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**CURRICULUM DECISION MAKING FOR NATIONAL INTEREST IN
THE TERTIARY SECTOR: AN EVALUATION OF A CURRICULUM
DEVELOPMENT PROJECT**

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ABSTRACT

This paper is concerned with a study of comparative curriculum practice within the tertiary sector. Within Australia, curriculum practice, innovation, planning and evaluation has occurred mainly within the primary and secondary school system. However, since the mid-1980s, educational strategies for national interest have seen the evolution of informed curriculum research and development within the tertiary sector, as universities and colleges endeavour to meet nationally determined educational goals and objectives. This study relates the research process involved when tertiary educators (and researchers) are faced with the task of reconciling local, regional and national objectives. In particular, it considers the dynamics of planning for nationally determined priorities as a basis for implementing sustainable and informed curriculum innovation and evaluation.

INTRODUCTION

In June 1988, a number of key consultants and educationalists met at Footscray Institute of Technology (FIT), to discuss the viability of a tertiary driven school-based curriculum development (SBCD) project in Mathematics-Science education. An outcome of the meeting was general agreement on the necessity of FIT to provide an outreach program which would involve the provision of Mathematics-Science resource materials to western suburban schools. Known as The Mobile Laboratory, the curriculum concept generated that day has since grown into a major curriculum development project well beyond the imagination of the original proposal.

This paper is concerned with describing the curriculum research and development process that has come to be called the Mobile Classroom.

What follows will very much appear as a process of transformation rather than standard curriculum research and development. The project in concern was a component of a more complex concept involving an increase in participation rates of secondary school students in science and mathematics and by implication, tertiary entry in those areas. To this end, the Mobile Classroom has had to meet divergent aims during the design and development process. A key purpose of this paper, is to discuss the implications surrounding SBCD projects in a tertiary institution and the capacity of the tertiary sector to meet educational and vocational objectives driven by government agencies as part of funding arrangements.

THE CONTEXT

The Mobile Classroom was conceived as one of three projects under the auspices of the Mathematics and Science Cooperative (FIT). This was a western regional project "designed to get more young people from the western suburbs ... to study mathematics, science and technology subjects" (McLean, 1989:1). The Cooperative eventually operated under the rubric of the Western Suburban Co-ordinated Area Project (WESTCAP), one of several CAP projects throughout Victoria that sought to establish firmer links between schools, industry and tertiary education.

The three WESTCAP projects involved:

1. Recruitment of STC Students (Special Selection)
2. Education/Industry Interaction (Industry Links)
3. Mobile Maths/Science Laboratory (The Mobile Classroom)

A feature of these projects was the level of cross-department and cross-faculty interaction in deciding upon the objectives and strategies for each initiative, and the level of involvement of government departments, particularly the (Victorian) Ministry of Education. A clear function of the CAPs concept was for all 'actors' to participate in the decision making process and for the various aims of each actor or agency to be somehow met in the coordinated approach to goal setting and policy implementation.

The projects, in building closer links with schools, industry and tertiary education, sought to:

- increase student interest and participation in post-primary maths/science and technology courses;
- increase student interest in higher education maths/science and technology programs;
- provide an increased range of maths/science technology [sic] graduates appropriate for local industry needs and to assist with the task of reorienting Australia's economy. (WESTCAP, 1988:2)

The Mobile Laboratory was an ambitious project. The Mobile concept was meant to serve three separate but related functions:

- to make available a wide range of curriculum programs and resources that provided innovative approaches to maths/science education;
- to provide a resource base for SBCD and a strategy for granting increased access for minority groups and girls in maths/science education;
- to provide an outreach program to so-called disadvantaged schools and the general community in maths/science education.

