling of national solidarity under the increasing impact of local, regional, linguistic, religious and other sectional or parochial loyalties. Effective steps must be taken to bridge these dangerous gulfs and strengthen national consciousness and unity. Social and national integration is a major problem which will have to be tackled on several fronts, including education.

THE COMMON SCHOOL

In a situation of the type we have in India, it is the responsibility of the educational system to bring the different social classes and groups together and thus promote the emergence of an egalitarian and integrated society. But at present instead of doing so, education itself is tending to increase social segregation and to perpetuate and widen class distinctions. At the primary stage, the free schools to which the masses send their children are maintained by the government and local authorities and are generally of poor quality. Some of the private schools are definitely better; but since many of them charge high fees, they are availed of only by the middle and the higher classes. At the secondary stage, a large proportion of the good schools are private but many of them also charge high fees which are normally beyond the means of any but the top ten per cent of the people, though some of the middle class parents make great sacrifices to send their children to them. There is thus segregation in education itself—the minority of private, fee-charging, better schools meeting the needs of the upper classes and the vast bulk of free, publicly maintained, but poor schools being utilized by the rest.

What is worse, this segregation is ‘increasing and tending to widen the gulf between the classes and the masses. This is one of the major weaknesses of the existing educational system. Good education, instead of being available to all children, or at least to all the able children from every stratum of society, is available only to a small minority which is usually selected not on the basis of talent but on the basis of its capacity to pay fees. The identification and development of the total national pool of ability is greatly hampered. The position is thus undemocratic and inconsistent with the ideal of an egalitarian society.

The children of the masses are compelled to receive sub-standard education and, as the programme of scholarships is not very large sometimes even the ablest among them are unable to find access to such good schools as exist, while the economically privileged parents are able to ‘buy’ good education for their children. This is bad not only for the children of the poor but also for the children from the rich and privileged groups. It gives them a short-term advantage in so far as it enables them to perpetuate and consolidate their position. But it must be realized that, in the long run, their self-interest lies in identifying themselves with the masses. By segregating their children, such privileged parents prevent them from sharing the life and experiences of the children of the poor and coming into contact with

the realities of life. In addition to weakening social cohesion, they also render the education of their own children anemic and incomplete.

Such an educational system has, for instance, been built up in the USSR and is one of the major factors which have contributed to its progress. It has also been developed, in different forms and to varying degrees, in other nations like the USA, France and the Scandinavian countries. The traditional English system has been different and has allowed good education, under private management, to be largely reserved for those who have the capacity to pay the necessary fees. But recently, the so-called Public Schools have come in for strong criticism in England itself and it is not unlikely that a radical change may be initiated to make them more democratic. A somewhat similar system was transplanted in India by British administrators and we have clung to it so long because it happened to be in tune with the traditional hierarchical structure of our society. Whatever its past history may be, such a system has no valid place in the new democratic and socialistic society we desire to create. We examine more fully elsewhere how this programme can be implemented.

SOCIAL AND NATIONAL SERVICE

The present educational system is also responsible for increasing the gulf between the educated and the uneducated classes, between the intelligentsia and the masses. The intelligentsia should try to become a real service-group striving to uplift the masses and should resist the temptation to become a parasitical group living for itself and perpetuating its own privileged position. Our traditional 'elite' as a whole—with some noble exceptions—had no close ties with the masses, and the new 'elite' created by modern education also remained largely aloof from the people, except during the struggle for freedom under Mahatma Gandhi when he was able to inspire large numbers of educated and even well-to-do persons to identify themselves with the interests of the masses and the country as a whole.

But from the time the struggle for freedom came to an end with the attainment of independence, they have again tended to move away from the people. This is a great danger and, with a view to meeting it, suitable programmes to help in the evolution of a well-knit and united nation have to be devised. For this purpose, we recommend that some form of social and national service should be made obligatory for all students and should form an integral part of education at all stages. This can become an instrument to build character, improve discipline, inculcate a faith in the dignity of manual labour and develop a sense of social responsibility.

Programmes of social and national service can be organized in one of two ways: they can either be carried out occasionally on a part-time basis during the period of education, or organized as a period of full-time service in addition to

the present period of education. The second approach was recommended by the National Service Committee appointed under the chairmanship of Dr. C. D. Deshmukh. It was suggested that national service should be a full-time programme of nine to twelve months for all young persons after passing out of higher secondary schools or the pre-university course and before entering employment or the university.

The programme was to include some military training, social service, manual labour and general education. These proposals have not been adopted so far; nor have the public reactions to them been very favourable. Instead, at the time of the national emergency, the scheme of compulsory *National Cadet Corps* (NCC) was introduced at the university stage. About the same time, the Ministry of Education, sponsored a study of national service in several countries including Yugoslavia, Czechoslovakia, Germany, Norway, Sweden, the UK, the USA, Japan and the Philippines. The report of this study has been published under the title *National Service for Youth*. Apart from discussing the salient features of such service in different countries, it made a number of recommendations about what could be done in India to develop a practicable scheme.

It did not favour the 'introduction of compulsion, which has not been tried or favoured in any of these countries, but recommended that national or social service should be introduced, at least to begin with, on a voluntary basis and extended as widely as possible and that it should provide a rich and varied programme of activities which will make an imaginative approach to youth. We believe that it would be more realistic and practicable to introduce the idea of social or national service broadly on the lines recommended in this study. Instead of adding one year to the total span of education for the purpose, a more feasible plan may be to develop, as an integral part of education, a programme which would run concurrently with academic studies in school and college.

The programme should begin from the upper primary stage and continue up to the university so that the right attitudes are developed from an early age and every young person is ultimately brought within its ambit.

COMMUNITY LIVING IN SCHOOLS AND COLLEGES

Every educational institution should try to develop a rich community life of its own and provide adequate and satisfying opportunities for students to participate in it and help in organizing it. Various opportunities for such work exist in the classroom, on the campuses of the schools and the colleges. in the hostels and on the playgrounds. For instance, instead of utilizing servants and hired labour for educational institutions and their hostels, it is possible to have much of the work done by students, not primarily to save money, but to provide valuable experience.

Japan has followed this Practice in her national system, and many schools in India are also doing so to some extent. This type of work-experience would cultivate in students the habit of work and a sense of the dignity of labour. If this is done on a nation-wide scale, it will incidentally effect some saving in expenditure which could be utilized for providing certain basic amenities for students.

The training institutions for basic teachers have tried to develop such traditions of community living by eliminating the use of servants to a large extent. We recommend that this pattern of hostel life should be introduced in all schools and colleges so far as possible. The practice of making self-help and manual work a part of the daily life and training in all types of educational institutions-as was the case in many of the old Ashrams and Academies-would yield good educational results. We cannot totally recreate the conditions of the past in our educational institutions; but we can certainly profit from the useful elements in past experience.

PARTICIPATION IN PROGRAMMES OF COMMUNITY DEVELOPMENT

In addition to these institutional programmes, it is essential to make participation in meaningful programmes of community service an integral part of all education from the primary to the undergraduate stage. Such participation can help to create positive attitudes towards social service and to develop closer ties between the educated persons and the rest of the people. It can also help in building up a sense of social purpose and self-confidence and giving students a sense of participation in community life and activities.

The NCC programme, which has been made compulsory at the university stage during the last three years, has shown some good results. It has possibilities of promoting national development by building up closer ties between the people and the defence services.

It also helps to lessen the difference between the so-called 'martial' and other classes and inculcates the idea of the defence of freedom in all classes of people. As it has been started comparatively recently, we think that it should be continued on its present basis for some time longer, say, till the end of the Fourth Five Year Plan.

We would, however, recommend that the authorities concerned explore the possibility of organizing this training, not throughout the period of three years as at present, but in a concentrated and whole-time programme spread over about 60 days which, as stated earlier, could be completed by students in one to three stretches according to their convenience.

As alternative forms of social service come into being, NCC should be made voluntary, leaving the students free to opt for it or any other form of social service provided.

EVOLUTION OF A LANGUAGE POLICY

The development of a proper language policy can also assist materially in social and national integration. Of the many problems which the country has faced since independence, the language question has been one of the most complex and intractable, and it still continues to be so. Its early and satisfactory solution is imperative for a variety of reasons- educational, cultural and political.

DEVELOPMENT OF MODERN INDIAN LANGUAGES

It is hardly necessary to emphasize that the development of the Indian languages is both urgent and essential for the development of the Indian people and as a way of bringing together the elite and the masses. It can make scientific and technical knowledge more easily accessible to the people in their own languages and thus help not only in the progress of industrialization but also in the wider dissemination of science and the scientific outlook. Energetic action is needed to produce books and literature, particularly scientific and technical, in the regional languages.

This should be regarded as a specific and imperative responsibility of the universities; and the UGC should provide general guidance and allot adequate funds for the programme. Medium of Education in Schools and Colleges. The development of the modern Indian languages is inextricably linked with the importance given to them in the educational system, specially at the university stage. The medium selected should enable students to acquire knowledge with facility, to express themselves with clarity and to think with precision and vigour. From this point of view, the claims of the mother-tongue are pre-eminent.

This proposal has also been supported strongly as a measure to promote social and national integration. The Emotional Integration Committee was of the view that the use of regional languages as media of education from the lowest to the highest stage of education was a matter of 'profound importance for national integration'. It has been sometimes argued that there should be a single medium of education at the university stage-English for the time being, to be ultimately replaced by Hindi-on the ground that it would promote mobility of teachers and students from one part of the country to another, provide for easy communication between academic and professional men and administrators, further intellectual cooperation amongst the universities and help in other ways in developing a corporate intellectual life in the country. We are inclined to think, on a balance of considerations, that this solution is not feasible.

In practice, it will probably mean the indefinite continuance of English as the only medium of higher education, a development that we cannot support in the larger interests of the country. The adoption of Hindi as a common medium of education in all parts of India is not possible for some years to come, and in non-

Hindi areas it will still have some of the disadvantages associated with the use of a foreign medium and is likely to be resisted. It would, therefore, be unwise to strive to reverse the present trend for the adoption of the regional languages as media of education at the university stage and to insist on the use of a common medium in higher education throughout the country. There will, however, be one important exception to this general rule, namely, all-India institutions which admit, in considerable numbers, students from different parts of the country. These now use English as the medium of education, which should continue undisturbed for the time being. A change-over to Hindi may be considered in due course provided two conditions are fulfilled.

The first is the effective development of Hindi as a medium of education at this level. This is a matter which can be left to the UGC and the institutions concerned to decide. The second is the equally important political consideration that, in such a change-over, the chances of students from non-Hindi areas should not be adversely affected and that the proposal should have the support of the non-Hindi States. The latter Principle has been already conceded by the Government of India even in the larger sphere of the use of Hindi in official communications between the States and the Centre. Simultaneously, it is necessary to make the regional languages the official languages of the regions concerned as early as possible so that higher services are not de facto barred to those who study in the regional medium.

The acceptance of the regional languages as media at the university is much more likely when good employment, which now depends largely on a knowledge of English and is more easily open to students who have studied through English, becomes available to those who have studied through the regional medium. We might also add here that, though Urdu is not a regional language in the ordinary sense of the word, it has an all-India significance since it is spoken by certain sections of the people in different parts of the country. Due encouragement must be given to it at all stages not only because of this peculiar character but also because of its close links with the official language, Hindi.

CHANNELS OF INTERNATIONAL COMMUNICATION

The introduction of the regional languages as media of education should not be interpreted to mean underrating the importance of English in the university. For a successful completion of the first degree course, a student should possess an adequate command over English, be able to express himself in it with reasonable ease and felicity, understand lectures in it and avail himself of its literature. Therefore, adequate emphasis will have to be laid on its study as a language right from the school stage.

English should be the most useful 'library language' in higher education and our most significant window on the world. It is also important to encourage the

study of other foreign languages on a more extensive scale for a variety of academic and practical purposes, Russian has a special significance for the study of science and technology in the present-day world. In addition, French, German, Japanese, Spanish and Chinese are important world languages for communication and for acquiring knowledge and culture. We recommend that all universities, some selected colleges, and also a small proportion of carefully selected schools should provide for the teaching of these languages. The knowledge of another foreign language besides English should be a requirement for a doctorate degree, and in certain subjects, even for the Master's degree.

The country will need in increasing numbers a group of persons, small but extremely proficient in important foreign languages and their literature. From this point of view, it would be necessary to establish a few schools which will begin teaching, right from an early age, the important foreign languages referred and will use them also as media of education. The admission to these schools should be on a selective basis and there should be an adequate provision of scholarships. It would be an important step towards the general development of higher education, and also towards international cooperation and understanding, if there were established a small number of institutions, at university level, with some of the important 'world languages' as media of education.

A beginning has already been made with the Institute of Russian Studies at New Delhi. It would be desirable to set up, during the Fourth Plan, institutions on somewhat similar lines for German, French, Spanish and Japanese languages. We could also establish one or two more institutions for Russian. The institutions will have to be largely residential. It will be an advantage to have them as constituent units of universities in their neighbourhood.

CHANNELS OF INTERNAL COMMUNICATION

Hindi must be greatly developed and enriched before it can attain the status of a library language, that is, a language which can serve as a vehicle for acquiring a substantial part of the current and rapidly expanding stock of world knowledge. This has to be taken into account fully in determining our language policy. This implies, as stated earlier, that every graduate will need to acquire a reasonable proficiency in a library language, which will be English for most students.

It will thus serve as a link- language in higher education for academic work and intellectual inter- communication. It is, however, equally obvious that English cannot serve as the link-language for the majority of our people. It is only Hindi which can and should take this place in due course. As it is the official language of the Union and the link-language of the people, all measures should be adopted to spread it in the non-Hindi areas. The success of this programme will largely depend on the

extent to which it is voluntarily accepted by the people of these areas. We were interested to know that in the Kerala University, where students can take Hindi in place of Malayalam at the undergraduate stage, a large proportion of students choose to study Hindi. We have also seen increasing evidence on the part of non-Hindi areas to take to the study of Hindi. AR their efforts in this matter, particularly in the non-official sector, should receive encouragement. In addition to Hindi, it is essential to provide multiple channels of inter-State communication in all modern Indian languages.

In every linguistic region, there should be a number of persons who know all the other modern Indian languages and some who are familiar with their literatures and able to contribute to them. For this purpose, we recommend that there should be adequate arrangements, both in schools and colleges, for teaching different modern Indian languages. In addition, steps should be taken to establish efficient departments in some of the modern Indian languages in every university. It may also be advisable to create a Small Dumber of special institutes for the comparative study of different languages and their linguistic problems. At the B.A. and M.A. levels, it should be possible to combine two modern Indian languages. This will incidentally supply the bilingual persons needed for language teaching in schools and colleges.

PROMOTING NATIONAL CONSCIOUSNESS

India is a land of diversities of different castes, peoples, communities, languages, religions and cultures. What role can the schools and universities play in enabling their students to discover the ‘unity in diversity’ that India essentially is, and in fostering a sense of national solidarity transcending narrower loyalties ? Unfortunately, our school system as a whole has had no strong tradition of striving to develop a sense of national unity and national consciousness. Under the British administration, the schools were expected to teach loyalty to the British rule rather than instil love for the motherland. Consequently, the effort to develop national consciousness was made largely outside the educational system, particularly during the struggle for freedom. Its foundation was a renewed belief in the value of national culture and traditions and a pride in India’s past achievements.

It recognized that, in the cultural exchange between India and the West, India also had something worth while to give in return for the gift of modern science and technology, and that Indians should strive to maintain the valuable elements in their own traditional culture while accepting all that is good in the West. This was not meant as an attempt at revivalism, though it was certainly so interpreted by some sections. It was an attempt, as Gandhiji put it, to refuse to be blown off one’s feet even when all the windows of one’s house were thrown open to fresh winds from every corner of the world. With the attainment of Independence, the situation

has changed greatly. The one rallying point which had kept many diverse elements together ceased to exist, and as the schools have been unable to inculcate and strengthen national consciousness, the sentiment itself seems to be wearing thin, particularly in the new generation now coming of age. We saw something similar to the old spirit reviving in recent years—in the wake of the Chinese invasion and during the recent conflict with Pakistan. Obviously, such unfortunate international conflicts cannot be considered the normal ways to awaken and strengthen the national spirit.

The only enduring solution to the problem is to place this responsibility on the educational system and to make it an effective instrument for the purpose. There is much evidence in the world to show that schools and universities can play a major and helpful part in the regeneration and advancement of a people and in generating the psychological energy needed for the purpose. The first would be promoted by well-organized teaching of the languages and literatures, philosophy, religions and history of India, and by introducing the students to Indian architecture, sculpture painting, music, dance and drama. In addition, it would be desirable to promote greater knowledge, understanding and appreciation of the different parts of India by including their study in the curricula, by the exchange of teachers wherever possible, by the development of fraternal relations between educational institutions in different parts of the country, and by the organization of holiday camps and summer schools on an inter-State basis designed to break down regional or linguistic barriers.

It would further be necessary to establish and maintain all-India institutions which will admit students from different parts of the country. Faith in the future would involve an attempt, as a part of the course in citizenship, to bring home to the students the principles of the Constitution, the great human values referred to in its preamble, the nature of the democratic and socialistic society which we desire to create and the five-year plans of national development. At the higher stages of education the students should learn to assess the value of modern movements and tendencies so that they may learn which of them can and should be usefully assimilated into our culture. We should, however, take care to avoid identifying all 'modern' with 'western' values.

EDUCATION FOR INTERNATIONAL UNDERSTANDING

There is no essential contradiction, as we have pointed out earlier, between this objective and the development of international understanding for the 'one-world' towards which we are moving. On the whole, textbooks used in national school systems perhaps contain fewer untrue or hostile remarks about other countries than they did in the past, thanks partly to the work of UNESCO, under whose auspices multi-national and bi-national efforts have been made for their revision.

The sins are more often now of omission than of active commission. We should, however, guard ourselves against this also, for ignorance is often not less dangerous than hostility. Our studies in the humanities and social sciences should be so oriented that, while helping students to become good and active citizens of their own country, these will also enable them to acquire a knowledge and understanding of the essential features of the outside world, particularly of our neighbouring and Afro-Asian countries.

Indian culture has had a strong and honourable tradition of international understanding, of valuing, on the whole with an open mind, the contributions of different countries and races to human civilization. For this purpose, the fact that she is a country with many communities but of one common citizenship should actually prove to be an advantage. The constitution Of UNESCO speaks of 'the fruitful diversity of the cultures of mankind'. If through the schools and universities, a person learns to appreciate the basic rightness of that phrase in his own federal and multi-community country, he is less likely to forget it on the international plane where he deals with persons belonging to different nations but enjoying equal membership in the community of mankind.

The programme of social and national integration which will minimize the internal barriers and suspicions which exist today will not only be a national gain, but may even make an impact on international relations and the international situation as a whole. This was one of the great inspirations of Jawaharlal Nehru's policy.

DEMOCRATIC VALUES

In this context, Special emphasis has to be laid on the development of values such as a scientific temper of mind, tolerance, respect for the culture of other national groups, etc., which will enable us to adopt democracy, not only as a form of government, but also as a way of life. As stated earlier, the population of India consists of persons who profess different religions, speak different languages, belong to different races, castes, classes and communities. It is precisely in such a situation that democracy can make its most significant contribution.

A healthy development of democratic trends will help to soften the impact of this division into social, economic and cultural groups. The task is admittedly difficult; but it can convert the differences of language, cultural pattern, religion, etc., into the warp and woof of a very rich and rewarding social and cultural life. The problem of national integration is essentially one of harmonizing such differences, of enabling different elements of the population to live peacefully and cooperatively and to utilize their varied gifts for the enrichment of the national life as a whole. We have to cultivate a spirit of large- hearted tolerance, of mutual give

and take, of the appreciation of ways in which people differ from one another. This is a very exacting experiment in living' that we have launched and no education will be worthwhile if the educated mind is unable to respond to this situation with intelligence and imagination.

EDUCATION AND MODERNIZATION

We have already stated that the most distinctive feature of a modern society, in contrast with a traditional one, is in its adoption of a science-based technology. It is this which has helped such societies to increase their production so spectacularly. It may be pointed out, however, that science-based technology has other important implications for social and cultural life and it involves fundamental social and cultural changes which are broadly described as 'modernization'. We shall briefly discuss the impact of this modernization on programmes of educational reconstruction.

EXPLOSION OF KNOWLEDGE

There has been a great explosion of knowledge during the last few decades. In a traditional society, the stock of knowledge is limited and grows slowly so that the main aim of education is interpreted to be its preservation. In a modern society, on the other hand, the stock of knowledge is far greater and the pace of its growth is infinitely quicker. One of the main tasks of education in a modern society is to keep pace with this advance in knowledge. In such a society, knowledge inevitably ceases to be something to be received passively; it is something to be actively discovered.

If this is rightly understood, it would involve a revolution in traditional education where 'to know' has come to mean 'to know by heart', where respect for all inherited knowledge is assiduously cultivated and where the assimilative faculties tend to be emphasized to the neglect of the critical and creative ones. In India, as in other countries where similar conditions prevail, this would require, among other things, a new approach to the objectives and methods of education, and changes in the training of teachers. Unless they are trained in new ways of teaching and learning, the students in schools and colleges will not be able to receive the type of education needed for the new society.