As articulated by WESTCAP, these functions were described in modest, yet diverse, terms. The original intent of the project was to plan, design and construct a 'mobile mathematics and science laboratory' which contained 'a variety of inspirational but generally accessible curriculum materials' (WESTCAP, 1988:9). The intent of the project was to provide inservice programs and curriculum/professional development days, to mount demonstrations of equipment for the local community, and to arrange special science and maths classes for local schools. Through carrying out these objectives and strategies, it was anticipated that there would be:

- a raised profile amongst parents for creative and enjoyable approaches to maths and science teaching;
- increased interest in maths and science by local youth and youngsters;
- increased interest by local teachers in innovative, creative and enjoyable approaches to maths/science study. (WESTCAP, 1988:9)

It was anticipated that most objectives and strategies would be implemented throughout 1988, leaving 1989 available for ascertaining the impact upon the projected outcomes. However, the strategies were not implemented throughout 1988.

Implementation of strategies throughout 1988, and indeed, the early part of 1989, was compromised by the form and function of WESTCAP altering during the same period. The WESTCAP projects altered according to the source and parameters of various state and federally funded projects. The school-industry links project, for instance, took on a wider scope and sequence and provided a mechanism for developing SBCD not unlike that envisaged for the Mobile Laboratory. As the Mobile Laboratory was meant to act as a strategy for the other WESTCAP projects, its form and function shifted or was redefined according to the general process of development of WESTCAP. More importantly however, was the function of the Mobile Laboratory itself. After all the objectives and strategy plans were peeled back to expose the inner purpose of the project, it was clear that this particular curriculum research and design package involved a reconstructionist function (on the theoretical implications of this term see Giroux, 1981:352-58; Zeichner, 1983:3-9; Giroux & McLaren, 1986:213-33; Williamson-Fien, 1988:143-67; Fien, 1989:1-9). The project concerned participation and access and effecting significant alterations in attitudes towards and about mathematics and science education. (This social reconstructionist function is discussed further under *Analysis* and *Conclusion*). Significantly, an aim involved the identification of an appropriate curriculum structure that matched the cognitive structure of female students to provide or create viable and enduring access to mathematics and science programs.

This critical reconstructionist function hooked the project into a thorough research and evaluation mould, but, it also put the project at variance with the other WESTCAP projects which aimed at different, but nonetheless normative

approaches to curriculum, transition and participation. The various stages of development of the Mobile Laboratory capture this duality in curriculum design.

THE PROCESS

The Mobile Classroom and Outreach concept has operated successfully throughout North America and the Pacific. These curriculum programs aim to provide remote schools and communities with a wide range of otherwise hard to obtain curriculum materials. A key feature of the North American programs has been the improvement of relationships between higher education and schools, and technology and science resources have often provided the pivot for the two sectors to meet that goal (Amodeo, 1982, 1983; Tkachuk, 1982; Klinger, 1983; Harry, 1985; Auer, 1985; Dennison, 1986; Gittenger, 1986). The curriculum projects in these cases provided more of a service than a "breakthrough" in curriculum design.

Throughout the Pacific, outreach programs have aimed at effecting a transition in both school and student behaviour and outlook. In these cases, it is recognised that the cognitive structure of non-western students may not (and sometimes will not) match the cognitive structure implicit to and contingent upon the curriculum materials and programs. The emphases of curriculum projects in Pacific rural and urban settings have involved identifying the cognitive structure of Pacific children and then designing resources and programs to match that structure (see Prince, 1969; Vulliamy, 1981; Crossley, 1983; Lancy, 1983; Delpit, 1984; Saxe, 1985:503-13; Pomponio & Lancy, 1986:40-61). Where the North American projects have been characterised by a reasonable level of success, principally in the spheres of increased access to materials and technology and also improved links between schools and higher education, the Pacific-based projects have been marked by a lack of success. The cognitive and behavioural changes aimed at have often evaded a means for measuring outcomes (see Vulliamy & Carrier, 1985:17-33), and when appreciable changes have been made, the outcome has been unexpected, and according to Lancy, 'dangerous' (1983:210). He argued:

How far would a child progress in mastering the village way of life if he firmly believed that answers are found in books, that problem solving is an individual, intellectual activity, that effort is always promptly rewarded, that the sexes are equivalent and so forth? (1983:210-11).