RAPID SOCIAL CHANGE

Another feature of a modern society is the quick, almost breath-taking rate at which social change takes place. In a traditional society, change is so slow that the conservatism of the educational system does comparatively little harm. In a modern society, on the other hand, change is so rapid that the school must always be alert if it is to keep abreast of significant changes. There is, therefore, an imperative

need for adopting a dynamic policy in such a situation. An educational system which does not continually renovate itself, becomes out of date and hampers progress because it tends to create a lag between its operative purposes and standards and the new imperatives of development, both in quality and quantity.

The very aim of education has to be viewed differently-it is no longer taken as concerned primarily with the imparting of knowledge or the preparation of a finished product, but with the awakening of curiosity, the development of proper interests, attitudes and values and the building up of such essential skills as independent study and the capacity to think and judge for oneself without which it is not possible to become a responsible member of a democratic society.

NEED FOR RAPID ADVANCE

Two other aspects of modernization need emphasis. The first is that once a society launches itself upon a programme of modernization, there is no turning back, no half-way house where we can arrest the process. In the initial stages, such a change must disturb the traditional equilibrium reached and maintained over centuries which, though it had its obvious disadvantages, had some built-in redeeming factors as well.

The attempt to create a new social order naturally creates a host of unexpected social, economic, cultural and political problems. But if one tinkers with the problems involved or tries to march with faltering steps, if one's commitments and convictions are half-hearted and faith is lacking, the new situation may turn out to be worse than the old one. The only solution to these transitional problems is to move rapidly forward and create a new equilibrium, based on the full implications of the process of modernization.

MODERNIZATION AND EDUCATIONAL PROGRESS

The progress of modernization will, therefore, be directly related to the pace of educational advance and the one sure way to modernize quickly is to spread education, produce educated and skilled citizens, and train an adequate and competent intelligentsia. The Indian society of today is heir to a great culture.

Unfortunately, however, it is not an adequately educated society, and unless it becomes one, it will not be able to modernize itself and to respond appropriately to the new challenges of national reconstruction or take its rightful place in the comity of nations. The proportion of persons who have so far been able to receive secondary and higher education is very small at present-less than two per cent of the entire population. This will have to be increased to at least ten per cent to make any significant impact. The composition of the intelligentsia must also be changed; it should consist of able persons, both men and women, drawn from all strata of

society. There must also be changes in the skills and fields of specialization to be cultivated. At present, the intelligentsia consists predominantly of the white-collar professions and students of the humanities, while the proportion of scientists and technical workers in its ranks is quite small.

To change this, greater emphasis must be placed, as we have argued earlier, on vocational subjects, science education and research. The average level of competence is not at all satisfactory, due mainly to inadequate standards maintained in the universities. This is damaging to Indian academic life and its reputation. In order to change this situation radically, it will be necessary to establish a few 'major' universities in the country which attain standards comparable to the best in any part of the world, and which will gradually spread their influence to others. This is one of the basic reforms needed in our system of higher education.

SOCIAL, MORAL AND SPIRITUAL VALUES

Modernization does not mean-least of all in our national situation-a refusal to recognize the importance of or to inculcate necessary moral and spiritual values and selfdiscipline. Modernization, if it is to be a living force, must derive its strength from the strength of the spirit. Modernization aims, amongst other things, at creating an economy of plenty which will offer to every individual a larger way of life and a wider variety of choices. While this freedom to choose has its own advantages, it also means that the future of society will depend increasingly upon the type of choice each individual makes. This would naturally depend upon his motivation and sense of values, for he might make the choice either with reference entirely to his own personal satisfaction or in a spirit of service to the community and of furthering the common good.

The expanding: knowledge and the growing power which modernization places at the disposal of society must, therefore, be combined with the strengthening and deepening of the sense of social responsibility and a keener appreciation of moral and spiritual values. While a combination of ignorance with goodness may be futile, that of knowledge with a lack of essential values may be dangerous.

The weakening of social and moral values in the younger generation is creating many serious social and ethical conflicts in western societies and there is already a desire among some great western thinkers to balance the knowledge and skills which science and technology bring with the values and insights associated with ethics and religion at Its best, *viz.*, a search for the knowledge of the Self, of the meaning of life, of the relationship of man to other human beings and to the ultimate reality in the situation that is developing it is equally important for us to give a proper value- orientation to our educational system. It is not our purpose to enumerate a list of values to be inculcated. What we would like to emphasize is the

need to pay attention to the inculcation of right values in the students, at all stages of education. We are happy to note that an awareness of this responsibility has been growing since independence. The University Education Commission considered both its philosophical and practical aspects and made certain valuable proposals for reform. However, except in a small number of institutions, they were not implemented. The Central Advisory Board of Education appointed a special committee on Religious and Moral Instruction. The Report of this Committee has been before the country for five years, but the response from educational institutions has been neither active nor enthusiastic.

This is having a very undesirable effect on the character of the rising generation. It has, therefore, become necessary and urgent to adopt active measures to give a value-orientation to education. Our proposals for such instruction at the school stage are discussed elsewhere. For higher education, we agree with the suggestions made by the University Education Commission and the Sri Prakasa Committee. A general study of the different religions of the world should be a part of the first degree courses and a graded syllabus should be prepared for the purpose.

For instance, in the first year, it can deal with the lives of great religious leaders; in the second, selections from the scriptures of the world with a universal appeal could be studied; and in the third year, the central problems of the philosophy of religions considered. We would also like to lay stress on the importance of encouraging students to meet in groups for silent meditation. In the attempt to inculcate values through education, we should draw freely upon our own traditions as well as the traditions of other countries and cultures.

There are strands within Indian thought itself which can lead to the new outlook appropriate for a modern society and which can prepare the people for a willing acceptance of life with all its joys and sorrows, its challenges and triumphs. In them, too, we can find inspiration for social service and a faith in the future. Mahatma Gandhi, for instance—and some other great leaders of thought—discovered the inspiration for their idealism and their passionate striving for social justice and social reconstruction largely from these sources. It is such re-interpretations and re-evaluations of the past that are now most needed. It is, however, specially important in the world of today that this effort should not be restricted to the national sources only.

It would be necessary to draw upon the liberalizing forces that have arisen in the western nations and which have emphasized, among other things, the dignity of the individual, equality and social justice, *e.g.*, the French Revolution, the concept of the welfare state, the philosophy of Marx and the rise of socialism. A major weakness of the Indian, and particularly of the Hindu society, in the past has been a lack of equality and social justice. These balancing influences have, therefore, a

great significance. Similar assimilations of whatever is significant should also be discriminately made from other important nations and cultures such as the Chinese, Japanese or Islamic.

SECULARISM AND RELIGION

In a multi-religious society like ours, it is necessary to define the attitude of the State to religion, religious education and the concept of secularism. The adoption of a secularist policy means that in political, economic and social matters, all citizens, irrespective of their religious faith, will enjoy equality of rights, that no religious community will be favoured or discriminated against, and that instruction in religious dogmas will not be provided in State schools. But it is not an irreligious or anti-religious policy; it does not belittle the importance of religion as such. It gives to every citizen the fullest freedom of religious belief and worship.

It is anxious to ensure good relations amongst different religious groups and to promote not only religious tolerance but also an active reverence for all religions. In such a society, however, one has to make a distinction between 'religious education' and 'education about religions'. The former is largely concerned with the teaching of the tenets and practices of a particular religion, generally in the form in which the religious group envisages them, whereas the latter is a study of religions and religious thought from a broad point of view—the eternal quest of the spirit. It would not be practicable for a secular State with many religions to provide education in any one religion. It is, however, necessary for a multi-religious democratic State to promote a tolerant study of all religions so that its citizens can understand each other better and live amicably together.

It must be remembered that, owing to the ban placed on religious instruction in schools and the weakening of the home influences which, in the past, often provided such instruction, children are now growing up without any clear idea of their own religion and with no chance of learning about others. In fact, the general ignorance and misunderstanding in these matters are so widespread in the younger generation as to 'be fraught with great danger for the development of a democracy in which tolerance is rated high as a value.

We suggest that a syllabus giving well-chosen information about each of the major religions should be included as a part of the course in citizenship or as part of the general education to be introduced in schools and colleges up to the first degree. It should highlight the fundamental similarities in the great religions of the world and the emphasis they place on the cultivation of certain broadly comparable moral and spiritual values. It would be a great advantage to have a common course on this subject in all parts of the country and common textbooks which should be prepared at the national level by competent and suitable experts on each religion.

When these courses have been prepared, it would be worth while to have them scrutinized by a small committee of eminent persons belonging to different religions to ensure that nothing is included in them to which any religious group could take legitimate objection. A vitalized study of science with its emphasis on open-mindedness, tolerance and objectivity would inevitably lead to the development of a more secular outlook, in the sense in which we use the word, amongst those who profess different religions. This process needs to be carefully and wisely encouraged.

Simultaneously, there is a sense in which the walls between the secular and the spiritual are tending to break down and what is secular is seen to have spiritual roots. In the words of Dr. Iqbal, 'the spirit finds its opportunity in the material, the natural and the secular. All that is secular is, therefore, sacred in the roots of its being'. This is what we envisage as the direction of our future development. We believe that India should strive to bring science and the values of the spirit together and in harmony, and thereby pave the way for the eventual emergence of a society which would cater to the needs of the whole man and not only to a particular fragment of his personality.

A CHALLENGE AND A FAITH

India is on the move again-with the promise of a new renaissance in the making. After a long period of foreign rule she has emerged into freedom. That her means for the winning of freedom, adopted under Gandhi and Nehru, were as noble as the ends, is a signpost of profound historical significance. Politically the land is free, but economically she has a long, way to go. The elimination of ignorance and of grinding poverty accumulated over centuries of inertia and exploitation is not an easy task.

India today has half of the total illiterate population of the world. About fifty million of her people, a tenth of the total population, live on an yearly income of no more than ₹ 120. The problems are grave and immense. But this is only one side of the picture. During recent, years, great strides have been taken towards industrialization, towards modernization of agriculture, and to provide better health and life to the people.

The most powerful tool in the process of modernization is education based on science and technology. The one great lesson of the present age of science is that, with determination and the willingness to put in hard work, prosperity' within the reach of any nation which has a stable and progressive government. There is no doubt that in the years to come India's trade and commerce will grow: there will be more food for all, more education, better health; and a reasonable standard of living will be available. But India's contribution can and should be far more than these material gains.

She should learn to harness science but she must also learn not to be dominated by science. In this respect India has a unique advantage with her great tradition of duty without self-involvement unacquisitive temperament tolerance, and innate love of peace and reverence for all living things. Too often are these precious assets forgotten and we tend to relapse into moods of pessimism, fears and forebodings, discord and destructive criticism. A new pride and a deeper faith expressed in living for the noble ideals of peace and freedom, truth and compassion, are now needed. In our efforts to go in a big way for science-based industrialization, we have the advantage of drawing upon a great stock of knowledge accumulated by the western world over the last two hundred years. We also have another lesson to learn.

The industrialization of the West was in some ways brought about at no small cost to the human spirit. The two world wars resulting in human killing on an unprecedented scale are a grim reminder of that suffering of the spirit. If we learn the lesson right, we can harness science to support rather than weaken our basic commitment to cultural and spiritual values. It should be our goal and obligation to re-interpret, and raise to a new level of understanding, the Insight gained by the ancient seers as regards the fundamental problems of life which in some ways is unique and 'represents the quintessence of deepest insight into the happenings of the world'. Man's knowledge and mastery of outer space and of his own self are out of balance. It is this imbalance which mankind must seek to redress. Man now faces himself.

He faces the choice of rolling down a nuclear abyss to ruin and annihilation or of raising himself to new heights of glory and fulfilment yet unimagined. India has made many glorious contributions to world culture, and perhaps the grandest of them all is the concept and ideal of non-violence and compassion, sought, expounded and lived by Buddha and Mahavira, Nanak and Kabir, and in our own times by Vivekananda, Ramana Maharishi and Gandhi, and which millions have striven to follow after them. The greatest contribution of Europe doubtlessly is the scientific revolution. If science and ahimsa join together in a creative synthesis of belief and action, mankind will attain to a new level of purposefulness, prosperity and spiritual insight. Can India do something in adding a new dimension to the scientific achievement of the West? This poses a great challenge and also offers a unique opportunity to the men and women of India, and especially to the young people who are the makers of the future.

6

Navigating the Literature Landscape of Educational Research

BREADTH OF EDUCATION RESEARCH

Ideally, the breadth of education research informs teaching and learning research in the life sciences. However, the body of theoretical and practical research in education is sprawling, making up >20,000 articles published each year in >1100 journals. The absence of any unified, systematic mechanism for cataloging or accessing this information makes it nearly impossible for scientists to keep abreast of the literature on science teaching and learning, much less use it to inform their own work. When the challenge of locating articles of interest is coupled with the difficulty of comprehending the findings of an entirely different discipline, with epistemologies, cultures, and practices distinct from those of the science community, many scientists throw up their hands in frustration. As we have transitioned from bench to classroom-based research, we have had both the necessity and the luxury, and sometimes the aggravation, of developing a working knowledge of theoretical and practical research in education.

As we have shared references with my scientist colleagues, we have witnessed several beneficial outcomes. Learning about others' teaching and outreach efforts from practitioner journals has helped us develop a more comprehensive idea of the needs, interests, and priorities of our colleagues in education and avoid "reinventing the wheel" in education programming. Reviewing the research literature has honed

our thinking about how to document the effects of educational interventions on teaching and learning. We have expanded my vocabulary such that we can have more informed discussions with the evaluators of our precollege outreach and partnership work. From a broader perspective, more departments of science are hiring faculty with education expertise. Scientists familiar with this scholarship may be better prepared to make informed decisions about the promotion and tenure of their education colleagues, and they may also learn that they themselves benefit from participating in pedagogical endeavors.

My intention is not to encourage scientists to become educational researchers, but rather to better position them to benefit as teachers from the education literature. Even education researchers themselves have noted that much of the literature is written for academics in the discipline, rather than a broader audience of researchers, practitioners, and policymakers. Assumptions are often delineated using foreign concepts such as “theoretical framework.” Methodology is a combination of research method and epistemologies of learning. Protocols are described using unfamiliar terminology such as “differentiated instruction.”

The data may take unfamiliar forms, such as quotes from focus groups, transcripts of interviews, or videotapes of classrooms. As I have learned to locate, decipher, and evaluate the literature, with significant guidance from colleagues and mentors, I have used analogies to science research and practice to clarify my thinking. Although these analogies have limitations, I have found them to be useful steppingstones in better understanding this body of knowledge, and I share several of them here. Thus, the intent of this essay, and one purpose of the new *CBE-LSE* feature Current Insights: Recent Research in Science Teaching and Learning, is to serve as a bridge for individuals with scientific expertise to enter the land of education scholarship, and to provide tools that may be useful on the journey.

PROBLEM-BASED LEARNING IN UNDERGRADUATE SCIENCE IN 21ST CENTURY PEDAGOGIES

In the PBL process, student learning is motivated using a problem, puzzle, or complex scenario presented in the same context, as it would be encountered in real life. Information needed to investigate the problem is not initially provided. Instead, when first presented with the problem, students organize their ideas and previous knowledge related to it, and attempt to define its broad nature. As they brainstorm initial hypotheses, the students find that they need to consult additional resources to fill in conceptual holes. They identify this needed information by posing questions that help to define why the information is needed – how it relates to the problem resolution.

They then assign one another the responsibility for researching this information before the next class meeting, and discuss the best sources (textbook, library, Internet, etc.) for finding the needed information. When students reconvene, they teach one another the results of their research on the questions posed in the previous session, ideally integrating their new knowledge and skills into the context of the problem.

The students continue to define new areas of needed learning (digging progressively deeper into the underlying content and assumptions) as they work through the problem, which typically unfolds in several stages through progressive disclosure. The PBL cycle thus provides a means for students to learn concepts in the context of their applications, and a forum for them to hone their ability to think critically, to find and process new information, to communicate effectively, and to become influential members of productive teams.

Problem-based learning as a formal cycle of teaching and learning strategies had its origins in medical schools to facilitate learning basic science concepts in the context of clinical cases. In this earliest PBL setting, students typically worked in groups of eight to ten, guided by a faculty facilitator. The role of the group facilitator was to guide, probe, and support students' initiatives, not lecture, direct, or provide easy answers. The group facilitator thus monitored both the quality of the information and intellectual arguments, and the quality of group interactions.

This original medical school model is generally not applicable to typical undergraduate courses for many reasons, including class size. However, the collection of strategies encompassed by PBL can be reassembled in ways that are appropriate for undergraduate courses and students without necessarily comprising its essential nature.

For example, a faculty instructor can facilitate many classroom groups by serving as a "roving" facilitator who walks around the classroom to listen to groups' conversations and pose and answer questions when appropriate. The PBL instructor in this setting may choose to use PBL problems that are structured so that they allow for natural interventions for instructor guidance, whole class discussions, or short clarifying lectures to move students beyond conceptual impasses.

The whole class discussions can be tailored to provide feedback on group progress, to challenge students to examine the underlying assumptions of evidence they apply to the problem's resolution, and to guide students by encouraging them to consult good quality resources. Faculty using this model in essence supply in a structured and planned way the guidance supplied in a more extemporaneous and informal way in the original PBL model.

Another model for monitoring multiple PBL groups in an undergraduate classroom is the use of peer group facilitators – undergraduates who have completed

a PBL course who return to work alongside the faculty instructor as guides for one or more groups. In both instances, the roving facilitator or peer facilitator model, PBL in the undergraduate setting is accompanied by use of typical cooperative or collaborative learning structures – that is, drafting by students of group contracts or guidelines, rotation of student roles as group members (for example, recorder, reporter, discussion leader, accuracy coach), and peer evaluation of performance as group members.

The relative absence of PBL instructional materials can be a major roadblock to implementation of PBL in a particular discipline. To incorporate the goals of PBL, these problems must be complex enough to engage students attention for several class periods or longer, and challenge students to think critically as they explore new content areas. Fortunately, collections of these materials are becoming more readily available – for example, the PBL Clearinghouse (accessible through a secure server at <https://www.mis4.udel.edu/Pbl> and the LifeLines OnLine collection offered through BioQUEST available at <http://bioquest.org/lifelines>; see PBL resources list).

My first encounter with PBL was introduced to the University of Delaware (UD) in 1992 in a workshop to prepare faculty to teach in a new Medical Scholars Programme. A group of science faculty immediately recognized the potential of the method and adapted it to their introductory science courses.

PBL at UD has since expanded to impact thousands of students and 30 per cent of the faculty in an array of undergraduate disciplines. My role in this effort was to co-design and implement a number of PBL courses in the biological sciences (both small and large enrollment), and to develop (with Harold White in UD's Department of Chemistry and Biochemistry) a formal in-service support programme for undergraduate peer facilitators.

Materials and methods from one of these courses (introductory biology for science majors) are published in *Thinking Towards Solutions*, and summarized in a recent essay on PBL in biology in *Cell Biology Education*.

With a group of PBL faculty on my campus, I also co-founded and continue to co-lead a faculty institute that was created in 1997 with support from NSF's Institution-Wide Reform programme. The institute uses a "faculty mentoring faculty" model to help faculty to develop a new PBL course or adapt an existing to incorporate active, group learning strategies such as PBL.

ADAPTING PROBLEM-BASED LEARNING TO THE UNDERGRADUATE SETTING

It was clear from the outset that the original medical school model for PBL would have to be adapted to fit the greater class sizes (and therefore greater demands

on faculty resources) and less intellectually mature population of learners in the undergraduate setting. Fortunately, PBL is not a single strategy, but rather a collection of strategies that can be assembled in many combinations, and thus lends itself to adaptation without necessarily comprising its essential nature. Nevertheless, the challenges of implementing PBL in an undergraduate setting are numerous. In the process of implementing PBL, we discovered many different strategies that could be used in the design of PBL activities for courses with different enrollment sizes, learning objectives, and populations of learners, and by faculty with varying perspectives and time constraints.

FURNISHINGS OF EXISTING CLASSROOMS

The layout and furnishings of existing classrooms were an obvious barrier to implementation of the group learning aspect of PBL. Fortunately, the University of Delaware's administration responded readily to faculty requests by funding and expediting the renovation of PBL classrooms as the need for them grew. These classroom renovations were designed to maximize blackboard space (for student groups to use when reporting on their research), include tables for group work, and provide cabinets for storing resource materials between classes. Nevertheless, some faculty using PBL in large classes (in which enrollment exceeds 80 students, the capacity of the University's largest PBL classroom) are still challenged by classrooms where seating is fixed. When possible, instructors in these classrooms typically under enroll them, so that the seating plan can include vacant rows for greater ease of instructor access to student groups. Groups are typically four students, so a group can use two adjacent rows by having the two students in the front row turn in their seats to more immediately face the remaining two students in the row behind.

MONITORING MULTIPLE GROUPS

The most daunting challenge is how faculty can facilitate the PBL efforts of many classroom groups simultaneously. In the earliest model of PBL, an expert facilitator guides the group process by observing, asking questions, and intervening when appropriate. The facilitator should also prompt the group to dig deeper into content, ensure that students make connections and tie information together, keep students on track during discussions, help to locate resources, examine evidence that can be used to support conclusions, ensure that all students are involved in the process, model the process of giving and receiving feedback, and help the group learn to plot its own course. Clearly, few undergraduate classes are small enough that the instructor can be a dedicated facilitator of a single small group of students in this intensive fashion. A roving facilitator strategy that is used in many cooperative learning settings, also works well in PBL classrooms. In this model the instructor

walks around the classroom to observe groups in action, looking for signs of engagement with the problem and for the participation of all students in their group discussions. Typically the roving instructor poses questions that encourage students to dig more deeply into essential content or get beyond a conceptual impasse.

The instructor looks for signs of behaviours that seem counterproductive to good group function and may enter into discussions when appropriate. This roving facilitator strategy works well with use of PBL problems constructed to provide natural break points that allow for insertion of instructor-led discussions.

Whole class discussions at key intervals in the problem-solving process allow the instructor to provide feedback and model the process of evaluating resources, and analyzing and summarizing information. Groups that are moving at a substantially slower pace can benefit from hearing about their peers' progress, but care must be taken to prevent groups from intentionally piggy-backing on other groups' efforts. During these whole-class discussions, the instructor can provide, in a more structured and formal way, some of what the classic PBL facilitator contributes when s/he guides a single group.

Assigned roles of responsibility and drafting of group guidelines - strategies commonly used in cooperative learning classrooms - can also work effectively in PBL. The roles of discussion leader, reporter (for group products and class discussions), recorder, and accuracy coach (the "skeptic") may rotate among group members on a regular schedule or with each new problem.

Students draft ground rules for effective group work that typically include their notions of acceptable attendance and preparedness, and include penalties for non-adherence that escalate with each incident.

Peer facilitators can also be effective as group monitors. Students who have successfully taken the course return to guide student groups as either a roving or dedicated facilitator, working alongside the faculty instructor. The use of peer facilitators has proved to be an excellent model for enhancing the effectiveness of classroom groups and is a model that can be extended to active learning activities other than problem-based learning.

THE LARGE CLASS

Instructors in large classes enlist the help of undergraduate and graduate TAs to have more individuals to monitor groups. They use carefully staged problems that allow the instructor to intervene at roughly 15-20 min intervals to help guide progress through the problem. The instructors typically choose to implement closely defined group monitoring strategies such as rotating roles and ground rules. They ask students to record their roles each week or with each problem to verify that roles have actually rotated among group members. Students are asked to make suggestions

for policies and penalties for group guidelines. Group evaluations often include ratings of each other's contributions to assignments and products. Highly streamlined versions of the written and verbal feedback strategies used in smaller-class PBL can be used.

PBL instructors of large enrollment classes also intersperse other classroom activities between the PBL problems. While the PBL problem often serves as the central focus, lectures, discussions, and short active learning activities associated with the problem are used to help students build conceptual frameworks. In "Who Owns the Geritol Solution Problem" a concept mapping exercise has been used. Between the first two stages of the problem, students are given map titles such as "the light-independent reactions of photosynthesis," "the carbon cycle," "the Geritol solution," or "the flow of energy through the biosphere" for which the student group constructs a concept map. This helps provide timely feedback to both students and instructor about whether the major concepts evoked by the problem have been understood and synthesized.

PBL strategies for large classes include use of hybrid models in which, for example, four to six shorter problems are presented for each major content unit. In these hybrid models, traditional methods such as lecture are used to support the PBL instruction but do not supplant it. In these large classes, the problems typically are used in association with clearly defined final products, such as whole class debates, position papers, and mock town meetings, trials or congressional hearings, that are naturally embedded in the context of the problem.

For instructors reluctant to commit to using PBL throughout the entire semester, even use of a single problem of several weeks duration can be effective. For instructors of large enrollment course who find the management of large numbers of classroom groups to be a daunting prospect, discussion, recitation or laboratory sections of the same course can provide the requisite smaller class setting for PBL. If using this strategy in conjunction with teaching assistants, however, care must be taken to select individuals who support the underlying goals and assumptions of PBL.

Is there a limit to how large a PBL class can be? Shipman and Duch compared selected outcomes in a class of 120 with those in a class of 240 students. Their preliminary findings suggest that PBL can work in the class with the larger enrollment. Students reported that problem solving and group work enhanced their learning and helped prepare them for their working lives, and these perceptions were backed up by independent assessments of classroom performance. From the perspective of both students and faculty, the PBL experience was better in the smaller class. Students reported more positive attitudes towards, and greater interest in learning the subject in the smaller class, and instructors were not enamored of the sheer magnitude of the management task involved in monitoring up to 60 classroom groups.

SOURCES OF PROBLEMS

A major roadblock when PBL was first implemented in undergraduate courses, particularly in the introductory basic sciences, was the absence of suitable problems. To meet the goals of PBL instruction, problems must be able to engage active, cooperative learning activities within student groups for up to a week or more. End-of-chapter textbook problems in general do not have the contextual richness, nor do they require the analytical, synthetic, and evaluative thinking needed for PBL. Consequently, a major hurdle for adapting PBL was the necessity to write problems appropriate to the instructional goals. While that hurdle ensured that only fully committed instructors became involved, it undoubtedly discouraged others from trying. Fortunately, this barrier is being lowered as more and more faculty drawn to PBL turn their creative energies towards writing and disseminating college level course materials.

PBL problem writers seek inspiration from a variety of sources, including fictionalized composites of events in a typical person's, articles from the popular press about inventions and discoveries, science and society interactions, or landmark experiments. Harold White (Chemistry and Biochemistry) and David Sheppard at the University use problems that provide explicit models for research. In White's Introduction to Biochemistry course, students build their understanding of what biochemists have learned about a specific area of biochemistry by reading a carefully selected series of articles that document the history of the seminal experiments in the field. In a course required for biology majors, Sheppard asks students to mine research quality nucleic acid and protein databases to resolve problems about important recent experiments in the field of genetics. In both cases, students discuss and resolve these research-oriented problems, using the PBL process.

Although the sources of problems and the contexts for their classroom use may vary, PBL problems have common features. To be appropriate, problems should engage students' interest and motivate learning, require students to develop a line of reasoning that is backed up by evidence, be complex enough to motivate participation of a group of students rather than just a single individual, be open-ended enough at the outset to allow participation by all students, incorporate the learning objectives of the course and allow for many legitimate resolutions or many paths to a single resolution. These objectives are embedded in the problem, rather than posed separately or otherwise set apart by the instructor.

The problem "Riverside's Dilemma" exemplifies the PBL process as it unfolds in a chemistry context. The problem, written for use in general chemistry courses, presents students with the dilemma faced by a town council that must decide on allowable limits for wastes flowing into a local river. In working on this problem, students encounter concepts related to the chemistry of weak and strong acids and

bases, neutralization reactions and related equilibrium calculations. In Stage One, Riverside's town council receives a proposal from a multinational chemical corporation to buy several old, closed-down factories. The dilemma is that the old design of the factories would result in discharge of wastes directly into the river; retrofitting of the factories seems prohibitively expensive.

Placed in the role of a consultant to the town council, students must consider the impact of these potential waste streams on the health of the river. Knowing the amount and types of emissions projected for each plant (various strong and weak acids and bases), students first determine what level of dilution of each waste stream would be needed to bring it to an acceptable pH value, then decide whether dilution would be an effective strategy. In doing so they are introduced to the concept of neutralization and its relationship to dissociation equilibria. In order to refresh students' memories of high school chemistry, the students complete a quiz - first as individuals, then within groups - on the basic terminology of acid-base chemistry.

In Stage Two of "Riverside's Dilemma," students realize that dilution is not a reasonable solution because of the very large volume of water that would be required. They now must consider the feasibility of neutralizing the waste streams to achieve an acceptable pH range in the river. Students, still in the role of consultants, must consider the use of two relatively inexpensive neutralization agents and determine how much of the appropriate agent would be required. This stage helps students discover the relationship between neutralization and dissociation reactions. Stage Two, like Stage One, typically requires one 50 minute class period for resolution.

The third and final stage of the problem is the most difficult and open-ended. Students must pull together the material dealt with in the previous two stages to consider a more complex situation. The town council has requested that the student consultants evaluate the feasibility of combining some of the waste streams before they are released into the river in order to bring pH into the acceptable range. In addressing this problem, students must recognize which combinations of waste streams are possible, decide which combinations constitute neutralization processes and of these, which have equilibrium constants appropriate for the desired results.

A stage-by-stage account of how a biological problem is worked out in the PBL classroom can be found in the University of Delaware's PBL Clearinghouse. This problem centres around John Martin's novel scheme to cure global warming by seeding the oceans with iron to harness the latent primary productivity of marine phytoplankton. The problem motivates students to research major concepts related to cellular energy transformations, biogeochemical cycles, global climate change, and marine ecosystems.

"A Bad Day for Sandy Dayton" provides an example for how an introductory physics problem is constructed and unfolds in the classroom. This problem is

designed to help nonscience majors understand forces, motion and mechanical energy by reconstructing a rear-end auto collision that occurs outside their classroom. In doing so, they explore the relationship between speed and stopping distance, reaction time and stopping distance, and the design and safety features of seatbelts and airbags.

Several collections of problems are available on-line for instructors who would like to use PBL. These include the University, which contains problems and teaching notes for the sciences and disciplines outside the sciences, Life Lines On-Line, a collection of introductory life sciences problems produced through collaboration between Southeast Missouri University and the BioQUEST Curriculum Consortium, The National Centre for Case Study Teaching in Science's which includes some appropriate for PBL instruction, a library of several hundred engineering case studies available through Carleton University, and a set of pharmacology problems.

Books containing PBL problems are not common but a collection of problems with teaching notes for general biology is available. There are also several books of case studies that provide ideas that can be adapted for use in PBL. To be appropriate for PBL, the cases would need to be written in a format of progressive disclosure, and the content would have to be reduced so that students would be motivated to do independent research.

EVALUATION OF PBL OUTCOMES

Faculty who use PBL instruction want students to develop skills such as the ability to find and analyze information from a multitude of sources, to engage effectively in self-directed study, to communicate well using diverse media, and to work productively with a group of peers.

These goals are often assessed by comparing student performance several times during the semester at such tasks as giving oral presentations, writing reports, or answering exam questions. Classroom observations and peer evaluations of group performance are helpful in assessment of students' contributions to their groups. Development of other skills, such as the ability to reason critically and creatively, and to make reasoned decisions in unfamiliar situations is not so easily assessed. Documentation of student attainment is hampered by the lack of instruments that have the sensitivity needed to detect changes in critical thinking (as defined by particular instructors or within particular disciplines) over the course of a semester.

PBL was not designed as a way to enhance content understanding alone, but the constructivist nature of its approach often invokes concerns about whether students are learning essential course content. Specific experiences with PBL, and meta-analyses of outcomes from PBL curricula in the medical school context have shown

that content learning in PBL matches that in a traditional curriculum. Additional outcomes in PBL include greater retention of knowledge and greater satisfaction with the educational experience.

Data comparing traditional and PBL classrooms can be more difficult to obtain in the undergraduate setting, with its diversity of majors and tracks. Disciplines such as physics, for which national standardized surveys of content learning outcomes exist, provide some comparison data. Williams reports gains in force concepts inventory scores for a PBL course in introductory physics that are nearly twice those found in courses using traditional methods. This is a common finding for physics courses that use active learning methods. However, care must be taken in interpreting the outcomes of these scores or those from any multiple choice pre- and post-test, since they capture only one of the goals (content understanding) of PBL instruction, and because students in PBL courses typically do not encounter multiple choice tests in the course of the semester. Conversely, it would be inappropriate to evaluate students in lecture-based courses with instruments that assessed PBL's additional goals if these students had had little opportunity to practice these skills in their courses.

The University of Delaware recently completed a broad study on PBL outcomes that was funded by the Pew Charitable Trusts. This study sought to document the instructional use and impact of PBL at the undergraduate level. Preliminary results include the following findings. Exposure to PBL positively and significantly affected the number and/or quality of student-faculty interactions, as well as the number of diversity-related experiences in which students participated. Exposure to PBL was defined as a composite measure of the number of PBL courses completed by each student and students' report of participation in several activities that collectively represent PBL activities in the classroom.

Discussion with students in structured focus groups offered further insights into students' learning experiences. Students indicated that the collaborative nature of PBL increased their level of comfort and inclusion in the class. In addition, students believed that their learning was enhanced because PBL increased their ability to consider, evaluate, and respect different points of view.

They discovered that there might be more than one good answer to a problem or an issue developed within the context of a problem. The PBL setting helped students to apply theory to real world issues, made course content more interesting, and helped them to learn course content more thoroughly. Students also believed that their communication and interpersonal skills had improved as a result of participation in PBL courses.

While gains in critical thinking skills were measured (using standard instruments such as the Watson-Glaser Critical Thinking Appraisal), it was not possible to

conclude that these changes were due to PBL, or to other aspects of the students' undergraduate experiences. Interpretation of findings was hampered by the presence of many different models of PBL instruction, including hybrid ones, on the University of Delaware campus, as well as the lack of a uniquely PBL curriculum track that could be compared to a more traditional track, as is the case in some medical school settings.

INSTITUTIONAL COSTS OF PBL TEACHING

Transformation of courses to incorporate PBL strategies has some costs associated with it. Classrooms were refurbished to include new furnishings and seating arrangements more conducive to group work; while these classrooms are ideal, they are not essential to successful use of PBL strategies. Other costs resulted from the additional demands placed on faculty time in the early phases of PBL adoption, when materials and activities were planned and developed. Outside consultants were brought in the first few years of PBL adoption on our campus to assist with faculty development in PBL instruction, but in later years, University of Delaware faculty took over this role. These faculty members formed a PBL institute supported in part by an extramural grant to provide the training and mentoring often needed by faculty attempting to redefine their teaching. Faculty incentives to attend the institute and to transform their courses were provided by a match of institutional funds to funds from extramural sources, including the National Science Foundation, the Pew Charitable Trusts, and for biomedical sciences faculty, the Howard Hughes Medical Institute. These incentives have taken the form of professional development accounts through which faculty can purchase materials, hire technology assistants for aspects of course design, or attend and present at education-related conferences in their scholarly disciplines. At the University of Delaware, there was no reduction in class size with adoption of PBL, so no additional faculty time was needed to accommodate greater numbers of course sections; faculty adopted PBL strategies that would work within existing class sizes. Although having additional graduate teaching assistants (TA) to help facilitate student groups might have been ideal, reallocation of TAs towards PBL courses or creation of new TA lines did not occur.

It is important to point out that these costs are mitigated by the way in which PBL contributes to a unique definition of instructional productivity. That is, PBL allows more students and student hours to be engaged in educational activities that resemble those of a faculty-directed undergraduate research experience without the associated costs of such one-on-one faculty-student interactions. Nearly 100 per cent of the science and engineering faculty at the University of Delaware already take undergraduate collaborators into their research and they are now serving as

many undergraduate researchers as they can handle. Therefore, this classroom-based mode of student engagement in the discovery process effectively scales up research-based learning so that all undergraduates can benefit.

BREAKING THE CYCLE OF TEACHING AS WE WERE TAUGHT

Despite the advantages for improving the undergraduate experience that PBL offers, the adoption of PBL as a mode of instruction is a change not undertaken lightly for faculty whose formative educational experiences were based on a different model. Ideally in the PBL classroom, the instructor guides, probes, and support students' initiatives rather than lectures, directs, or provides solutions. When faculty incorporate PBL in their courses, they empower their students to take a responsible role in their learning and as a result, faculty must be ready to yield some of their own classroom authority to their students. Giving up the safety and authority of the podium can be unsettling for faculty accustomed only to a traditional teacher-centred lecture format. Attempts to adopt PBL at a level beyond a small collection of courses and committed faculty, therefore, must be accompanied by broader efforts to change the campus culture to one more accepting of active, student-centred, and enquiry-based learning.

The 'faculty mentoring faculty' model has been effective in moving the initial grass-roots effort to improve undergraduate courses through use of PBL into a thriving reform of the undergraduate experience at the University of Delaware. With support from NSF's Institution-Wide Reform Initiative, faculty who had adapted PBL for courses in the basic sciences established a campus-wide teaching and learning institute. This institute sponsors weeklong, hands-on workshops twice yearly (plus follow-up activities) that are led by faculty who have transformed their own teaching. The institute and the workshops it sponsors provide institute fellows with the support, resources and training needed to encourage them to transform their courses to incorporate PBL and related active learning strategies. At last count over 200 faculty (65 in the SMET disciplines) from all colleges at the University of Delaware have participated as institute fellows. Over 30 per cent of the faculty at the University have participated either in institute activities or shorter PBL workshop sessions (held before the institute was founded), for a total impact on more than 150 courses.

Elements that were crucial to the development of UD's PBL programme include a critical mass of individuals who were attracted to PBL's underlying philosophies and committed to moving the programme forward, our success at attracting external funding that helped to leverage support and validate the effort, a mechanism for preparing and mentoring other faculty in the new pedagogy and administrative support to help remove potential barriers to innovation and to make adequate resources available. Because these key elements were in place, PBL is now a byword

on the University of Delaware campus. In fact, the PBL effort was cited in the summer 2001 alumni magazine as one of the university's top accomplishments of the past 10 years. What began as an effort on the part of a few science faculty to find a better way to teach, has cascaded into a broader community of educators committed to involving a community of learners in the essence of what scholarship entails.

THE INSTITUTION

The University of Delaware is a mid-sized, research-intensive institution with approximately 15,000 full-time undergraduates, who are taught by about 1000 faculty members in 122 degree programmes. Of the undergraduate students receiving degrees each year, 1671 received degrees from the College of Arts and Science, the largest college, 204 from the College of Engineering, 178 from the College of Agriculture and Natural Resources, and 380 from the College of Health and Nursing Sciences. Campus wide, approximately 10 per cent of the student body participates in faculty-mentored research, although this number rises to 30 per cent and greater in the basic and applied sciences.

STRATEGY TO APPROACH IN STYLES- AND STRATEGIES-BASED INSTRUCTION

Traditionally, the emphasis has primarily been on the teaching side of second language instruction, rather than on the learner side. It has been assumed that if teachers do their job of teaching well, students would certainly learn and retain the language as well. Yet, it became clear that if students are not learning or are not motivated to learn, it may not matter how well the teachers are teaching. With this realization an effort has emerged to improve language teaching methodology by adding a component that focuses on the learner.

As the "domain" of language teaching has become more learner-focused and interactive, there has also been a heightened emphasis on helping students take more responsibility for meeting their own language learning needs. Students are being asked to self-direct the language-learning process and become less dependent on the classroom teacher. However, what may well stand in the way of learners' genuine success at language learning is an insufficient awareness of how various strategies may help them learn and use a foreign language more effectively.

Given that language learning and the use of what is learned inevitably involve considerable memory work, as well as ongoing and meaningful practice, a systematic and purposeful approach to learning can help to ease the burden. And the classroom teacher can perform a key role in this effort as learner trainer. Styles- and strategies-based instruction is a name that has been given to a form of learner-focused language teaching that explicitly combines styles and strategy training activities with everyday

classroom language instruction. The underlying premise of the styles- and strategies-based approach is that students should be given the opportunity to understand not only what they can learn in the language classroom, but also how they can learn the language they are studying more effectively and efficiently. Research seems to suggest that there are a wide variety of strategies that learners can use to meet their language learning and using needs.

Styles- and strategies-based approach to teaching emphasizes both explicit and implicit integration of language learning and use strategies in the language classroom. This approach aims to assist learners in becoming more effective in their efforts to learn and use the target language. SSBI helps learners become more aware of what kinds of strategies are available to them, understand how to organize and use strategies systematically and effectively given their learning-style preferences, and learn when and how to transfer the strategies to new language learning and using contexts. SSBI is based on the following series of components:

Strategy Awareness-Raising

In this phase, the goal is to alert learners to presence of strategies they might never have thought about or may have thought about but had never used. The SSBI tasks are explicitly used to raise the students' general awareness about: 1) what the learning process may consist of, 2) their learning style preferences or general approaches to learning, 3) the kinds of strategies that they already employ, as well as those suggested by the teacher or classmates, 4) the amount of responsibility that they take for their learning, or 5) approaches that can be used to evaluate the students' strategy use. Awareness-raising activities are by definition always explicit in their treatment of strategies.

Strategy Preparation

In this phase, the goal is to determine just how much knowledge of and ability to use strategies the given learners already have. There is no sense in assuming that students are a blank slate when it comes to strategy use. They most likely have developed some strategies. The thing is that they may not use them systematically, and they may not use them well.

Strategy Training

In this phase, students are explicitly taught how, when, and why certain strategies (whether alone, in sequence, or in clusters) can be used to facilitate language learning and use activities. In a typical classroom strategy-training situation, the teachers describe, model, and give examples of potentially useful strategies. They elicit additional examples from students based on the students' own learning experiences; they lead small-group or whole-class discussions about strategies (*e.g.*, the rationale

behind strategy use, planning an approach to a specific activity, evaluating the effectiveness of chosen strategies); and they can encourage their students to experiment with a broad range of strategies.