Lancy had a flair for the dramatic in presenting this conclusion concerning the cognitive consequences of a formal mathematics education program in Papua New Guinea schools, but he has not been alone in equating the significant impact formal schooling can make on patterns of cognitive processing.

The Mobile Laboratory conceived under WESTCAP aimed at meeting both objectives: improved school-community relationships, and, cognitive and attitudinal changes amongst students, particularly females. The strategies for

achieving the former were relatively clear-cut and involved an informed approach to marketing, cross-referenced with school-based feasibility studies (WESTCAP, 1988:6-7,12; McLean, 1989:7-8, 10-13). The strategies for the latter were never clearly articulated (WESTCAP, 1988:10), and in the case of one proponent, never spelt out (see Schultz, 1988:12, 38-60, 85-89, 113-15). An outcome has seen the form and function of the Mobile Laboratory altered according to the form and function of WESTCAP. Consequently, a wide dissemination approach to school-communities (a public relations function of the project) tended to supersede the curriculum function. A brief overview of objectives and strategies in conjunction with anticipated outcomes reflects the general process of development the project has taken. The MASC argued:

The laboratory will be used by... consultants; students in the Graduate Diploma in Education (Mathematics and Science) at FIT; FIT Teacher Education Staff.

These people will use the laboratory for the following exercises:

inservice programs and curriculum days for local teachers designed to inform them of high student interest and motivational approaches to junior mathematics and science programs;

community involvement programs in Mathematics and Science where FIT students take the laboratory into shopping centres and other local sites to demonstrate the excitement and enjoyment obtainable from the study of mathematics and science;

special maths/science classes for local primary/post primary students. (WESTCAP, 1988:9)

Several months after this description of strategy and intent was provided, the Mobile Laboratory was described as a Mobile Resource Laboratory which:

is a collection of "inspirational", "hands on" curriculum packages designed to intrigue young people, teachers, parents and the general community about a range of mathematical and scientific concepts ... [which] have been developed with particular audiences in mind, including...

[A kit] is used with clusters of parent groups as a basis for the development with the parents of further activities [sic] in the family mathematics style.

The parents are then encouraged to put these activities into practice and to share them with other parents. (McLean, 1989:8-9)

As originally conceived, the project was targeted at consultants and FIT students and staff for professional development and curriculum training, or

what Schultz termed PRIMITE (*PR*ojects *I*n *r*eal *l*ife *I*ntegrated *M*athematics *I*n *T*eacher *E*ducation). This was essentially a cognitive and attitudinal function whereby approaches to maths/science education moved away from the "pure" to the "applied" as a foundation for informed concept formation in maths and science. The intent in this sense was to change current and future practitioners and to involve them in the development phases of the project, and indeed, for them to grasp a sense of ownership of the project, the resources and the concepts in the development of SBCD maths/science education.

The second stage, parental involvement, took on other emphases, namely to increase competence and confidence amongst students in maths/science through assisting their parents in the same area. Again, curriculum development involved people acquiring a sense of ownership of the project and concepts through contributing to the development of resources. In this sense, access and participation involved the production of learning resources rather than simply being exposed to a variety of "hands-on" materials.

It is clear from this, that the Mobile concept was meant to go beyond the public relations exercises conducted in North American and approximate the Pacific-based notion of matching curriculum structure with cognitive structure through school and community based curriculum development. The FAMPA projects operating throughout the metropolitan area are aimed at community and school based curriculum development, and it was imagined that the Mobile Classroom would complement FAMPA and later FASPA initiatives.

To this end, the focus of evaluation for the project in 1989 included:

- [determining] the extent to which local parents, teachers and students have become more interested in doing mathematics and science related activities as a consequence of contact with the mobile laboratory.
- [determining] which aspects of the use of the mobile laboratory have had greatest impact in changing attitudes to mathematics and science.
- [interviewing] local parents, teachers and students who have had contact with the mobile laboratory. (McLean, 1989:13)

The approach to community based and real life education suggested by the project was a real advance in both teacher education and SBCD. However, another variable was operating whilst these objectives and strategies were being planned. Funds were made available by the Victorian Post-Secondary Education Committee for the development of the Mobile Laboratory. Some funds were to be used for the purchase of a vehicle (the "mobile" component) whilst some was to be used for curriculum/resource development and professional training.