Personalization of Strategies

In this stage, learners personalize what they have learned about these strategies, evaluate to see how they are using the strategies, and then look to ways that they can transfer the use of these strategies to other contexts.

In SSBI, it is the curriculum writers' and the teachers' role to see that strategies are integrated into everyday class materials and are both explicitly and implicitly embedded into the language tasks to provide for contextualized strategy practice. Teachers may:

- Start with the established course materials and then determine which strategies might be inserted,
- Start with a set of strategies that they wish to focus on and design activities around them, or
- Insert strategies spontaneously into the lessons whenever it seems appropriate.

These strategies-based activities are designed to raise awareness about strategies, to train students in strategy use, to give them opportunities to practice strategy use, and to encourage them to personalize these strategies for themselves. Teachers also allow students to choose their own strategies and do so spontaneously, without continued prompting from the language teacher.

Strategy Practice

In this phase, students are encouraged to experiment with a broad range of strategies. It is not assumed that knowing about a given strategy is enough. It is crucial that learners have ample opportunity to try them out on numerous tasks. These “strategy-friendly” activities are designed to reinforce strategies that have already been dealt with and allow students time to practice the strategies at the same time they are learning the course content. These activities should include explicit references to the strategies being used in completion of the task. In other words, either students:

- Plan the strategies that they will use for a particular activity,
- Have their attention called to the use of particular strategies while they are being used, or
- “debrief” their use of strategies (and their relative effectiveness) after the activity has ended.

STRATEGIES TO ENCOURAGE A PROFOUND APPROACH TO READING

It is a recurring complaint among faculty that students do not complete their assigned readings or that they read them superficially. Despite the importance of academic reading skills for university success, we seldom teach them, as we generally presuppose that students already acquired these skills either as part of their secondary education or elsewhere in college. The reality is that most university students, particularly first-year students, lack academic reading skills and adopt a surface approach to reading.

Deep Reading

A deep approach to reading is an approach where the reader uses higher-order cognitive skills such as the ability to analyse, synthesize, solve problems, and thinks meta-cognitively in order to negotiate meanings with the author and to construct new meaning from the text. The deep reader focuses on the author's message, on the ideas she is trying to convey, the line of argument, and the structure of the argument.

The reader makes connections to already known concepts and principles and uses this understanding for problem solving in new contexts.

Surface Reading

Surface reading is the tacit acceptance of information contained in the text, which leads to superficial retention of materials for examinations and does not promote understanding or long-term retention of knowledge and information.

The Need for Constructive Alignment

An aligned course is a course where there is maximum consistency among the objectives, the teaching and learning activities, and the assessment. Research shows that placing academic reading at the forefront of the curriculum in aligned courses encourages students to take a deep approach to reading.

The Following Strategies Aim at Promoting Deep Reading

- *Course objectives:* Design a course whose main objective is to encourage students to take a deep approach to reading and to use higher order cognitive and metacognitive skills to understand and process academic texts, and to negotiate meanings with the author of academic texts. Make these objectives explicit to students, as most students tend to see only facts and principles as the sole content of courses.

- *Assessment:* Assessment is the component of the teaching system that plays the most influential role in the decision on whether to take a deep or surface approach to reading and learning. Design the course assessment in order to measure whether students: (i) use higher-order cognitive skills to read assigned materials, (ii) can effectively negotiate meanings with the author, (iii) can evaluate the strength of the author's arguments, (iv) deconstruct hidden assumptions in the texts, and (v) see the non immediate implications and applications of the author's arguments.
- *TLAs:* Design TLAs to promote a deep approach to reading and learning in consonance with the proposed objectives and learning outcomes. If, for example, you lecture the textbook, students will probably not read the text as they will rely solely on your oral explanations and the notes they take from these lectures.

Examples of creative TLAs that foster a deep approach to reading:

- *The Apprentice:* Assign each group a journal article. Give teams reading guides to encourage them to evaluate, judge, compare, and synthesise information from these texts. Ask each team to make a presentation to the rest of the class on some aspect of the text. The worst teams are fired and the best one is hired.
- *Facebook or MySpace profile:* Give students an article and ask them to create a MySpace type of profile about the topic of the article. For example, if they read about Lucrecia Martel's films, ask them to choose a character and to imagine that character's favourite songs, films, books, and friends not mentioned in the article or film. Or if they read about theoretical models of criminal justice, ask students to imagine a criminal justice agent that is enrolled in one of the theoretical models such as Due Process or Crime Control and ask them to build her Facebook profile.
- *The movie studio:* Students need to read an article on a topic discussed in class. Then, they need to write a treatment (script outline) for a documentary about the content of the article and pitch the idea for funding to executives from a film company.
- *The Amazing Race:* Students in teams have to run from the classroom to the library, then to the teacher's office, then to the computer lab, and then back to the classroom. In each of these stops, they have to analyze academic texts and answer some questions about the texts aimed at helping them engage in deep reading. Examples of questions include: explain a quote from the text, give an example not mentioned in the book, identify the author's thesis, evaluate the author's argument, and compare the author's argument to another article read in class.

All these activities have in common the fact that they encourage students to read for a purpose, which they find motivating. Also, in order to achieve the activity goals, students need to use higher-order cognitive skills to process academic texts.

ETHICAL ISSUES IN CONDUCTING RESEARCH

Primary research is conducted all of the time—journalists use it as their primary means of reporting news and events; national polls and surveys discover what the population thinks about a particular political figure or proposal; and companies collect data on their consumer base and market trends. When conducting research in an academic or professional setting, you need to be aware of the ethics behind your research activity.

Here are some specific points to consider:

- You should have the permission of the people who you will be studying to conduct research involving them.
- Not all types of research require permission—for example, if you are interested in analyzing something that is available publicly (such as in the case of commercials, public message boards, etc) you do not necessarily need the permission of the authors.
- You don't want to do anything that would cause physical or emotional harm to your subjects. This could be something as simple as being careful how you word sensitive or difficult questions during your interviews.
- Objectivity vs. subjectivity in your research is another important consideration. Be sure your own personal biases and opinions do not get in the way of your research and that you give both sides fair consideration.
- Many types of research, such as surveys or observations, should be conducted under the assumption that you will keep your findings anonymous. Many interviews, however, are not done under the condition of anonymity. You should let your subjects know whether your research results will be anonymous or not.
- When you are doing research, be sure you are not taking advantage of easy-to-access groups of people (such as children at a daycare) simply because they are easy to access. You should choose your subjects based on what would most benefit your research.
- Some types of research done in a university setting require Institutional Board Approval. This means that your research has to be approved by an ethics review committee to make sure you are not violating any of the above considerations.

- When reporting your results be sure that you accurately represent what you observed or what you were told. Do not take interview responses out of context and do not discuss small parts of observations without putting them into the appropriate context.

Ethics concern with all the human interaction, including human research. Educational research is a part of human research which has potential ethical problems. Therefore, “Each stage in the research sequence may be a potential source of ethical problems (. There are “three primary ethical principles: (1) autonomy and self-determination, (2) beneficence, (3) Justice”. “Ethical concerns arise in connection with core values the researcher holds, as in the case of honesty or justice. Therefore, the researchers feel that the ethical rules will limit their effectiveness doing research. However, the ethics is the part important of the research process. Therefore, in my research, I try to investigate it carefully to cope with the ethical problems. There are several ethical issues while I am conducting my research: access and acceptance, informed consent, privacy and confidentiality, misinterpretation and misrepresenting of data.

The first ethical issue is access and acceptance. “The initial stage of research project-that of access to the institution or organization where the research to be conducted, and acceptance by those whose permission one needs before embarking the task”. Furthermore, “access to personal records, both as a primary or secondary source of data, must be approached both ethically and legally. In this research,

The informed consent will offer the information to the participants about “the nature and the purpose of the research, the risks, and benefits”. Furthermore, “Informed consent is a central canon of research ethics policy. According to Anderson and Arsenault, my informed consent will involves the purpose of the research, risks and discomfort, benefits, participant’s right and statement. I realize that my informed consent have to “ensure the individual’s mental capacity, disclose sufficient information, provide sufficient time and privacy, provide the safeguard, ensure the individual’s awareness”.

My research will involve the semistructured interviews such as participants’ opinion, subjectivity, relationship, and life story. We try to meet the ethics requirements through giving list of interview questions for my participants for interview protocol). We also will give information of the time consuming and the process of interviews.

Privacy and confidentiality need to be addressed. We will explore the phenomenon of my students’ opinions and behaviours when we applied metacognitive skills and green chemistry approaches. Some stories will be related with their personal experiences, such as their misunderstanding. Therefore, I

have to respect their individual privacy. “It is the duty of researcher to protect the identity of individuals, there is a distinction between one’s public role and private life”. I also have to be aware with my institution privacy, because I will describe some of the weakness of the laboratory in my department such as safety and management. “Having empathy can be beneficial in research...if [the confidential information is] not handle correctly, can cause discomfort and even a job loss”. Keeping the participants and institution as anonymous as possible, using the promise of confidential. I also have to protect my privacy which related with my professional development.

The risk that I will face is investigating the background of applying green chemistry approaches. I need to describe how the weakness of safety and management in laboratory, such as using the dangerous chemical substances. The story will relate to the reputation of university and some people who include in this story. It is also related to my professional development as a lecturer when I am back to my university. However, the story is very important because the accident which caused me poisoned, motivated me to improve the quality of the laboratory such as using green chemistry approaches. Therefore, I need to use the appropriate language to describe it properly. I also need to protect the name and the way to access the private information. In addition, I will use pseudonym through changing my participants’ name. Hence, the information will not be published or used for any other purposes from this research.

Adequate interpretation and representation of data must be addressed. My subjectivity can influence the research process and the possibility of interpretation and representation of data. I realize that I have to remember my experiences one year ago when I applied metacognitive skills and green chemistry approaches. It is not only difficult for me to interpret my experiences but also other peoples’ perspective and behaviour. Therefore, I will ask them to write the stories on the same phenomena to check my stories from a different perspective. This form of member checking will be important to avoid the misinterpretation of my stories. This collaboration will reduce “the potential gap between narrative told and narrative reported”. The narrative enquiry is the predominant method that I will use in this research. Therefore, my stories and other people’s stories will be represented to answer my research questions. I have to be aware that I cannot only focus to answer my research questions but also I have to outweigh the risks and benefits to professional development, my institution participants, and myself. Therefore, I will ask my participants to comment on relevant parts of my report which represent their perceptions, behaviour and cultural context. Therefore, I need to “be compassionate to individuals and avoid language that discriminates on basis of gender, sexual orientation, race or ethnic group”. The appropriate language will help me to avoid this conflict.

WHAT IS ETHICS IN RESEARCH AND WHY IS IT IMPORTANT?

When most people think of ethics (or morals), they think of rules for distinguishing between right and wrong, such as the Golden Rule (“Do unto others as you would have them do unto you”), a code of professional conduct like the Hippocratic Oath (“First of all, do no harm”), a religious creed like the Ten Commandments (“Thou Shalt not kill...”), or a wise aphorisms like the sayings of Confucius. This is the most common way of defining “ethics”: norms for conduct that distinguish between acceptable and unacceptable behaviour.

Most people learn ethical norms at home, at school, in church, or in other social settings. Although most people acquire their sense of right and wrong during childhood, moral development occurs throughout life and human beings pass through different stages of growth as they mature. Ethical norms are so ubiquitous that one might be tempted to regard them as simple commonsense. On the other hand, if morality were nothing more than commonsense, then why are there so many ethical disputes and issues in our society? One plausible explanation of these disagreements is that all people recognize some common ethical norms but different individuals interpret, apply, and balance these norms in different ways in light of their own values and life experiences.

Most societies also have legal rules that govern behaviour, but ethical norms tend to be broader and more informal than laws. Although most societies use laws to enforce widely accepted moral standards and ethical and legal rules use similar concepts, it is important to remember that ethics and law are not the same. An action may be legal but unethical or illegal but ethical. We can also use ethical concepts and principles to criticize, evaluate, propose, or interpret laws. Indeed, in the last century, many social reformers urged citizens to disobey laws in order to protest what they regarded as immoral or unjust laws. Peaceful civil disobedience is an ethical way of expressing political viewpoints.

Another way of defining ‘ethics’ focuses on the disciplines that study standards of conduct, such as philosophy, theology, law, psychology, or sociology. For example, a “medical ethicist” is someone who studies ethical standards in medicine. One may also define ethics as a method, procedure, or perspective for deciding how to act and for analyzing complex problems and issues. For instance, in considering a complex issue like global warming, one may take an economic, ecological, political, or ethical perspective on the problem. While an economist might examine the cost and benefits of various policies related to global warming, an environmental ethicist could examine the ethical values and principles at stake.

Many different disciplines, institutions, and professions have norms for behaviour that suit their particular aims and goals. These norms also help members of the discipline to coordinate their actions or activities and to establish the public's trust of the discipline. For instance, ethical norms govern conduct in medicine, law, engineering, and business. Ethical norms also serve the aims or goals of research and apply to people who conduct scientific research or other scholarly or creative activities. There is even a specialized discipline, research ethics, which studies these norms.

There are several reasons why it is important to adhere to ethical norms in research. First, norms promote the aims of research, such as knowledge, truth, and avoidance of error. For example, prohibitions against fabricating, falsifying, or misrepresenting research data promote the truth and avoid error. Second, since research often involves a great deal of cooperation and coordination among many different people in different disciplines and institutions, ethical standards promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and fairness. For example, many ethical norms in research, such as guidelines for authorship, copyright and patenting policies, data sharing policies, and confidentiality rules in peer review, are designed to protect intellectual property interests while encouraging collaboration.

Most researchers want to receive credit for their contributions and do not want to have their ideas stolen or disclosed prematurely. Third, many of the ethical norms help to ensure that researchers can be held accountable to the public. For instance, federal policies on research misconduct, conflicts of interest, the human subjects protections, and animal care and use are necessary in order to make sure that researchers who are funded by public money can be held accountable to the public. Fourth, ethical norms in research also help to build public support for research. People more likely to fund research project if they can trust the quality and integrity of research.

Finally, many of the norms of research promote a variety of other important moral and social values, such as social responsibility, human rights, animal welfare, compliance with the law, and health and safety. Ethical lapses in research can significantly harm human and animal subjects, students, and the public. For example, a researcher who fabricates data in a clinical trial may harm or even kill patients, and a researcher who fails to abide by regulations and guidelines relating to radiation or biological safety may jeopardize his health and safety or the health and safety of staff and students.

CODES AND POLICIES FOR RESEARCH ETHICS

Given the importance of ethics for the conduct of research, it should come as no surprise that many different professional associations, government agencies, and

universities have adopted specific codes, rules, and policies relating to research ethics. Many government agencies, such as the National Institutes of Health (NIH), the National Science Foundation (NSF), the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the US Department of Agriculture (USDA) have ethics rules for funded researchers. Other influential research ethics policies include the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (International Committee of Medical Journal Editors), the Chemist's Code of Conduct (American Chemical Society), Code of Ethics (American Society for Clinical Laboratory Science) Ethical Principles of Psychologists (American Psychological Association), Statements on Ethics and Professional Responsibility (American Anthropological Association), Statement on Professional Ethics (American Association of University Professors), the Nuremberg Code and the Declaration of Helsinki (World Medical Association).

ETHICS ISSUES TERMS

Compliance and ethics are both necessary for the conduct of responsible research. Compliance means that investigators and institutions follow the rules that are set out for them. Rules regarding research come from the federal government, from funders, and from the institution itself. The essential elements of compliance are that an individual researcher knows the rules and that he or she is motivated to follow the rules.

Ethical behaviour requires more than simply following the rules. Ethics is the study of how human action affects other humans, sentient beings, or the ecosystem. Ethical researchers understand that their actions have the potential of causing harm and the potential of promoting good for others, for the profession, for society, and for the natural world. They are aware of the special responsibilities that follow from the researcher role and work to fulfill those responsibilities. In the process of meeting their responsibilities, they seek to promote good when possible. Always, at a minimum, they choose actions that do not cause unjustified harm.

Ethical analysis provides a way of making sense of the rules and regulations. Fabrication, for example, is a type of research misconduct. It is legally and ethically prohibited. Fabrication is the act of making up data or results, then recording or reporting them as part of the research record. It is legally required for funding agencies and research institutions to take punitive actions against researchers who fabricate. They are held accountable for their actions.

Fabrication is ethically wrong because it is likely to lead to harm to others. The harm could be direct to a patient who takes a drug that is erroneously reported as having no serious side effects. The harm could be direct to another researcher who trusts the results of fabricated research and wastes valuable time, money and other

resources in using that research as a basis for his or her own work. The harm is almost always indirect as well. Indirect harms include the decrease in trust that the general public has in research when they learn about cases of scientific misconduct. This decrease in trust is harmful to the public, who must depend on the accuracy of research.

COMPLIANCE TERMS

Research: Includes all basic, applied, and demonstration research in all fields of science, engineering, and mathematics. This includes, but is not limited to, research in economics, education, linguistics, medicine, psychology, social sciences, statistics, and all research involving human subjects or animals, regardless of originating discipline. Research, according to the *Belmont Report*, is an “activity designed to test a hypothesis, permit conclusions to be drawn, and thereby to develop or contribute to generalized knowledge (expressed, for example, in theories, principles, and statements of relationships). Research is usually described in a formal protocol that sets forth an objective and a set of procedures designed to reach that objective.”

Research Misconduct: Fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest error or honest differences in interpretations or judgements of data.

Fabrication: Making up data or results and recording or reporting them as factual results.

Falsification: Manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.

Research Institutions: All organizations using federal funds for research, including, for example, colleges and universities, intramural federal research laboratories, federally-funded research and development centre, national user facilities, industrial laboratories, or other research institutes. Independent researchers and small research institutions are also included in this definition. Research institutions have the primary responsibility for prevention and detection of research misconduct.

Research Integrity Officer: Institutional official responsible for assessing allegations of research misconduct. The Research Integrity Officer at most institutions, is the Vice President for Research, or that person’s designee.

Research Record: The record of data or results that embody the facts resulting from scientific enquiry and includes, but is not limited to, research proposals, laboratory records, both physical and electronic, progress reports, abstracts, theses, oral presentations, internal reports, and journal articles.

Plagiarism: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit, including those obtained through confidential review of others' research proposals and manuscripts.

Findings of Research Misconduct: A finding that research misconduct, in fact, occurred requires that the fabrication, falsification, or plagiarism be a significant departure from accepted practices of the relevant research community; and the misconduct be committed intentionally, knowingly, or recklessly; and the allegation be proven by a preponderance of evidence.

Legally Required

This terminology is used in the course to differentiate actions that are merely in compliance (legally required) from those actions that are ethically permitted.

Ethics Terms

Ethical: Within the realm of considerations that looks at the potential harms caused to other persons, sentient beings or systems.

Moral Agent: Someone who is aware or who has the capacity to be aware of the expectation that he or she not cause unjustified harm to other persons, sentient beings or systems.

General Morality: The questions relating to ethics in research are a subset of the questions that relate to general morality. General morality dictates that it is not acceptable to cause pain, death, disability, or deprive someone of freedom or pleasure without justification. General morality also requires that acts of deception, cheating, promise-breaking, law-breaking and neglect of responsibility be considered examples of wrongdoing unless there is justification for the acts.

Publicity: It is reasonable to expect individuals to act ethically only if it possible for them to know what those ethical expectations are and if following those expectations will not cause them unjustified harm. The expectations should be public. Exceptions that people want to make for not doing what is usually expected should be public as well.

Ethically Prohibited: Actions that are contrary to those required by general morality or by reasonable expectations within the research community and are not justifiable. People are blameworthy for acting in ethically prohibited ways. By way of example, it is ethically prohibited to violate the rules and regulations regarding responsible research that are set out by the federal government, funders, and research institutions.

Ethically Permitted: Actions that are consistent with those required by general morality and by reasonable expectations within the research community. It is ethically permitted to do more than follow minimal rules and regulations.

Ethically Required: Actions that follow from the special role-related responsibilities of being a researcher. It is ethically required that researchers be in compliance with federal and institutional rules and regulations.

Ethically Encouraged: Actions that are ethically permitted and, in addition, are intended to lessen suffering or lessen the risk of suffering harms.

- *Blameworthy:* One who acts in ethically prohibited ways.
- *Praiseworthy:* One who acts in ethically encouraged ways.
- *Descriptive Ethics:* The study of how people *do* act.
- *Normative Ethics:* The study of how people *should* act.
- *Justification:* Ethically acceptable exceptions to doing what is usually expected have the following features:
 - If they are justified for any person, they are justified for every person when all of the ethically relevant features are the same (one cannot justifiably make an exception of oneself if one is not willing to make the same exception for everyone in the same situation);
 - The exception cannot cause unjustified harm to oneself or others; and
 - The exception can be known publicly.

Ethical Rules: Rules that identify ethically questionable actions that are known to cause suffering or cause an increased risk of causing harm. One set of rules is that it is ethically prohibited to cause pain, death, disability or deprive others of opportunity or pleasure without justification. Another set of rules is that it is also ethically prohibited to do any of the following without good reason: deceive, cheat, break promises, break the law, or neglect one's duty.