Funding by FIT was injected into a FIT Library account for the purchase, organisation, cataloguing and storage of commercially produced curriculum

programs and resources. The involvement of the FIT Library was a critical factor in this curriculum project in that it made available a much wider range of personnel, expertise and skill for controlling what promised to be an ambitious outreach program. Library involvement assisted participation in that another FIT department was able to contribute to curriculum and resource development. However, the Library budget was recurrent and had to be committed by December 1988.

SBCD and indeed, community based curriculum development, cannot be subject to uncompromising time-lines. The process of research (including feasibility studies), design, development, trialling/ evaluation, modification and re-development needs to be a finite but realistically planned process. The recurrent accounts had to be accommodated. Consequently, the Mobile Classroom involved a second stream of development: the purchase of "inspirational" and "hands-on" materials and programs before the development of community and school based resources. At this point (i.e., late 1988) the project adopted a firmer public relations profile through the purchase and planning and distribution of commercially produced materials. This met WESTCAP's aim of providing increased access to mathematics and science education on something of an immediate basis and also provided the Mobile Classroom with a "visible face" (McLean, 1989:2). The commercially produced programs and resources had the effect of giving some substance to what an outreach program would look and behave like. What was not anticipated was the range and depth of need amongst western region primary schools for curriculum materials in an area that had long been neglected and yet was rapidly becoming a national priority (i.e. Science, Mathematics and Information Technology). To use a metaphor, experience would prove, rather than policy, that the Mobile Classroom had the potential for providing an oasis in a very expansive desert of educational need. And, moreover, that need included informed advice on the selection, and indeed purchase, of curriculum materials by schools. Indeed, educational consultancy was a major requirement throughout the primary school system. The project team was frequently requested to provide input for curriculum days and, indeed, to arrange and run these professional development occasions for school communities.

Again, the impetus came from the schools and did not have to be generated by the project team.

DEVELOPMENT

It was envisaged that 1989 would witness a "relatively low implementation" of the Mobile Classroom as the project moved towards meeting the goals set early in 1988 (McLean, 1989:1-3). This was an accurate prediction as the project had to plan for three separate tasks:

- Fitting out the Mobile Classroom with curriculum "kits" and establishing an effective working relationship with Library staff;

- Establishing an effective and efficient purchasing, cataloguing and storage system that would accommodate the expansion of the Mobile concept and "mass" borrowing by FIT departments and western region schools (this involved designing an innovative borrowing, retrieval and turn-around system);
- Trialling and evaluating kits within schools to:
 - assist in determining usage patterns and areas of need,
 - form the basis for future SBCD; and,
 - to introduce FIT teacher education students to a resource base for real life maths and science.

These objectives were of equal importance but nonetheless, disparate in their intent. The outcomes to date, are quite clear:

- all have been met and indeed, the first two have made a major breakthrough in Library operations and relations (personal communication with John Rogan);
- the success of and subsequent demand for the Mobile Classroom and professional development from primary schools exceeded expectations and the volume of demands could not be adequately met; demand will escalate during 1990;
- the project team operated well beyond their research and development capacity to meet these and related objectives resulting in their having to work in isolation on many occasions in order to meet disparate local, regional and even national needs and demands;
- the objectives and strategies have had to be redefined by the project team to meet school-based needs. This required the consideration of high quality, intense working relationships with a limited number of schools in preference to wide ranging yet limited contact with a greater number of schools; this in turn affected public relations profiles;
- WESTCAP public relations requirements and recurrent budgets were at variance with those stipulated by WESTCAP (1988:2,9) and reiterated by McLean (1989:1-2)

This variance is directly related to the relationship between intent and outcomes discussed earlier. If the project is to "increase interest" in maths/science education, then it is a public relations project not unlike the travelling science shows. If, however, it is concerned with increased access to maths/science education and by implication, changes in approaches to teaching and learning, then it is a curriculum development project. Educationalists will be tempted to argue that the project can meet both ends. That is simply untrue. Certainly "increased interest" can result as a multiplier effect from an informed curriculum

development project. However, curriculum development leading towards attitudinal and cognitive changes does not result from a project concerned with creating or increasing interest. Yet this is clearly the main aim. An examination of the implementation phase of the project during 1989 bears out this conclusion.

IMPLEMENTATION

By March 1989, the commercially produced kits had been purchased, catalogued and organized into themes. The kits were then ready for trialling by FIT students, local schools, and if the need arose, local community groups. As a curriculum project, the Mobile Classroom faced a problem of a research and development type.

The research problem could be defined as identifying the relationship between the concept of the Mobile Classroom as described by WESTCAP and the concept of the Mobile Resource Centre as perceived by school communities. It was hypothesised at the time that the western region was characterised by a particular school-community relationship where maths-science-technology education was either undervalued and/or subject to mystification, resulting in low levels of participation and access to higher education. The Mobile Classroom, it was suggested, could look towards altering that relationship (WESTCAP 1989:1). These hypotheses raised strategy questions concerning the level of need for particular types of maths/science education and potential target groups.

The project team suggested that four primary schools and three post-primary schools should be targeted for trialling, evaluation and SBCD. They suggested also that four groups of research teams, consisting of undergraduate, graduate and graduate diploma students, be formed, to trial the kits with a view to finding limitations and faults in curriculum packages.

During the trialling and evaluation, it was stipulated that the Mobile Classroom would "not be available to the general public or other schools" (WESTCAP 1989:2). Two research teams were to operate during the first half of the year and two during the second sector, whilst the schools were to be brought into the trialling process for periods of between four and eight weeks over the year. The schools were to trial the kits and to provide the research teams with a frank evaluation of the potential and limitations of the material and programs. It was anticipated that trialling of this nature would allow for the elimination of 'bugs' before the kits were released to western regional schools and community groups. The brief for the research teams was more detailed and involved meeting the original intent statements provided by MASC and WESTCAP.

It was the task of the research teams to:

- identify appropriate support material from existing published texts and programs to enable the 'raw' (i.e., unevaluated) kits to operate as units of work;

- identify tasks and activities appropriate for particular year levels;
- reconstitute existing published material in a more appealing and acceptable form;
- group, collate and label support material as a coherent package;
- develop "grassroot" kits ... to bring into existence simple projects as new kits. (WESTCAP 1989:3)

It was clear to the project team that LEGO materials (Duplo, Lego and Technic) were extremely popular and readily incorporated into existing or new programs. However, the research teams and graduate education students were not receptive to the material nor the curriculum concept of hands-on, problem solving maths and science.

The graduate students (many of them practising teachers) who were meant to trial also did not approach the project team over borrowing material despite the mounting of several familiarisation sessions during March and April. A member of staff suggested later that students found the non-textbook and non-written application approach to maths and science too difficult and felt that they did not have a firm idea of how the kits or the Mobile Classroom operated. The suggestion was made to the project team that they should consider a thorough familiarisation program for graduate students in 1990, tantamount to a detailed professional development program. Given that the kits were meant to increase interest amongst teachers, the project team found it somewhat mystifying to consider creating interest through additional teacher training at the graduate level.

In contrast to the graduate students, undergraduates adopted the kits and the concept of hands-on problem solving maths and science more readily. These students were either exposed to the materials as part of their formal pre-service training (e.g. Year 1 Mathematics Education) or decided to use the material as part of their overall assessment program (e.g. Year 3 Science Education).

The development of lesson plans based on LEGO-Technic by Year 1 students demonstrated that cognitive and attitudinal changes in maths education were quite achievable within a very short period of time, provided that there was an intense exposure to a limited range of innovative material within set objectives and criteria.