Ethical Ideals: Ideals are actions that lessen the amount of harm suffered or decrease the risk that people, other sentient beings, or the ecosystem will suffer harm. As long as one is not violating an ethical rule, general morality encourages, but does not require, following ethical ideals. People are praiseworthy for following ethical ideals, but are not blameworthy for not performing the ideal.

TOOLS FOR ACCESS THE LITERATURE

Although these and other indexing and abstract services provide points of access, the information provided may not be sufficiently detailed regarding a study's purpose, setting, participants, research design, or other aspects that would help a non-expert reader evaluate its relevance to his or her interests. In addition, researchers, policymakers, and even parents are increasingly demanding a rapid way to access concise information about educational outcomes to use "scientifically based research" as the grounds for "evidence-based practice". These demands have spurred

a grassroots effort within the education research community to make the research process, including assumptions, qualifiers, and limitations, more transparent by accompanying manuscripts with a “structured abstract.”

Practitioners and Decision Makers

First the structured abstract is designed to make clearer and more accessible a study’s salient features so that practitioners and decision makers can more easily locate studies of interest and assess their implications for teaching practice. Propose that structured abstracts be used to “make the argumentative structure of education research articles more apparent and open to scrutiny.”

Advocates contend that authors should make explicit the nature of their evidence and claims (*e.g.*, descriptive, correlative, causal), circumstances that may affect the strength of their claims (*e.g.*, study setting, size, context), and other qualifiers that might influence the applicability of their claims to teaching practice. ERIC now requests that authors submit a structured abstract with their contributed materials. As structured abstracts become more commonplace, they will likely result in greater accessibility for researchers and decision makers outside the education community.

TOOLS FOR INTERPRET THE LITERATURE

Even if an article of interest is successfully located, it may not be decipherable by nonexperts. Life scientists are familiar with the old adage that learning biology, which is replete with discipline-specific terminology, resembles learning a foreign language. Similarly, grappling with the education literature requires learning the vocabulary of both practice and scholarship. Several tools have been developed to assist nonexperts in learning the jargon, including online and hard copy dictionaries and glossaries.

Some life scientists may be well prepared to understand the complexities of the anthropological, psychological, and sociological underpinnings of teaching and learning. Ecologists and evolutionary biologists often study phenomena in which they are unable to control, predict, or even characterize all the variables involved. Similarly, education researchers are often not able to control all the factors at play in a learning situation, and they may not want to do so. Rather, some of their most valuable findings emerge from investigating the real contexts in which learning may occur.

Investigations of Teaching and Learning

Like all research, investigations of teaching and learning begin with a question. Research questions generally fall into three categories: description, causation, and

mechanism. In addition, learning behaviour can be examined at different depths and with different time frames in mind, including changes in skills, knowledge, attitudes, or interests (short term), behaviour and decisions (middle term), and life condition, status, or values (long term). Choices regarding methods of data collection and analysis are influenced by the outcomes that are of interest to the researcher, as illustrated in this fictional example:

A researcher is interested in determining if and how high school students understand the dynamic interplay between gene expression and environmental stimuli. The researcher chooses to investigate this phenomenon in a class that is taught by a teacher who has a good understanding of the relevant concepts in genetics, physiology, and ecology and in a school that is geographically convenient, enabling multiple visits to the classroom.

During the several weeks that students learn about these concepts, the researcher engages in substantive conversations with a few high school students within that class (documented by audiotape), observes relevant class-wide discussions (documented by videotape and/or a classroom observation protocol), collects student work, and interviews the teacher several times. The researcher and members of her research team analyze and interpret the entirety of the data to develop a rich picture of students' thinking. Before publishing her findings, the researcher shares the interpretations with the teacher to see if he thinks they have captured what the students understand.

Document the Learning

The researcher intended to document the learning of a limited group of students whose teacher may be well positioned to help them, rather than draw conclusions about how all students learn genetics or what students in general learn by using this curriculum. Her initial research question guided her choices regarding data collection, analyses, and interpretation, as well as the scope of her conclusions. Because she collected data by using several approaches, including discussions with students, she was able to ask them questions that made clear their understanding or lack thereof. Because she collected data over time rather than at just one or two time points (*e.g.*, the beginning and end of the relevant units), she was able to develop hypotheses about what classroom occurrences may have altered students' conceptions. Finally, because she sought feedback from the teacher, who has a greater depth and breadth of experience working with these students, she has enhanced the credibility and trustworthiness of her interpretations.

A researcher's perspective and theoretical framework also guide how and why he or she conducts studies. A life scientist's styles of reasoning and experimental practice (*e.g.*, taking a biochemical or genetic approach to studying the cell cycle)

are usually obvious from a quick reading of the methods in a paper or from knowledge about the journal where the work was published. Approaching investigations from a genetic versus biochemical perspective influences the questions that are asked, the experimental tools that are used, the data that are collected, the analytical methods that are used, and the conclusions that are drawn, as well as the hypotheses and subsequent questions that are generated.

Similarly, understanding the theoretical framework that guides an educational study can help readers identify the perspective of the researchers and anticipate the types of questions, data, analyses, and findings that will be included. For example, cognitive load theory rests on the premise that learning happens best in ways that are aligned with the organization of the brain and the nature of cognition, as understood from cognitive psychology and neuroscience research.

For example, the cognitive load of learners depends on their experience and expertise, which influences their short-term, long-term, and working memory capacities. Experts' knowledge is organized into schemas that facilitate learning, lowering the cognitive load required for learning and enabling them to process information with greater efficiency. Novices have not developed such schemas; thus, they are more limited in the amount of information they can take in and incorporate using working memory. A study framed by cognitive load theory might consider how learning materials could be designed to minimize the amount of information provided to novice learners during the learning process, or to teach novices explicitly about expert schemas to help them organize their thinking during learning.

TOOLS FOR EVALUATE THE LITERATURE

The intent of most education research is to understand or explain social and psychological phenomena related to learning. Researchers have developed models that are cognitive, behavioural, and social, with respective focuses on reasoning and memory, doing and action, and interacting and culture. Regardless of which model is used, research entails subjecting data, in whatever form, to systematic analysis. Yet, human thinking and relationships are extraordinarily complex phenomena that are not straightforward to analyze systematically.

In other words, the data should be adequate to support the claim, and there should be a reasonable relationship between the data and the claims they support. The methods for data collection and analysis should be appropriate for supporting the claims, and so on. These points may seem obvious, but, when considering the literature as a whole, the data and methods can be strikingly varied depending on the questions being asked. Thus, a common rubric for evaluating the quality of studies in education must be considered at this broad level, rather than based on any particular methodological approach or type of data

Evaluating the Methodology of an Education Study

In evaluating the methodology of an education study, the reader must take into account what research questions are addressed. For example, randomized controlled trials or investigations with well-matched comparison groups are well suited to investigating causal relationships between interventions and outcomes. Yet, in many cases, these study designs are not feasible (*i.e.*, it is unrealistic to randomly assign students to classes) and they are costly.

For experimental or quasi-experimental findings to have value, the instrument used for data collection (*e.g.*, an exam, survey, or questionnaire) must be valid (*i.e.*, it actually measures what it is purported to measure in the participating population) and reliable (*i.e.*, the instrument would yield the same responses from the same individual if it is administered at different times). High-quality instruments must be informed by current theory and knowledge about teaching and learning (*e.g.*, what are students' misconceptions about cellular respiration and how can they be identified with the instrument?), and they must be validated by pilot testing within the population of interest and conducting appropriate statistical analyses.

Insight gleaned about causal relationships between teaching strategies or curricular innovations and student and teacher outcomes may be applicable only to those individuals in that setting at that point in time. For such findings to be generalizable, credible evidence must be collected to demonstrate their applicability across populations and settings. If claims are being made about the transferability of findings to other students or teachers, the individuals in the new setting must resemble in some way the individuals in the original setting of the study. For example, findings from investigations in urban schools may not be applicable for rural schools, because urban schools have larger immigrant populations and more English language learners.

Qualitative approaches provide opportunities to capture unintended outcomes, understand why certain outcomes occurred, and gain a deeper understanding of a phenomenon. Such research is intended to describe an experience and infer patterns about it or consider how it is representative of a broader set of experiences. Qualitative data tell a story by capturing and communicating someone else's experience, taking into account the perspectives, time, and situation of individuals involved, including the participants and even the researcher. The results can illuminate the actuality of teaching and learning in the real time and setting of a classroom (*e.g.*, what is actually happening in this teaching and learning situation?).

In addition, qualitative findings can serve as a proof of principle (*e.g.*, is it possible to teach and learn in this way or using this curriculum?), a basis for generating new hypotheses (*e.g.*, if these students learn in this way, do other students in other settings at other times learn in this same way or in other ways?), and a way

to discover unanticipated outcomes (*e.g.*, students did not seem to gain knowledge about cellular respiration, but they did expand their understanding of how scientific knowledge is generated).

Scientists also use qualitative approaches and evidence in research (*e.g.*, photographs to illustrate differences among cells or organisms, rich descriptions to explain the identification of a new species) and in training. A less obvious example is the oral preliminary exam that is the rite of passage to degree candidacy for all scientists-in-training. These exams are designed to ensure that the student is prepared to pursue an original line of enquiry, for example, by demonstrating awareness and understanding of relevant literature and methods, as well as some ability to interpret data, develop hypotheses, and design experiments to test them and rule out alternative explanations.

Some aspects of exam content and structure are generalizable across the doctoral student population (*e.g.*, all exams involve questioning by a group of faculty, all exams have a “grade” or outcome for the student). Yet, each exam is unique to the student, the student’s research interests and completed course work, and the panel of faculty examiners. Faculty may start with certain questions in mind but may develop new questions or alter the direction of their questioning as the student articulates his or her understanding. The trouble with generalizations is that they don’t apply to particulars. The goal of the preliminary exam is to investigate in-depth the quality of one student’s thinking by speaking with the individual and considering the context, not to generalize to other students.

Yet, I expect that all students and faculty involved in preliminary exams intend for such experiences to yield trustworthy, dependable, and confirmable outcomes. The structure of the exam helps maximize the likelihood that this is the case. Preliminary exams involve multiple faculty asking many questions from different perspectives (*i.e.*, triangulation of data sources and methods) over a length of time. Although preliminary exams are not research studies, they demonstrate how qualitative methods of data collection, analysis, and interpretation can be designed to maximize the sufficiency, credibility, and accuracy of the resulting data and the claims they support.

SCIENTIFIC RESEARCH IN EDUCATION

For over 100 years, education research as a scientific endeavor has been at the centre of scholarly and political debate. With the recent advent of “evidence-based” policy and practice in education and related fields the debate has taken on heightened importance and political overtones. Indeed, in the summer of 2000 a bill to reauthorize the primary federal education research agency included a legislatively, not scientifically, devised definition of what constitutes “scientifically based

research” in education. This action signaled the field’s lack of credibility with policymakers and the high stakes associated with articulating and upholding standards of high quality science.

This is the context, in the winter of 2001, when a National Research Council committee met to address three related questions in response to a request by the National Educational Research Policy and Priorities Board: (1) What are the principles of scientific quality in education research? (2) How can a federal research agency promote and protect scientific quality in the education research it supports? And (3) how can research-based knowledge in education accumulate? About a year later, we published our answers to these questions, being careful to point out that our charge was to explore the *scientific basis* of education research, and that “...historical, philosophical, and literary scholarship can and should inform important questions of purpose and direction in education”.

Since the release of the NRC report, public debate has intensified, and several congressional and executive branch actions have focused on bringing scientific research to bear on education policy and practice.

A strong focus of these efforts has been on shoring up the (perceived) low quality of current scholarship by pushing the use of randomized field trials—held up as the “gold” standard—in education research.

RESEARCH QUESTIONS AND METHODS

We inevitably took up this contentious topic, the design of education research. At one extreme we found some experimentalists (and policy makers) who believed that unless research involved a randomized trial, it was not scientific and not worth doing. At the other extreme were postmodernists who didn’t put much stock in scientific research of any kind. Committee members held a wide range of views on what they personally considered to be scientific.

Perhaps the Committee’s greatest contribution was to recognize that defining scientific research by method was wrong minded. It’s the question—not the method—that should drive the design of education research or any other scientific research. That is, investigators ought to design a study to answer the question that they think is the important question, not fit the question to a convenient or popular design.

Incidentally, once this insight had been reached, unbeknownst to my colleagues, a ditty from Gilbert and Sullivan’s *Mikado* started running through my mind,

“His object all sublime
He shall achieve in time—

To let the punishment fit the crime—
The punishment fit the crime.”

I simply substituted question for crime and method for punishment:

“His object all sublime
He shall achieve in time—
To let the method fit the question—
The method fit the question.”

SCIENTIFIC RESEARCH IN EDUCATION

In hindsight, this idea should have been obvious once we had argued our way to the conclusion that scientific research in education was, in general, like scientific research in the social and natural sciences, and should:

- Pose significant questions that can be investigated empirically
- Link research to relevant theory
- Use methods that permit direct investigation of question
- Provide a coherent, explicit chain of reasoning to rule out counter-interpretations
- Replicate and generalize findings across studies
- Disclose research to encourage professional scrutiny and critique.

To be sure, each area of science has crafted its methods to fit its paradigmatic questions and phenomena, something that Thomas Kuhn pointed out decades ago.

This is true of education as well as the natural and social sciences. What is common among methods is that they build into research design the characteristics of scientific research, such as ruling out counter interpretations and generalizability.

TYPES OF QUESTIONS AND CORRESPONDING METHODS

The insight that the method should follow from the question, now pretty obvious and something graduate students often hear from their professors, led to another conundrum. There are so many research questions, how do we say anything cogent about method? The Committee reasoned that most scientific research questions were of three general types: (1) What’s happening? (2) Is there a systematic (causal) effect? And (3) what is the causal mechanism or how does it work?

What’s Happening?

The question—what’s happening?—asks for a description. We could ask this question in a materials science laboratory or in a middle school. We could describe

the years of experience possessed by elementary school teachers in the U.S., or the types of science instruction students receive, or the changes in students' mathematics achievement over 20 years. In these cases, statistical estimates of population parameters could be obtained from available national surveys. Or we could describe what school, home and community look like through the eyes of an inner-city youth using ethnographic methods. Or we could describe different approaches to the assessment of learning in colleges and universities that have been nominated as "exemplary" using case study methods.

Holland and Eisenhart's (1990) study exemplifies scientific research into what's happening, and, as we shall see, beyond. They were concerned about explanations for why so few women pursued careers in non-traditional majors such as science: women were not well prepared before coming to college, women were discriminated against in college, women did not want to compete with men for jobs. They began their study by *describing, in depth over several years through ethnography*, the lives of 23 volunteer women from two small public residential colleges. Half of these women pursued traditional careers and the other half non-traditional careers. They were matched on grades, college majors, college activities, and college peers. Based on extensive, detailed data collected through participant observation and interviews, Holland and Eisenhart found that what best described these women's academic pursuits were, *contrary to popular conjecture*, how they viewed the value of schoolwork, what their reasons were for doing school work, and how they perceived financial and opportunity costs. Simply put, detailed description of the college lives of these women portrayed their career trajectories in a very different light than the distal conjectures based on statistical data.

Now if you are thinking, "well, this is just idiosyncratic description and is suspect," Holland and Eisenhart one up you. They took the next step, going beyond description and entering the arena of model testing by predicting with their descriptive models what each of the 23 women would do after college: continue in school, get a job in her field, get a job outside her field, get married, etc. At the end of 4 years and another 3 years, they followed these women up with telephone interviews. In *all* 23 cases, predictions based on their model of commitment to schoolwork were confirmed. In all cases, their model provided a better predictor than did data on precollege preparation (grades and courses taken), discrimination against women, or feelings about competing with men.

Is there a Systematic (Causal) Effect?

Questions about effects are, ultimately, questions about causal effects. Did x cause y ? Perhaps the most widely known study of systematic effects in education is the Tennessee randomized trial on class size reduction. The question posed by the Tennessee legislature was whether reduced class size would improve students'

achievement. To this end, within 79 schools across the state, a total of 11,600 students were randomly assigned to a regular class (22-26 students), a class with an aide (to decrease the student/adult ratio economically) or to reduced class size (under 13-17 students). Three findings stand out: (1) students in small classes outperformed students in the other classes, (2) minority students particularly benefited, and (3) the effect persisted when students returned to regular class sizes. Here the method, randomized trial, followed directly from the legislature's question and was feasible and ethical to implement. In such cases as this, randomized trials are the preferred method for ferreting out causal effects.

There are many cases, however, when randomization may not be feasible. Such cases include the effect of smoking on health and longevity, and the effects of hunger, alcohol use, drug use or child abuse on students' academic performance. For these research questions, other methods need to be used, are available, and include quasi-experiments (control and experimental groups without random assignment), correlational studies using large-scale probability-sampled data sets (that adjust for selectivity bias), and various time series designs. To be sure, as you move away from the randomization in some cases uncertainties increase; nevertheless, causal interpretations are possible and replication is important to increase confidence in the interpretations.

Application of Correlational

Loeb and Page's (2000) study of teacher salaries exemplifies the application of correlational (structural) modeling in a situation where random assignment is unlikely. They asked, "If teacher quality affects student achievement, why do studies that predict student outcomes from teacher wages produce weak results?" That is, shouldn't teachers' salaries reflect, at least to some degree, teacher quality after controlling for other things?

Loeb and Page tested two competing models. One was the usual production function model that links inputs (salary) to student outcomes (dropouts in this case) after controlling for relevant variables. The second model followed their reasoning that there are other things in the lives of teachers than salary that may have meaning, and there also may be local job markets that provide attractive alternatives to teaching in the area. So their second, competing model incorporated opportunity costs into the production function: non-pecuniary rewards and competition in the local job market. They replicated prior research with the usual production-function model, showing a weak effect of salaries on outcomes. However, once they adjusted this model for opportunity costs (non-pecuniary and job market incentives), they found that raising wages by 10 per cent reduced high school dropout rates by 3-4 per cent.

Three points about studying causal effects seem appropriate here. First, in dealing with causal assertions we are always trying to rule out all the possible counter hypotheses that we know of at the time. As a research programme moves along, new challenges (counter hypotheses) arise and get ruled out; in this way confidence increases in the causal interpretation. Oftentimes we don't know all the counter hypotheses; challenges arise with novel counter-interpretations, and research and debate continues as it has with the Tennessee study. This type of debate—hypothesis/counter-hypothesis—is the basis of science and should be looked upon positively and not as “backbiting” among scholars with different views when the issue is one of interpretation; it is backbiting when personal attacks are made.

A second point has to do with the role of description in causal studies—what's happening? When feasible, descriptive research should be used in causal studies to help us understand, as fully as possible, what “treatments” were actually implemented, and to reveal what possible causal mechanisms might be operating.

And the third point is that establishing a causal effect may be necessary when possible but not sufficient in policy and practice. The questions of mechanism and context inevitably should arise in order to design education policies or practices. We need to understand how interventions were articulated and implemented in diverse contexts with whom, under what conditions with what resources in order to design more than superficial education policy.

Causal Mechanism

The third type of research question focuses on the mechanism that creates a causal effect. For example, reducing class size seems to have a salutary effect according to the Tennessee study. But what was the mechanism that caused the effect and why did it persist even after students returned to regular class sizes? Was the effect due to an increase in the number and personal nature of teacher-student contacts or to less off-task student behaviour or to the level of student engagement?

Empirical Studies of Mechanism

Empirical studies of mechanism, following on studies that have established causal effects are most common. Bryk, Lee and Holland (1993) sought to understand the causal mechanism(s) underlying the causal evidence that Catholic schools outperform public schools in the U.S. This longitudinal study used both qualitative (*e.g.*, case studies of effective Catholic schools) and quantitative data to address the mechanism question. Three potentially explanatory models were tested: (1) sector effects only (spiritual and private characteristics of Catholic schools), (2) compositional effects (kinds of students attending Catholic schools), and (3) school

effects (school operations contributing to school context). A combination of models, characterizing “...the *coherence* of school life in Catholic schools ... most clearly accounts for its relative success in this area”.

Nevertheless, there is another way to approach the question of mechanism—namely, to build an artifact based on a causal theory and establish its causal effect. Studies such as “design experiments” or “design studies” posit a theory with a causal mechanism, and design educational artifacts (*e.g.*, a curriculum, a computer application) and iteratively test them out in complex real-world classroom environments, revising both artifact and theory along the way. Once evidence accumulates to suggest a causal mechanism, the onus, of course, is on design researchers to then establish generalizable causal effects.

7

Research Methodology in Higher Education

In recent years, with the advent of liberalization, and the growing fascination with all things American, there has been a concerted attempt to discount the role of enlightened state intervention in the economy. Certain ideologues—particularly those affiliated with the BJP, and other neoliberal have been slamming Nehruvian “socialism” as the single main cause for India’s poverty and underdevelopment. They have been contending that had the Indian government left everything to the Private Sector after independence, India would have grown much faster, and would have been like a “developed” nation today.

Although such an argument is entirely untenable when one looks at the concrete experience of most other developed and developing nations—particularly the Asian nations that have developed the most (such as S. Korea and Japan), this argument has been repeated so often, that it has now been accepted as gospel truth by many younger Indians—especially young software engineers and technology managers.

Unfamiliar with how both the Japanese and S. Korean governments have invested enormous sums of money in both higher education and cutting-edge research, they cling to the naive and misinformed belief that privatization is the magic wand for all of India’s ills. In fact, most advanced nations in the world have developed thanks to much higher levels of state intervention in higher education and scientific and technological research than India. For instance, it might be worth mentioning, that to this day, Moscow—with its plethora of Soviet era educational institutes and scientific labs remains a world leader in cutting edge research. In many areas of

modern Physics and other physical sciences, the research output from Moscow exceeds that of long-established US centres of privately-funded higher education such as Stanford or Yale.

So prolific are Moscow's scientists that even GM has now decided that it stands to gain more from building its newest research centre in Moscow rather than in the US. In fact, a scan of the leading online scientific journals reveals that many former Eastern-Bloc capitals (with state-funded universities and Science Academies modelled along Soviet lines) such as Budapest, Warsaw or Prague—are all significant contributors when it comes to cutting-edge research. In both S. Korea and Japan (Asia's technologically most advanced nations), scientific and technological research at publicly funded universities generally outstrips research at privately funded institutions. And it cannot be emphasized enough that in the past half-century, Korea has grown much faster than the US. In Korea, there has been greater state intervention in the economy-not less.

This is not to discount the leading role played by US universities in the world of scientific and technological research. But it is often forgotten that many of them are state-funded. In any case, Indians ought to know that US universities are at best mediocre when it comes to undergraduate education, and half of all Ph.Ds in the Natural sciences and Engineering are awarded to scholars who were not born and educated in the US.

Although in the 19th century, the US became a world leader in science and technology largely on its own merits, in the past half century, the reputation of its universities has been maintained as much or more by immigrants than US-born citizens. Soon after World War II, US universities became a magnet for Japanese, Korean and European scientists since the war had greatly diminished opportunities at home. Now that Western Europe, Japan and Korea have developed (or redeveloped) their economies, US universities are enjoying the benefit of the best minds from India, China, Eastern Europe, Iran, the Middle East, and many other nations. But even in the case of the US, it should be pointed out that when it comes to fundamental research in the physical sciences, it is the government labs and state universities such as UC Berkeley, UCLA, UC Santa Barbara, Minnesota or Ohio State-along with a hundred other state universities, that make up the backbone of basic scientific research in the physical sciences. Private universities, who are better known for their management, architecture and engineering programmes complement state investment in higher education and research-but even in the US, they do not play the leading role. In any case, no sustained engineering innovation is possible without a strong foundation in Maths, Physics, Chemistry and Geology. If it weren't for all the basic research emanating from state-funded universities and government labs, even private universities such as Stanford would be hard pressed to achieve what they have so far.

However, regardless of the situation prevailing abroad, the greatest indictment of India's Private Sector comes from a perusal of data pertaining to scientific and technological research. Facts always speak louder than ideological speculations and opinions, and when it comes to research output-whether in refereed internationally indexed journals, or domestic journals, or presentations at international or national conferences, India's Private Sector institutions simply don't make it anywhere near the top. According to a search on Google Scholar (which appears to have access to about 70-80 per cent of Japanese and Western scientific journals, as well as all internationally-recognized Chinese, ASIAN and some Indian journals), the research output in the last 5 years in the Physical Sciences and Engineering from all the BITS institutions combined (in Pilani, Goa and Mesra) was about 510.

Compare that to IISc Bangalore's 4500, or IIT Delhi's 2700, or TIFR Bombay's 2670. In fact, BITS' combined research output not only trails the IITs in Bombay, Kanpur, Kharagpur, and Chennai (2700-2200)-but also lags Jadavpur University (1250), Delhi University (1100), ISI (1100), BHU Varanasi(900), Madras University (800), Calcutta University (740), Anna University (740), Pune University (740) and Hyderabad University (700).

The situation for other private institutions is even less impressive.

Thapar's TIET Patiala logs in at 70, Manipal at 55, SASTRA (Thanjavur) and MEPCO Schlenck (Sivakasi) at 25 and Ahmedabad's NIRMA at 15.

Thapar's TIET equals little known state-funded SLIET (Longowal, Sangrur), but is behind Punjab's Amritsar University and Patiala University as well as NIT Kurukshetra or Kurukshetra University.

In fact, CUSAT Cochin, Allahabad University, Mysore University, Jaipur University-all do as well or better than BITS Pilani (or any other privately funded deemed university or autonomous engineering college). If BITS Pilani is excluded from the list, even state universities in smaller cities and towns such as in Tirupati, Kottayam, Burdwan, Jodhpur, Shillong, Jabalpur, Gorakhpur, Karaikudi, Sambalpur, Berhampur, Jalgaon, or Rajkot do better in terms of research activities.

In fairness to India's Private Engineering Colleges, it may be pointed out that Google Scholar generally fails to pick up on papers published in most Indian (or African) journals or those presented at Indian conferences. In addition, only a very small fraction of Indian Ph.D. theses get indexed in international scientific databases, so Google Scholar tends to significantly under-report India's research output. This is particularly the case with research relating to Chemistry, and all branches of Engineering.

At the private engineering colleges, papers presented at national or regional conferences can exceed journal papers by a factor of 4 or 5. (In the case of NIST,

Berhampur, only 10 per cent of its research output is picked up by Google Scholar). This is not a bad thing, because national conferences have become an important venue for Indian scientists and engineers to get to know one another and to become quickly familiar with the latest research. It is especially useful for small colleges and universities to link up with larger and more established institutions.

But even after making appropriate adjustments to include papers published in Indian journals or presented at domestic conferences, the results will not be dramatically different. This is because Google's coverage of international engineering journals is also somewhat spotty. As a result, the data for the IITs and the NITs is also under-reported (by a factor of about 1.5 for the IITs, and by a factor of 2-2.5 for the NITs). For government-funded SLIET Sangrur, the Google results are just a third of the actual research output.

Even in Tamil Nadu-where the private colleges are most engaged with national engineering conferences, no unaided private engineering college would be able to match the overall research output of Anna University's Constituent Colleges or NIT Trichy (4-500), let alone IIT Madras.

This is not to entirely write off the Private Engineering colleges. The best private engineering colleges in Tamil Nadu, Karnataka, Maharashtra or Orissa-all do slightly better than the weak government engineering colleges who aren't especially well-staffed or well-funded. With the retreat of the state, private engineering colleges have begun to play a decisive role in undergraduate education. But so far, fewer than 10 per cent of the private engineering colleges are equipped to offer Post-graduate programmes; less than half offer Post-graduate courses in more than one or two disciplines; and several are government-aided colleges. Moreover, almost all of these Post-graduate colleges are concentrated in just a few states: Tamil Nadu, Karnataka, Punjab and Haryana. Besides, at many of these Post-graduate colleges, only a few departments are well-developed; most departments have only a few active researchers. Whereas the Google-indexed research output from all of Delhi's government-funded institutions (at about 8-9000) puts Delhi on par with Japan's number three city, Nagoya, (and several European capitals), BITS Pilani's output of about 450-500 puts it in the same league as Indonesia's Bandung, and somewhat behind Malaysia's Penang.

TIET logs in with Accra, Ghana, (or Peshawar, Pakistan), but behind Lagos, Nigeria. Had Nehru left India's higher education entirely to the mercy of India's private trading companies and industrialists, it is much more likely, that today, India would look more like a struggling African country than a Singapore or South Korea as claimed by the detractors of Nehruvian socialism. It is thanks almost entirely to Nehruvian planning that India has a scientific and technological infrastructure in its metros that can match what is available in the European capitals.

In fact, contrary to the canard that CSIR (and all other government labs) are simply white elephants that ought to be disbanded, the data shows that government labs are playing an indispensable role in the country. While it may well be true that structural rigidities, bureaucratic conservatism and inadequate interaction with Ph.D. students and Post-Docs may be hampering their productivity, the research output of the government labs continues to exceed that of the private sector. For instance, IICT Hyderabad's log of 1000, BARC's 840, or PRL Ahmedabad's 625-all outpace BITS' combined output. In fact, if the research output from the government labs is included in the mix, Kolkata's overall research output is ten times that of Kuala Lumpur or Penang, and easily exceeds that of Bangkok.

With the inclusion of the research output from CSIR labs and all other government research institutions, several of India's tier-2 cities (such as Ahmedabad, Thiruvananthapuram, Lucknow, Bhubaneswar, Chandigarh, Indore, Kochi and Allahabad) outrank the internationally reputed university towns in Malaysia. If research presented at national conferences were also included, Tamil Nadu's Coimbatore, Madurai, Trichy and Karaikudi, Karnataka's Mysore, and other state capitals such as Jaipur, would also exceed the Malaysian university towns-not only in terms of Ph.D. guidance, but also in terms of papers published or presented. But because India's private media has largely ignored the research activities emanating from the government labs and small town universities, such work has received inadequate recognition and support. Of course, what needs to happen is that a comparable structure needs to be in place in all the state capitals and other second-tier and even third-tier cities and towns. But since 1991, hardly anyone has paid any attention to augmenting the scientific and technological capabilities of the non-metros.

The prime entities for this neglect are the Indian media, CII and FICCI, and the BJP-who have done nothing but malign the nation's best state-funded institutions, yet done little to replace or even complement them.

Rather than berate the Nehru era for the problems of the present, they ought to be enquiring as to why more recent governments did so little to infuse fresh blood into India's key research institutions, and why no new research institutions were launched in the last two decades. If the older institutions have stagnated, why wasn't anything constructive done to re-energize them? And above all, if India's private sector were the true alternative, why hasn't it been able to step in (in any significant way) in the past decade and a half? The truth of the matter is that India's private sector has been so intoxicated with its rising profits, that it has largely failed to see the reality beyond its blinkered ideological compulsions.

Unlike industry associations in Korea and Japan, who have pushed their governments to increase state spending in higher education and research, and

who themselves have encouraged the national press and electronic media to promote scientific and technological upgrades and innovations through dedicated columns on science and technology, and sought special media coverage of all major science and technology conferences, symposiums and workshops, India's business leaders have often behaved as petty traders-preferring to market internationally-manufactured goods in India. Others have sought to import off-the-shelf technologies rather than spend any of their own money on R&D or encourage the government spend it for them. Hawkish neo-liberals like Chidambaram have only encouraged such behaviour with their reckless approach to slashing import duties and undercutting tax support for domestic research and capital improvements.

Unlike in other aspiring nations (such as Iran, Thailand or Malaysia), organizations like CII or FICCI have taken little interest in championing Indian science and technology. They have instituted few grant schemes for serious researchers, and their funding of academic research has been puny in relation to their rising profits. Nor have they attempted to launch any journals where scientific and technological research performed at the country's government labs and universities could be easily disseminated to industry and concerned professionals. In most developed nations, there are not only industry journals dedicated to specific areas of science and technology but also to niche industries; and it is almost routine for major newspapers to have scientifically-trained professional journalists who regularly report science and technology news. Scientists have a way of communicating with each other in academia. Their work needs to be interpreted for industrial use. Advanced industrial nations have put exactly such an infrastructure in place so that important scientific and technological breakthroughs can be communicated to industry in language that is intelligible to working engineers and technology managers. But the Indian Private Sector has done little to mimic such an apparatus in India. Instead, India's leading English language dailies (such as Times of India, Hindustan Times or the Economic Times) are beginning to look more and more like tabloids than serious newspapers. Only the Hindu devotes some of its coverage to reporting on scientific and technological events, and even the Hindu's reporting tends to be limited to developments in Tamil Nadu or Southern India.

India's industrialists often complain that Indian scientists are not in touch with industry-but how often have they ever bothered to keep in touch with India's scientists? The fact of the matter is that a nation's industrialists develop a keen interest in scientific and technological research when they begins to manufacture their own machine tools and capital goods. Some of India's small and medium industries are trying to do just that. But the captains of Indian industry aren't supportive of such moves.

Instead, a dominant section of Indian industry merely wants to be an outsourcing agent for the transnationals, and prefers to shop for cheap second-hand assembly lines abroad. But that will never provide any real fillip for hard-core technological research in India. For instance, Indian industry appears to be thrilled at the booming demand for airline tickets-but no one is talking about the escalating trade deficit that is a result of the 30 per cent growth in imported capital goods, transportation equipment, tools and machinery. No one is talking about manufacturing civilian aircraft in India. This is ironical, because today, India is graduating 350,000 engineers. In five years, that number will grow to 450,000, and is projected to hit 600,000 in ten years. Within 5-10 years, India will have an experienced pool of engineers that is far greater than either the US or the EU.

Where India may lag (if corrective steps aren't taken soon) is in Post-graduates and Ph.D.s capable of engaging in advanced research and capable of designing virtually any assembly line, or any type of complex capital good. With the right leadership, India has the intellectual potential to match any developed nation in producing virtually anything.

What is missing is not the scientific or engineering willingness, it is the spirit of patriotism necessary to make it happen—the visionary entrepreneurial spirit that could marshal India's intellectual talents that are too quickly being sold to the highest international bidder. The Infosys strategy of outsourcing Indian intellectual labour does not build anything solid and lasting for India. It brings in quick money with very limited long-term gains. It should be seen as a stop-gap measure, as something to utilize any engineering extras the nation may have. It should never be seen as the primary use of precious Indian talent.

India's best scientists and engineers should be designing and building things the country doesn't yet have: such as the latest deep-sea prospecting and drilling equipment. They should be designing and manufacturing a range of capital goods and machine tools, or new corrosion-resistant and energy-efficient materials; they should be experts at managing and developing new (and existing) energy resources; they should be experts at fuel-efficient mass transit; they should be as comfortable building civilian aircraft (or advanced submarines) as they are building the world's most fuel-efficient two-wheelers. They should be capable of developing the latest environmental, sanitation or mass-transit solutions-instead of always seeking technological collaborations from others. There should simply be no holes in India's technological capabilities. A nation of a billion plus people should be able to take pride in its broad-based engineering design and manufacturing acumen, not just its ability to write smart banking software.

Companies such as Infosys should be the last place where a good engineer should want to build his or her career-not the first choice. Outsourcing should be a

back-up option for the Indian engineer, hardly the only game in town. But for too many Indian business analysts and investors, outsourcing has become the sole or key driving option. Core engineering is treated as a mere adjunct—when, in fact, it should be quite the other way around. The truth is, India's private sector is unduly euphoric over the opportunities presented through outsourcing. A nation as large as India cannot become prosperous through outsourcing alone.

In the long run, India should aim to be a Germany, a Japan or a Korea, and let others fight over an exhausted outsourcing pie. Serious scientists and engineers should not be swayed by the hype, and seriously look beyond the Infosys-model of development.

Indian businessmen who constantly whine about the government not giving enough concessions for this or that should instead be held accountable by the Indian public and asked as to what they have done for the nation. What is their vision for India's advancement? What sacrifices have they made for India's progress? The truth is, that notwithstanding the barrage of private sector oriented propaganda from the nation's press, the actual contribution of the India's private sector to higher education and scientific and technological research is eight parts hype and only one part substance.

Barring the more dedicated amongst India's private colleges who are indeed trying to do their best, the majority aren't even trying. But even the best of them are in no position to replace government efforts in the foreseeable future.

Whereas India's scientists and engineers have not failed the Private Sector, India's Private Sector has indeed failed the nation—not only by failing to recognize the importance of the scientific and technological foundation that was laid in the very difficult years following freedom from colonial rule, but by doing all too little to augment what was done then.

In fact, India's Private Sector has yet to articulate a truly forward-looking vision for India's scientific and technological transformation. While it has profited greatly from India's state-funded institutions (such as the IISc, the IITs, and the NITs), it has yet to give anything significant back. India's concerned citizens should have few illusions in this regard.

ERA OF GLOBAL COMPETITIVENESS IN HIGHER EDUCATION

The 21st century propelled by a new economy—an economy indisputably driven by knowledge, information and technology. With intellectual capital underpinning unprecedented prosperity, colleges and universities must play a pivotal role in

addressing the challenges of the future and sustaining America's pre-eminence, as well as New Jersey's leadership role within it. The era of global competitiveness has spawned historic economic progress.

Technological advances and innovations are stimulating high rates of productivity growth. In the six-year period from 1994 to 1999, the national rate of growth in jobs doubled the rate in the previous decade; high-tech industries account for 1 million of the 19 million new jobs created. As a result of the nation's significant job growth, unemployment has dipped to a 30-year low. The unemployment rate in New Jersey during the first six months of 2000 was equal to or below the national rate and in June 2000 the number of unemployed state residents was the lowest since June 1989. The trend towards higher incomes and an improved standard of living is expected to continue, but the dynamic economy and globalization present formidable challenges as well.

The gap in access to computers and the Internet between the highest and lowest income levels continues to grow. In addition, inequality in the labour market has escalated as high-paying jobs have increased and well-paid low-skilled jobs have become more difficult to find. Strength and manual dexterity no longer suffice to ensure employment and a comfortable standard of living.

As employers increasingly require verbal, mathematical, organizational, interpersonal, critical thinking, problem solving and high-tech skills, higher education opportunities must be extended to a segment of the population that could once prosper with a high school diploma or less. Further, as a result of globalization, low-skilled jobs that remain are often filled by low-paid workers from other parts of the world, leaving less-skilled Americans at a disadvantage.

Thus, although the trend towards increased inequality in the labour force showed signs of reversing in the late 1990's, the gap in earnings is currently much larger than it was 20 years ago. Like the job market, the demographic landscape in America has changed dramatically and will continue to do so. According to the U.S., Department of Labour, by 2050 the country's population is expected to increase by 50 per cent, with ethnic minority groups making up nearly half the population. At the same time, the population of older Americans will continue to grow, more than doubling in 50 years. These changing demographics will be closely reflected in the make-up of the workforce.

Beyond these challenges, passing our civilization on to the next generation is a fundamental role of education – primary, secondary and post-secondary. Higher education has a unique job in that regard, because it not only polishes the thinking, quantitative and communication skills of students, it is also responsible for transmitting the civic and social values of our society.

ADDRESSING THE CHALLENGES

To prosper in the new millennium, America must aggressively address the challenges inherent in the new economy while seizing opportunities to enhance the nation's economic capacity and technological growth. New Jersey is well positioned to do that, boasting abundant human, geographical, commercial and industrial assets. Its public and independent higher education institutions are integral to expanding those assets and assuring the economic future of the state. The nation's economy is more dependent than ever on the knowledge and skills of its workers.

THE EDUCATION AND CONTINUAL UPGRADING

With its diverse population and changing demographics, the United States can capitalize on its multiracial, multi-ethnic society to compete successfully – domestically and in the global marketplace.

To do so, all citizens must be equipped with the skills and knowledge they need to succeed in and contribute to the new economy. The country is facing a shortage of workers prepared to meet the needs of the competitive marketplace and the economy will surely suffer if that shortage is not addressed. This is particularly true in New Jersey and other states where industries are intensely knowledge-dependent. The education and continual upgrading of the workforce and citizenry to sustain the economy and quality of life are dependent to a large degree on higher education.

Colleges and universities prepare entry-level workers, middle management and corporate executives, while providing essential civil and social foundations. Enrolment in higher education across the nation is increasing and the trend is expected to continue. More Americans are graduating from high school and according to the U.S., Department of Labour, in 1998, 57 per cent of the high school graduates entered college the following fall.

In the past 50 years, enrolment in U.S., higher education institutions has grown from 2.5 million to more than 14 million. Here in New Jersey, college and university enrolment increased 160 per cent since 1965, rising from 127,000 students to over 330,000. More than one-third (123,000) of these students are enrolled in two-year community colleges. Over 140,000 attend senior public institutions, with 62,000 at the three research universities and 78,000 at the state colleges and universities. About one-fifth (67,000) of the students attend independent colleges and universities, including 14 public-mission institutions, 3 proprietary institutions and 8 theological institutions. Since 1965, graduate enrolment in New Jersey doubled from 25,000 to 50,000, undergraduate enrolment grew from 100,000 to 280,000 and part-time enrolment grew from 58,000 to 1,41,000.

The growth of the nation's population certainly explains part of the increase in participation in higher education. Enrolment growth, however, is influenced also by labour market requirements, which have increased steadily. Put simply, the information-based economy is skills-intensive and knowledge is essential for growth. High-tech industries account for a significant portion of the new jobs being created across the nation. In New Jersey, technology is the fastest growing sector, requiring specific skills and ongoing training and development.

Nationally, occupations that require a college degree are growing twice as fast as others and the value of those degrees continues to increase. In 1979, the average college graduate earned 38 per cent more than the average high school graduate; by 1999, it had jumped to 71 per cent more. While the fastest growing jobs do require a college degree, many jobs being created require specific skills but less than an associate degree. For individuals with training and those with a degree, life-long learning to upgrade skills and prepare for multiple careers over a lifetime is now a standard expectation.

The dynamic economy and global marketplace have significantly increased the demand for higher education and training at New Jersey colleges and universities. The institutions are expanding their capacity to meet increasing enrolment and needs, enhancing flexibility to serve students effectively through non-traditional means and strengthening parity among all minority groups in respect to enrolment, academic performance, faculty retention and graduation rates. As colleges and universities strive to provide both access and success for all potential students, government support for institutions is crucial.

Given the key role higher education plays in preparing future citizens and leaders and sustaining the economy and well-being of the state, the return on investment in colleges and universities is high. Operating support from state and local governments provides the very foundation on which New Jersey's 31 public institutions exist; the state also provides financial support to the 14 independent institutions with a public mission. The state's targeted support for student assistance; higher education facilities, technology and equipment; special programmes; and research and development is also fundamental to sustaining a higher education system prepared to meet the challenges of the future.

EDUCATION OPPORTUNITY FUND (EOF)

Although minority enrolment continues to increase, the state must ensure that all New Jerseyans are able to contribute to and participate in our economic prosperity. The Educational Opportunity Fund Programme exemplifies the state's commitment to higher education access and success. Since 1968 the programme has assisted students who must overcome economic and educational disadvantages in order to achieve their academic potential. Recognized as one of the nation's

premier state programmes to enhance higher education access and opportunity, EOF provides supplemental financial aid to help defray college costs and expenses as well as campus-based academic support services.

In FY 2001, student grants were increased, providing an additional \$100 per student at public institutions and \$200 for those attending independent colleges and universities. Considering the academic and social hurdles EOF students must overcome, EOF's counselling, tutoring, academic, career exploration, pre-freshman and other support programmes are also absolutely vital to their success at the college level. It is the link between financial aid and intensive academic and student support services that distinguishes EOF from other student assistance programmes. The EOF programme has demonstrated significant achievement, easing access to college for roughly 12,400 students annually and improving short-term student retention.

For example, third semester retention rates among EOF students at the state colleges increased from 64 per cent in fall 1986 to over 80 per cent by fall 1998. Given New Jersey's growing number of immigrants and minorities and the increasing importance of a college degree in our high-tech economy, EOF must build on this success to help more students overcome disadvantaged backgrounds to succeed in college and achieve their educational goals. As we begin the 21st century, the EOF community is committed to narrowing the gap between transfer and graduation rates for low-income and minority students and those who do not face educational or economic disadvantages. Addressing this challenge will not only ensure a brighter future for more New Jerseyans, but will also enhance the state's overall economic prosperity and quality of life by narrowing the gap between the "haves" and the "have-nots."

To this end and consistent with the recommendation of the Fund's Board of Directors, increased state funding to strengthen the capacity of campus EOF student services is a top priority for FY 2002. State Article IV funding for the campus-based support programmes requires a partnership with institutions, which must provide at least a dollar-for-dollar funding match. An increase in state Article IV programme support will enable the individual campus programmes to enhance student support services and have a greater impact on transfer and graduation rates.

The Fund's Board of Directors also stresses the ongoing challenge to ensure that finances are not a deterrent to college attendance for EOF students. While Article III academic year grants did increase in FY 2001, some students and their families continue to face extraordinary costs relative to their incomes, even when EOF, TAG and federal Pell grants are considered.

College Bound: Efforts directed towards the educational advancement of disadvantaged children prior to entering college have proven effective across the nation. New Jersey's College Bound Grant Programme was established in 1986 to

address the educational needs and aspirations of disadvantaged, at-risk youth in grades six through twelve. Without a funding increase in the past 10 years, this exemplary programme has supported pre-college enrichment activities to help students in Abbott school districts complete secondary school and successfully pursue a Post-secondary education in the sciences, mathematics, or technology. Like EOF, the programme has proven to have an enduring effect on participants' future academic and career pursuits.

The College Bound programme currently serves approximately 2,100 students in 15 programmes run by New Jersey colleges and universities. Students from low-income families face many barriers to attending college. Nationally, only about one student in four from a low-income family background makes it to college at all between the ages of 18 and 24 years. To help New Jersey students overcome these obstacles, the College Bound programmes reinforce the state's school reform efforts in Abbott districts. The per student cost of College Bound is significantly less than comparable programmes at the federal level. In FY 1999, the state's contribution to the programme was \$1,381 per student, whereas the federal government's contribution to Upward Bound was \$4,164 per student. Nevertheless, the College Bound programmes have achieved success; over 80 per cent of the seniors participating in the programme in 1999 attended college upon high school graduation.

An increase in FY 2002 will increase and improve services, allowing for additional campus-based programmes and expanding the number of Abbott district students served. Further, it will provide for an adequate investment in the computer hardware and software and scientific equipment needed to support high-quality pre-college exposure and enrichment in the sciences, mathematics and technology. According to a 1999 U.S., Department of Commerce report, the gap in Internet access between those in the highest and lowest income levels grew by 29 per cent from 1997 to 1998. College Bound helps to bridge that gap with after-school, weekend and summer programmes that allow students to understand and benefit from the Internet and become skilled in the technology that drives the future.

When College Bound helps disadvantaged, at-risk students stay in school, do well and go to college, New Jersey reaps vast benefits. These students will become part of the state's educated citizenry. They will be more employable, earn higher incomes, pay more taxes and contribute to their communities.

Increased investment in College Bound also will enable the programmes to leverage funding from other sources, such as the federal government, foundations and corporations. Last year the state appropriation for College Bound and institutional contributions provided a match to enable the Commission to obtain a five-year \$10 million federal GEAR UP grant.

CAPITAL AND RELATED SUPPORT

Establishing and preserving a safe and adequate physical plant are critical to educating the populace, recruiting and retaining students, fostering research and development and enhancing the overall quality of higher education. Colleges and universities across the nation are faced with the challenge of keeping facilities and equipment current in order to prepare students for the rapidly changing workplace and to contribute to the research and development that underlies the nation's economy and future.

Funding for institutional facilities, technology infrastructure and other equipment is essential to the nation's success in the information-based economy. To meet the challenge of maintaining modern facilities and providing students with access to world-class instruction and technology, New Jersey currently supports five targeted capital programmes for higher education: In this book for community colleges, the Higher Education Facilities Trust Fund, the Equipment Leasing Fund, the Technology Infrastructure Fund and the newly created Capital Improvement Fund to address deferred maintenance and renewal at the four-year institutions. Each of these programmes helps to keep the colleges and universities current, competitive and responsive to student and research needs. The state's recognition of the need to renew and possibly expand these programmes as needed is vital.

The FY 2001 commitment to renew the \$100 million Equipment Leasing Fund allows institutions to make significant new investments to keep up with the fast-paced emergence of new equipment and technology. Recognizing the need to continually replace and upgrade today's high-tech equipment, consideration should be given to raising the cap on this fund and issuing an additional \$100 million in bonds within the next two to three years. The need for increased assistance in procuring equipment is driven by high-tech workforce needs and rapidly obsolescing equipment and staggering the availability of dollars from the Equipment Leasing Fund will avoid the six to seven year lag in availability of state assistance. The return on the state's investment in capital programmes is considerable. A noteworthy example is the \$50 million Higher Education Technology Infrastructure Fund, which was established in 1997.

The 45 eligible institutions expeditiously moved to enhance their campus technology infrastructures, enabling advanced student and faculty connectivity and growth in distance learning capabilities. A centralized electronic library (VALE) was established to allow the colleges and universities to share full-text, reference databases and provide access to journals, business directories and government publications. Perhaps most important, an unprecedented collaborative effort was undertaken to establish a broadband, systemwide telecommunications network, which is close to realization.

Support for these enhancements to campuses are crucial to institutional quality and economic advancement. However, an annual appropriation to assist the state's senior public institutions with capital maintenance and renewal is also a necessary and sound investment that will benefit students and the state. New Jersey is located at the heart of the nation's most prosperous and culturally rich marketplace. The state is a global pioneer and leader in science and research, communications, pharmaceuticals, computer technology and biotechnology. Clearly, the state's prominence contributes greatly to the robust economy and the resulting good it produces. On the other hand, such prominence also carries with it responsibilities and challenges relative to higher education's role in the economy. Continued investment in facility and equipment infrastructure is essential to developing the workforce and research required to meet the high-tech, rapidly advancing needs of employers.

Investment in Excellence

New Jersey's system of higher education aspires to be among the best in the world, embracing excellence, access and affordability. The 1999 update of the long-range plan for higher education cites the considerable progress made since 1996 in addressing the critical state issues around which the plan is designed. It also calls for more deliberate planning and bold action to achieve the goal of being among the best.

Over the past several years, many states have significantly increased investments in higher education institutions, recognizing that knowledge is the principal engine of economic growth and societal well-being. Initiatives designed to enhance excellence within the colleges and universities while directly addressing statewide economic development and societal goals provide dual dividends: students benefit from the enhanced quality of programmes and the state benefits from higher education's efforts to address critical state needs. Annual state investments targeted to such needs will strengthen New Jersey's overall competitiveness in the global economy.

High-tech Workforce Excellence Grants

The FY 2001 \$165 million economic development package, *New Jersey Jobs for the New Economy*, is designed to increase the state's competitiveness in the creation of high technology jobs and ensure that all citizens share in the state's technology advances and economic success. Recognizing the central role higher education plays in advancing technology and economic growth, the initiative includes a High-tech Workforce Excellence Grant programme, which build on the strengths of New Jersey's colleges and universities.

As a result of the \$15 million competitive grant programme, nine outstanding high-tech education projects received funds to create a pipeline of graduates to meet future workforce needs. At the same time, the top quality technology-related programmes will help to create, attract and retain high-tech companies and jobs in New Jersey. The nine programmes, ranging from sophisticated engineering and biomedical programmes to improved training for math and science teachers, demonstrate the synergy that exists between higher education and New Jersey's high-tech workforce. An appropriation for a second round of grants in FY 2002 will further develop outstanding high-tech academic programmes that are essential to meet the demands of New Jersey's highly competitive marketplace.

The excellence grants are consistent with *New Jersey's Plan for Higher Education: 1999 Update*, which calls for state resources to assist institutions in the pursuit of excellence in areas that coincide with state priorities. There is great promise that in addition to spurring the economic well-being of the state, higher education excellence grants will significantly help to move New Jersey's colleges and universities into the upper echelon nationally. As the excellence programme evolves in future years, other academic disciplines that are related to state goals should be targeted. The grant programme has the potential to attract students and faculty to New Jersey institutions by enhancing programmes in a wide range of academic disciplines. For many students and faculty, the strength of disciplines and programmes, the quality of faculty and institutional reputation play a primary role in choosing a college or university.

By investing in excellence at selected colleges, the state will help them become institutions of choice for more New Jersey resident students and attract those from out of state. Similarly, it will attract talented faculty and enhance institutional prominence among the business and government communities. The excellence grants will provide a significant return on investment over time.

TEACHER PREPARATION AND DEVELOPMENT

The preparation of the state's future leaders and workforce begins at an early age and is influenced enormously by teachers from preschool through high school. Teacher quality is recognized as important across the nation. However, after more than a decade of school reform efforts, the nation still has not succeeded in making systemic improvements in teaching and learning. Reform efforts have focused primarily on addressing core content standards, student assessment and other equally important areas, with little attention to teacher preparation, professional development, or teacher standards.

Over the past three years, however, there has been an unprecedented convergence of opinion on the need to improve teacher quality in order to effect true school

reform. The National Commission on Teaching and America's Future reported in 1996 saying, "What matters most as Americans prepare for a new century is the quality of teaching in American schools." The American Council on Education recently stated that the nation will effectively adapt to the new economy only if the quality of teachers entering the profession improves. And the American Association of State Colleges and Universities called upon higher education institutions to accept responsibility for ensuring they produce excellent teachers.

As states across the nation and the federal government place teacher quality at the top of the agenda, colleges and universities face an enormous challenge and responsibility. The consensus around the need to renew teacher education programmes and ensure the quality of all teachers comes at a time when the nation estimates the need for more than two million new teachers over the next decade to meet enrolment increases, fill vacancies due to retirements and replace thousands of teachers who leave each year in search of new careers. Higher education must therefore prepare more teachers and ensure that they are prepared to effectively undertake their role as educators in a new economy that depends more than ever on knowledge and its application. The level of need for new teachers will vary among states; New Jersey's population is not expected to increase as much as many other parts of the nation. Nevertheless, the state will experience a significant demand for new teachers. While there will be comparatively modest enrolment increases, there will be large-scale retirements and continuing resignations. In addition, New Jersey faces the need for large numbers of new teachers for three- and four-year-olds to meet the state's Supreme Court mandate growing out of the *Abbott v. Burke* decision. In fact, the effort to improve the quality of education in the state's most disadvantaged school districts will require more and better-prepared teachers in all grades in the Abbott districts. Like other states, New Jersey also faces pressures to decrease class sizes in the early grades and to address shortages in bilingual education, foreign language, special education and math and science. The state also faces aggressive recruiting competition. Many states are already offering signing bonuses and recruiting aggressively beyond their own borders.

Concurrent with this increased demand are the findings of a number of large-scale studies that provide evidence that the most significant factor in student achievement is the quality of the teacher. There is widespread agreement that teachers must be well prepared in subject areas, understand their students and what they need and master the professional skills required to make learning come alive. Unfortunately, this is not always the case as evidenced by the significant inequities in teacher quality that currently exist. Recent studies show that poor and minority children – those who are most dependent on their teachers – are more likely to have ineffective teachers, which contributes mightily to the achievement gap between poor and minority children and others.

The challenge, then, goes beyond preparing two million new highly qualified teachers. The nation must also aggressively overcome inequities in teacher quality – deepening knowledge of subjects and how to teach them. The recent report from the American Council on Education, *To Touch the Future*, calls upon the institutions to transform the way teachers are taught.

New Jersey's future prosperity is inextricably linked to its success in preparing high-quality teachers who can provide all citizens with the learning foundation to be productive members of society. State efforts are under way to improve teacher quality in several ways:

- The State Department of Education (DOE), working with the P-12 and higher education systems, is in the process of reviewing and revising the state regulations for teacher education programmes and certification of educational professionals.
- The grade-point average necessary for teacher certification was recently raised to 2.75.
- The DOE is engaged in state-supported teacher recruitment efforts.
- A two-year beginning teacher-mentoring programme is getting under way.
- Teachers are now required to complete 100 hours of approved professional development every five years.
- Professional development schools received additional state funding to expand existing and establish new P-16 partnerships.
- The state continues to implement an NSF Statewide Systemic Initiative (SSI) grant to improve science and mathematics instruction.
- Individual colleges continue to undertake various initiatives to enhance teacher preparation and professional development programmes.

Higher education plays a role in most of the above initiatives – in some cases a very significant role. Each of these initiatives is important in building a quality teaching corps. Additional efforts must be considered to expand the capacity of colleges and universities to prepare high-quality teachers; expand the recruitment and retention of minority teachers; address the critical teacher shortages in preschool, special education and mathematics and science; recruit and retain effective teachers in disadvantaged areas; and raise the overall desirability of teaching as a profession. The New Jersey Commission on Higher Education and Department of Education are working jointly to develop a series of related initiatives to comprehensively address these teacher quality and shortage issues.

Much of the responsibility for improving the quality of the educators in our nation's schools depends heavily upon the strength and effectiveness of teacher preparation and development programmes provided by colleges and universities

in collaboration with the elementary and secondary schools. In many states, special support is now directed specifically to teacher preparation and professional development programmes to assist the colleges and universities as they address the challenge of training and retraining more and better-prepared teachers for the 21st century. With overall enrolment growth in higher education and widely ranging responsibilities and concerns, the state is working in tandem with the institutions to ensure that teacher quality resides atop the state's educational agenda. A special state appropriation in the FY 2002 budget would help colleges and universities that have teacher preparation programmes to construct a comprehensive approach to change, with a focus on four primary goals:

- (1) Moving the education of teachers to the top of institutional agendas and articulating the centrality of teacher preparation to the roles and missions of institutions, with a focus on the role of arts and sciences faculty.
- (2) Increasing the state's capacity to produce highly effective teachers to fulfil ever-growing demands and shortages.
- (3) Improving teacher preparation and professional development in a manner that links knowledge and performance expectations for teachers with the content standards for P-12 students.
- (4) Expanding collaborative efforts with P-12 schools in areas such as curriculum development, mentoring, induction and professional development.

Such an initiative would strike at the very core of teacher quality by assisting the institutions in their move towards comprehensive programme improvement and increased capacity to prepare highly effective educators. It has the potential to become the linchpin programme in the state's efforts to improve teacher quality, which in turn will lay the groundwork for parity in educational opportunity and workforce preparedness for all racial, ethnic and socio-economic groups.

Recognizing the diversity among the institutions, a state incentive grant to be used over one to three years should be provided to each college or university with a teacher preparation programme. The Commission and Department of Education are working with the state colleges and universities and representatives from other institutions that have teacher education programmes to define criteria that will guide disbursement and use of the grant funds. Each institution will develop a plan to address the above goals and funds will be available for use following a review by the Commission, in consultation with the Commissioner of Education.

Special emphasis should be placed on implementation of practices and programmes proven to be effective and enhanced efforts to facilitate the smooth transfer of teacher candidates from two- to four-year colleges should also be a priority. Ongoing state support for senior public institutions is recommended through

additional state-funded positions that are necessary in order to increase the institutions' capacity to meet the growing demand for more teachers. In addition, the senior public institutions may request that a portion of their grant funds be included in their base budgets to assist in supporting ongoing salaries for new faculty hired to increase capacity.

The Department of Education is working with representatives from the state colleges and universities and with the Commission to shape two related initiatives. The first is a targeted effort to recruit highly qualified, undergraduate and post-baccalaureate teacher candidates of colour, as well as highly skilled candidates for areas of shortage such as math, science, special education and preschool. The Department, in consultation with the Commission, would oversee a programme to provide bonuses for such candidates who teach in Abbott school districts. The programme could have an immediate effect in FY 2002 by placing more highly qualified new teachers in disadvantaged schools. It could also have a long-term effect by enticing more students of colour and students interested in math, science, special education and preschool to complete teacher preparation programmes and teach in an Abbott district.

The second related initiative is focused on teacher retention and quality. The Department, in consultation with the Commission, would provide grants to the six state colleges and universities that prepare the majority of new teachers in the state. The institutions (The College of New Jersey, Kean University, Montclair State University, New Jersey City University, Rowan University and William Paterson University) would establish Professional Development Academies. These six academies would be learner-centred, content-based and tied to the Core Curriculum Content Standards. They would provide two- to three-week paid summer sessions for current teachers, as well as ongoing seminars during the school year. Elementary and secondary students could participate in summer Learner's Academies on campus, which would provide academic enrichment for students and a laboratory setting for teachers to try out new strategies and ideas.

Together, these three, targeted initiatives have the potential to significantly advance school reform efforts and meet state needs. They will positively impact schools statewide and play a particularly important role in the effort to provide parity in the state's Abbott school districts. High-quality educators are among the state's most precious resources and the investment in these initiatives will reap significant returns. However, the issue of an adequate number of high quality educators extends beyond preschool to grade 12. In future years, planning efforts should consider a means to better recruit, retain and develop high-quality diverse faculties for colleges and universities as well, recognizing that a large turnover is expected in the first decade of the 21st century.

NEW APPROACHES AND TOPICS IN HIGHER EDUCATION

Genuinely interdisciplinary research spawns the new disciplines of tomorrow and is more likely to be relevant to industrial opportunities and the resolution of industrial or societal problems. One challenge is how to stimulate interdisciplinary research pro-actively when institutions are normally organised on discipline-based departments and when much external evaluation reinforces this, by itself reviewing disciplines and implicitly discouraging interdisciplinary connections. The rigid disciplinary boundaries between the hard sciences and the social sciences and the humanities that limited the comprehension of the fundamental processes of nature and society are already breaking down in some fields.

There must be a stimulus to the creation of interdisciplinary programmes and resources must be ensured for collaborative research among different disciplines and involving groups around thematic projects. A further issue is the extent to which higher education institutions perceive themselves as having the optimum range of disciplines for their likely future needs. An individual institution may seek solution to its problem through strategic alliances with other institutions or with companies, through amalgamation with other institutions, or by growing its new specialisms itself.

Many experts see the need for renewal of teaching and learning approaches and contents. They emphasise that higher education institutions must be more responsive in meeting the needs of employers and adapting to the generation of new knowledge in the various academic disciplines. It is important and urgent to carry out a series of case studies in the different regions on regional priorities, in which higher education institutions should play an important role.

The exercise prepared by the CRE for the Palermo European Regional Meeting with 20 institutional case studies from European higher education institutions is worthwhile looking into. In the case of Africa, case studies proposed in the Action Plan (1997) include: the type of leadership to be promoted, strategic management and planning, systemic interactions between primary, secondary, tertiary and continuing education, revision of programmes of education and training, the relative importance and feasibility of face-to-face and distance teaching programmes, strategies for ensuring improved participation of women in education and in decision making bodies, town and country planning, measures against the security problems of Africa (such as poverty, displaced populations, the trauma of war).

In connection with relevance, the Action Plan for Latin America proposes to elaborate projects on the problems of widening access to higher education, design of integrated educational systems and life-long education for all throughout life.

Appropriate emphasis needs to be placed on renewal of curriculum; new approaches to both classroom and distance education curriculum, which traditionally focused on academic disciplines in arts and sciences and training for elite professions, now put considerable emphasis on applied science and technology, business and management studies and professional training in such fields as engineering, accounting and computer science. Frequently new programmes are begun within the framework of the international UNITWIN/UNESCO Chairs and form students on different subjects, such as the resolution of conflicts, regional development and the social integration of marginalised groups, including refugees who constitute a grave problem in the African region. These formal initiatives must be complemented by community sensitivity activities such as public conferences and the creation of relevant groups such as those of NGOs and diplomatic and cooperation staff.

To overcome the limitations of higher education institutions, in the European university case studies some strategic issues and tensions as well as directions for action are proposed:

- Limited development of new fields of multi-disciplinary study from the stimulation of synergy between existing foci (Basel: ecological studies), especially where these correspond to market opportunities. This is seen as a means of sustaining critical masses in key subject areas.
- The addition of new disciplines perceived as critical to the university's contribution to society -a form of horizontal diversification (Jagiellonian University of Cracow, University College of South Stockholm).
- Accessing wider learning networks, through strategic alliances with other universities with complementary disciplines (Catalonia) or extensive use of Internet arrangements (Copenhagen Business School).
- The possibility of institutional mergers over the next decade to facilitate the creation of critical mass, as a natural regional consequence of the foregoing. The Australian experience has already been mentioned above.
- Accessing the knowledge base of industry, especially where professional/vocational training is a core element in institutional mission (Pau, Porto, Sheffield Hallam).

ADVANCEMENT OF KNOWLEDGE BY RESEARCH

To fulfil its mission to society, ideally every system of higher education should have the capacity to carry out research and have staff who are actively involved in research activities. At a minimum, this is desirable to support regular teaching activities and the staff development needs of academics, as well as to provide expertise in accessing the international body of research knowledge and assisting in technology transfer to local industry. At the same time, in many countries it is

now recognised widely that not all higher education institutions need to be involved in research and not all academics need to be undertaking research activities on a regular basis in order to provide high quality teaching, especially at more junior levels.

The World Bank has advised developing and newly industrialised countries, in the interests of economic efficiency, to strictly limit the establishment of new research universities and the number of students enrolled in them and to provide cheaper and more cost effective alternatives, such as junior colleges, technological institutes and short cycle institutions, to cater for a large proportion of the student population. Because of pressures on resources, in some countries research funding has been reduced over the past decade, but in others research funding has increased appreciably and special efforts have been made to establish new research centres and build additional links between universities and industry.

A major policy dilemma for higher education systems and research universities is how scarce research resources should be distributed and what mechanisms should be employed to do this. A common trend is the allocation of research funds to institutions and individuals on a competitive basis depending on the research funds they have already attracted, publication output and the number of research higher degree completions. There is a policy debate about whether research and research infrastructure funds should be concentrated to a greater degree in order to develop a small group of stronger internationally recognised research universities, or whether the current method of competition will ensure a sufficient degree of concentration. Another policy dilemma relates to the balance between basic and applied research.

While effective applied research needs to be supported by basic research, the actual mix of basic and applied within a higher education system varies greatly, depending on government and institutional priorities and the respective roles in research of higher education and industry within the country. In China, the policy of the State Education Commission is 'that scientific research should be oriented to the economy, that training people and developing science and technology should be combined and complement each other and that different types of institutions should conduct scientific and technical activities in different ways'. It seems that there is a growing feeling that the distinction between basic, strategic and applied research is breaking down in the higher education institution which is genuinely oriented towards economic regeneration and societal modernisation. How this synthesis is accelerated and planned for is a genuine agenda item for the next century?

There is an exponential growth in knowledge, with very little direct contribution from some regions, among them the African region, as a consequence of insufficient

attention to and insufficient resources for research, as well as lack of a long-term vision in the planning and management of teaching and research activities. Institutions of higher education in Africa should make special efforts to develop scientific and technological programmes to help meet the demands of the accelerated development of new technologies, especially new information and communication technologies.

These programmes should be supported by intensive research activities, from which will emerge the critical mass of the expertise needed for the region's development as it faces the pressures of globalisation.

Existing potentials of information and communications technologies should be boosted to give rise to virtual universities, which could considerably improve access, while at the same time proving world-class educational resources. Research should be made to bear a closer relation to the needs of African societies, so that basic research can be more closely linked with applied and development-oriented research stressing genuine partnerships with public and private institutions and the civil society. This would be one way of ensuring the active involvement of higher institutions in societal development efforts.

Responsibilities to Other Educational Levels

One area where there is consensus that universities can make a major contribution that will have direct benefits in the longer term for higher education is direct involvement in the training of school teachers and staff development activities for teachers. The University of Campinas in Brazil is a good example of this, with a large responsibility in teacher training at the national level parallel to its concentration on research. Strengthening the quality of teaching in schools will lead in time to better prepared university students, who can become agents of their own education; promoting socio-educational research into such problems as early school drop-outs and students' repeating courses; and ensuring its contribution to the design of State policies in the field of education.

It is widely recognised that higher education has an important contribution to make in community service and in assisting other education sectors in society. However, in some contexts there is some measure of disappointment with performance, especially with that of more traditional universities. This is unfortunate, since close links with the community and the other education sectors can do a great deal for universities in building wide community and political support, achieving renewal of the curriculum and sometimes generating new forms of financial support. The last point is particularly important since in the current environment of financial constraint there is often a strong tendency for universities to decrease or abandon much of their more traditional community service.

GROWTH IN EXPENDITURE ON HIGHER EDUCATION

Higher education in India is in financial stress. However, it should be noted that huge investments have been made in higher education in independent India. Total expenditure on higher education has increased remarkably during the post-independence period. At the inception of planning in the country (1950-51), India was spending ₹ 172 million on higher education. Government expenditure alone was of the order of ₹ 42,035 million in 1996-97 and it has risen further during the subsequent period. This impressive growth is, however, considerably offset by increase in prices and increase in population, more particularly student numbers in higher education.

Inflation has had an adverse effect on education. Nevertheless, on the whole, the trends suggest that higher education had a good start during the 1950's (with real growth of 7.5 per cent per annum) and had its golden days during the 1960's, with the real expenditure increasing at an annual rate of growth of 11 per cent; but it suffered significantly during the 1970's, with the rate of growth coming down to a meagre 3.4 per cent as educational planners aimed at consolidation of higher education instead of its rapid expansion; and showed some tendencies to recover during the 1980s. Though the growth in expenditure on higher education has been erratic during the 1980's, it had increased on the whole at a rate of growth of 7.3 per cent per annum. The 1990s heralded an era of austerity and higher education suffered greatly.

SHARE OF HIGHER EDUCATION

The relative priority accorded to higher education can be measured in terms of the share of higher education in GNP. Starting from a very low figure of 0.19 per cent of GNP invested in higher education in 1950-51, the share of higher education increased five-fold by 1980-81; but it came down to nearly one per cent of GNP after three decades of development. But ever since, allocation of resources has been steadily coming down: it tended to decline to 0.4 per cent of GNP by mid 1990s.

India has adopted Five Year Plans as an important development strategy since 1950. The Five Year Plans set new directions for development—quantitative expansion, improvement in quality and relating to several other dimensions of education development—and represent the serious intention of the planners to further develop the system.

The share of higher education doubled in the total education outlay from 9 per cent in the first Five Year Plan to 18 per cent in the second Five Year Plan and

increased to an all time peak of 25 per cent in the fourth Five Year Plan and ever since it has been consistently declining and was about 15 per cent in the seventh Five Year Plan.

The share of higher education in the total education outlay in the eighth Five Year Plan was estimated to be 8 per cent.

In case of education, including higher education, plan expenditures are of relatively small size and huge amounts are incurred as ‘non-plan expenditures’, *i.e.*, for the maintenance of the gigantic system, recognised as the second largest system in the world. In the total expenditure on education, the share of higher education was less than one-fifth in 1950-51, it increased to about a quarter by 1955-56 and became stable around one-fourth, suggesting that the relative importance given to higher education in the total education system remained unchanged since the beginning of the second Five Year Plan up to the sixth Five Year Plan, though there had been marginal increases during this period. But the situation has changed considerably from the seventh Five Year Plan onwards.

Devaluation and the accompanying price rise, has led to an enormous increase in prices of books and journals; and as a result, many universities have had to inflict very serious cuts on their library budgets.

SOURCES OF FUNDS

The various sources of finances for higher education in India are: (a) government sector— central government and state government; and (b) Non-governmental sector— students/parents (or families), *e.g.*, fees and other maintenance expenditure and the rest of the community at large, *e.g.*, donations and endowments. The relative shares of various sources in ‘total’ expenditure on higher education in India have changed considerably over the years.

The share of the government has increased in financing higher education and correspondingly that of every other source, *viz.*, student fees, community contributions and other internal sources declined steeply, though in absolute money terms there has been a significant increase in the contribution of these sources as well. The share of government (central and state) increased from 49 per cent in 1950-51 to 76 per cent in 1986-87.

And the share of the non-governmental sector declined remarkably. Students’ contributions in the form of fees used to form more than one-third of the total until the beginning of the 1960s; its relative share declined to less than half of what it was in 1950-51. The share of “other” sources (including voluntary donations, endowments, etc.) also declined, though the decline is not as sharp as the decline in the share of the fees. Non-governmental finances (fees and others) accounted for one-fourth of the total.

Thus, higher education in India is characterised by massive public investment, though the investment is still regarded as much below optimum. Such a rapid growth in public financing of higher education in India has been necessary for the following reasons:

- Facilities for higher education available at the time of independence were insignificant. Independence had created an abnormal increase in the social demand for higher education and public expenditure has had to cope with the demand.
- Building up a new socio-economic system after the end of the colonial rule required large scale manpower with varied skills; so the government had to expand investment in higher education.
- The very development models emphasised high skilled labour force and building up of huge social infrastructure for excellence in science and technology and research and development.
- Government policies towards equality in education led to the growth in public investment in education, since it involves huge subsidies at all levels of education to a substantial number of students, belonging to weaker sections.
- The rapid growth of school education naturally pushed the demand for higher education.

Recently, efforts are being made to mobilise resources and it has been recommended that while the government should make a firm commitment of funding higher education, colleges and universities should also make efforts to raise their own resources.

SHAPING A NEW VISION OF HIGHER EDUCATION

Equity of Access:

- (a) Universal Declaration of Human Rights, admission to higher education should be based on the merit, capacity, efforts, perseverance and devotion, showed by those seeking access to it and can take place in a life-long scheme, at any time, with due recognition of previously acquired skills. As a consequence, no discrimination can be accepted in granting access to higher education on grounds of race, gender, language or religion, or economic, cultural or social distinctions, or physical disabilities.
- (b) Equity of access to higher education should begin with the reinforcement and, if need be, the reordering of its links with all other levels of education, particularly with secondary education. Higher education

institutions must be viewed as and must also work within themselves to be a part of and encourage, a seamless system starting with early childhood and primary education and continuing through life. Higher education institutions must work in active partnership with parents, schools, students, socio-economic groups and communities. Secondary education should not only prepare qualified candidates for access to higher education by developing the capacity to learn on a broad basis but also open the way to active life by providing training on a wide range of jobs. However, access to higher education should remain open to those successfully completing secondary school, or its equivalent, or presenting entry qualifications, as far as possible, at any age and without any discrimination.

- (c) As a consequence, the rapid and wide-reaching demand for higher education requires, where appropriate, all policies concerning access to higher education to give priority in the future to the approach based on the merit of the individual, as defined in Article 3(a) above.
- (d) Access to higher education for members of some special target groups, such as indigenous peoples, cultural and linguistic minorities, disadvantaged groups, peoples living under occupation and those who suffer from disabilities, must be actively facilitated, since these groups as collectivities and as individuals may have both experience and talent that can be of great value for the development of societies and nations. Special material help and educational solutions can help overcome the obstacles that these groups face, both in accessing and in continuing higher education.

Enhancing participation and promoting the role of women:

- (a) Although significant progress has been achieved to enhance the access of women to higher education, various socio-economic, cultural and political obstacles continue in many places in the world to impede their full access and effective integration. To overcome them remains an urgent priority in the renewal process for ensuring an equitable and non-discriminatory system of higher education based on the principle of merit.
- (b) Further efforts are required to eliminate all gender stereotyping in higher education, to consider gender aspects in different disciplines and to consolidate women's participation at all levels and in all disciplines, in which they are under-represented and, in particular, to enhance their active involvement in decision-making.
- (c) Gender studies (women's studies) should be promoted as a field of knowledge, strategic for the transformation of higher education and society.

- (d) Efforts should be made to eliminate political and social barriers whereby women are under-represented and in particular to enhance their active involvement at policy and decision-making levels within higher education and society.

Advancing knowledge through research in science, the arts and humanities and the dissemination of its results:

- (a) The advancement of knowledge through research is an essential function of all systems of higher education, which should promote postgraduate studies. Innovation, interdisciplinarity and transdisciplinarity should be promoted and reinforced in programmes with long-term orientations on social and cultural aims and needs. An appropriate balance should be established between basic and target-oriented research.
- (b) Institutions should ensure that all members of the academic community engaged in research are provided with appropriate training, resources and support. The intellectual and cultural rights on the results of research should be used to the benefit of humanity and should be protected so that they cannot be abused.
- (c) Research must be enhanced in all disciplines, including the social and human sciences, education (including higher education), engineering, natural sciences, mathematics, informatics and the arts within the framework of national, regional and international research and development policies. Of special importance is the enhancement of research capacities in higher education research institutions, as mutual enhancement of quality takes place when higher education and research are conducted at a high level within the same institution. These institutions should find the material and financial support required, from both public and private sources.

Long-term orientation based on relevance:

- (a) Relevance in higher education should be assessed in terms of the fit between what society expects of institutions and what they do. This requires ethical standards, political impartiality, critical capacities and, at the same time, a better articulation with the problems of society and the world of work, basing long-term orientations on societal aims and needs, including respect for cultures and environmental protection. The concern is to provide access to both broad general education and targeted, career-specific education, often interdisciplinary, focusing on skills and aptitudes, both of which equip individuals to live in a variety of changing settings and to be able to change occupations.
- (b) Higher education should reinforce its role of service to society, especially its activities aimed at eliminating poverty, intolerance, violence, illiteracy,

hunger, environmental degradation and disease, mainly through an interdisciplinary and transdisciplinary approach in the analysis of problems and issues.

- (c) Higher education should enhance its contribution to the development of the whole education system, notably through improved teacher education, curriculum development and educational research.
- (d) Ultimately, higher education should aim at the creation of a new society—non-violent and non-exploitative—consisting of highly cultivated, motivated and integrated individuals, inspired by love for humanity and guided by wisdom.

Strengthening cooperation with the world of work and analysing and anticipating societal needs:

- (a) In economies characterized by changes and the emergence of new production paradigms based on knowledge and its application and on the handling of information, the links between higher education, the world of work and other parts of society should be strengthened and renewed.
- (b) Links with the world of work can be strengthened, through the participation of its representatives in the governance of institutions, the increased use of domestic and international apprenticeship/work-study opportunities for students and teachers, the exchange of personnel between the world of work and higher education institutions and revised curricula more closely aligned with working practices.
- (c) As a life-long source of professional training, updating and recycling, institutions of higher education should systematically take into account trends in the world of work and in the scientific, technological and economic sectors. In order to respond to the work requirements, higher education systems and the world of work should jointly develop and assess learning processes, bridging programmes and prior learning assessment and recognition programmes, which integrate theory and training on the job. Within the framework of their anticipatory function, higher education institutions could contribute to the creation of new jobs, although that is not their only function.
- (d) Developing entrepreneurial skills and initiative should become major concerns of higher education, in order to facilitate employability of graduates who will increasingly be called upon to be not only job seekers but also and above all to become job creators. Higher education institutions should give the opportunity to students to fully develop their own abilities with a sense of social responsibility, educating them to become full participants in democratic society and promoters of changes that will foster equity and justice.

Diversification for enhanced equity of opportunity:

- (a) Diversifying higher education models and recruitment methods and criteria is essential both to meet increasing international demand and to provide access to various delivery modes and to extend access to an ever-wider public, in a life-long perspective, based on flexible entry and exit points to and from the system of higher education.
- (b) More diversified systems of higher education are characterized by new types of tertiary institutions: public, private and non-profit institutions, amongst others. Institutions should be able to offer a wide variety of education and training opportunities: traditional degrees, short courses, part-time study, flexible schedules, modularized courses, supported learning at a distance, etc.

Innovative educational approaches: critical thinking and creativity:

- (a) In a world undergoing rapid changes, there is a perceived need for a new vision and paradigm of higher education, which should be student-oriented, calling in most countries for in-depth reforms and an open access policy so as to cater for ever more diversified categories of people and of its contents, methods, practices and means of delivery, based on new types of links and partnerships with the community and with the broadest sectors of society.
- (b) Higher education institutions should educate students to become well informed and deeply motivated citizens, who can think critically, analyse problems of society, look for solutions to the problems of society, apply them and accept social responsibilities.
- (c) To achieve these goals, it may be necessary to recast curricula, using new and appropriate methods, so as to go beyond cognitive mastery of disciplines. New pedagogical and didactical approaches should be accessible and promoted in order to facilitate the acquisition of skills, competences and abilities for communication, creative and critical analysis, independent thinking and team work in multi-cultural contexts, where creativity also involves combining traditional or local knowledge and know-how with advanced science and technology. These recast curricula should take into account the gender dimension and the specific cultural, historic and economic context of each country. The teaching of human rights standards and education on the needs of communities in all parts of the world should be reflected in the curricula of all disciplines, particularly those preparing for entrepreneurship. Academic personnel should play a significant role in determining the curriculum.

- (d) New methods of education will also imply new types of teaching-learning materials. These have to be coupled with new methods of testing that will promote not only powers of memory but also powers of comprehension, skills for practical work and creativity.

Higher education personnel and students as major actors:

- (a) A vigorous policy of staff development is an essential element for higher education institutions. Clear policies should be established concerning higher education teachers, who nowadays need to focus on teaching students how to learn and how to take initiatives rather than being exclusively founts of knowledge. Adequate provision should be made for research and for updating and improving pedagogical skills, through appropriate staff development programmes, encouraging constant innovation in curriculum, teaching and learning methods and ensuring appropriate professional and financial status and for excellence in research and teaching, reflecting the corresponding provisions of the Recommendation concerning the Status of Higher-Education Teaching Personnel approved by the General Conference of UNESCO in November 1997. To this end, more importance should be attached to international experience. Furthermore, in view of the role of higher education for life-long learning, experience outside the institutions ought to be considered as a relevant qualification for higher educational staff.
- (b) Clear policies should be established by all higher education institutions preparing teachers of early childhood education and for primary and secondary schools, providing stimulus for constant innovation in curriculum, best practices in teaching methods and familiarity with diverse learning styles. It is vital to have appropriately trained administrative and technical personnel.
- (c) National and institutional decision-makers should place students and their needs at the centre of their concerns and should consider them as major partners and responsible stakeholders in the renewal of higher education. This should include student involvement in issues that affect that level of education, in evaluation, the renovation of teaching methods and curricula and in the institutional framework in force, in policy-formulation and institutional management. As students have the right to organize and represent themselves, students' involvement in these issues should be guaranteed.
- (d) Guidance and counselling services should be developed, in cooperation with student organizations, in order to assist students in the transition to

higher education at whatever age and to take account of the needs of ever more diversified categories of learners. Apart from those entering higher education from schools or further education colleges, they should also take account of the needs of those leaving and returning in a life-long process. Such support is important in ensuring a good match between student and course, reducing drop-out. Students who do drop-out should have suitable opportunities to return to higher education if and when appropriate.

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AN INTRODUCTION TO EDUCATIONAL RESEARCH

Educational research is a systematic inquiry into various aspects of education, aimed at advancing knowledge, improving practices, and informing policy decisions within the field. It encompasses a wide range of methodologies, including quantitative, qualitative, and mixed-method approaches, to explore diverse educational phenomena. Researchers in educational research may investigate topics such as teaching methods, curriculum design, assessment practices, learning environments, educational technology, and the impact of educational policies. By conducting rigorous studies and analyzing data, researchers seek to uncover patterns, trends, and relationships that contribute to our understanding of educational processes and outcomes. Educational research also plays a vital role in addressing pressing issues and challenges facing the education sector, such as achievement gaps, equity and inclusivity, teacher effectiveness, and the integration of technology in classrooms. Through collaborative efforts between researchers, educators, policymakers, and other stakeholders, research findings can be translated into actionable strategies to improve educational practices and outcomes. Educational research serves as a cornerstone of evidence-based practice in education, driving innovation, improvement, and equity in educational systems worldwide. Through rigorous inquiry and collaboration, researchers work to address complex educational challenges and ensure that all learners have access to high-quality educational experiences. The book offers a comprehensive overview of educational research methodologies and their applications, guiding readers through the process of conducting rigorous studies to enhance teaching and learning practices.



Dr. Ritu Bala is a distinguished academician with a strong foundation in Zoology, having earned her M.Sc. from Maharaja Ganga Singh University, Bikaner (Rajasthan). Her educational journey also includes B.Ed. and M.Ed. degrees from the University of Rajasthan, Jaipur, showcasing her dedication to a well-rounded academic background. Driven by her passion for research, she successfully obtained a Ph.D. in Education from Rajasthan University, Jaipur (Rajasthan).

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