An unplanned development occurred during the implementation phase. After an initial "silence", there was unprecedented demand upon the Mobile Classroom by western region schools. Much of this demand was attributable to the careful dissemination of project material by one project officer to targeted schools. This had a multiplier effect by May 1989. The approach employed by the project officer was to explain clearly and carefully to schools what material was available, how it might be effectively used, when it would be available, and

what the school could do to assist in the evaluation and future development plans of the project. Demand soon outstripped supply and the role of the research teams was steadily superseded by the patterns of usage by local schools. This development, however, does not reveal the critical but copious amount of effort and attention to detail the project officer put into this rapid shift from trialling to the incorporation of the Mobile Classroom into existing school programs. There is considerable ethnographic and educational significance in the fact that this transition occurred through the willingness of the project officer to carefully manage the change in direction in conjunction with the highly responsible approach by schools in their use and care of the material. In this case, existing local needs determined directions, and not national priorities.

TRIALLING

Since trialling began in May 1989, students and teachers from twenty-one primary schools and four secondary schools have used the resource kits as part of daily school programs.

In effect, the Mobile Classroom reached some 5,000 students and 250 teachers in around six months of operation. The Classroom also involved special school and community groups in its delivery of resources.

These included School Support Centre activities, professional development programs, community displays, and, within schools, hands-on theme displays, a FAMPA session and "Science" shows.

Much of February, March and April was devoted to collaborative work with Library staff (FIT) preparing the resource kits for use. This activity included the collection of relevant material for inclusion into the kits, cataloguing and the preparation of content sheets. It also involved organising a manageable and practical system for borrowing and delivering kits to schools. This was a time consuming and labour intensive period, and one based on trial and error. Considerable Library assistance and expertise saw the development of a viable borrowing and retrieval system. During this period, a descriptive brochure was prepared and the Mobile concept was presented to selected schools. One teacher reported:

The children really appeared to like the challenge of creating, constructing, solving problems, etc. I feel that the upper school children often miss out on such experiences and I was pleased to have the opportunity for them to take part.

As information spread about the Mobile Classroom, requests for details and to borrow equipment escalated. Although the plan for seven target schools had been designed for 1989, the decision was taken to attempt to cater for school needs as they arose. At this point, the volume of demand for innovative materials exceeded expectations. Once the demand was fully appreciated, the transition from a trialling phase to a fully operational stage was effected and

continued throughout 1989. Interest in the concept clearly grew on a district to regional basis: a visit to Williamstown PS was followed by requests from Williamstown North PS and Newport PS.

This cluster type relationship emerged also at Werribee. Four Werribee schools drew on the Mobile Classroom, not so much as a coordinated plan predetermined by the project officers, but rather in response to separate requests that were drawn together into a coherent time-table or schedule that allowed for a maximum use of material within a given time.

Schools approached and planned for the Mobile Classroom quite differently. The most successful visits occurred when the equipment was organised into "hands-on" displays in one room (for instance, the Library). Time was allocated to each class of at least one session, and children and teachers had the opportunity to explore equipment appropriate to their grade and skill level. A project officer assisted in these programs but was unable to run them daily. These programs were organised at Mossfield, Manorvale and Stevensville primary schools. This proved to be an effective technique for acquainting teachers with the equipment. Yet a criticism of the approach concerned the additional demands the administration of the experience made on particular teachers:

I am extremely impressed with the program and the equipment ... a suggestion for other schools regarding staffing: too much responsibility and action for a teacher to maintain all day, lessons backed onto each other.

At several schools equipment was placed in the staffroom. This allowed teachers to explore and select kits appropriate for their classrooms. It was clear, that at these schools, only teachers already interested in teaching science and exploring innovative maths ideas used the equipment. Without an organised in-service activity, it was not possible to obtain an optimal level of teacher participation and enthusiasm.

Schools familiar with the contents of the Mobile Classroom soon booked specific kits to complement existing school programs. This proved to be a most successful and practical use of the resource, and LEGO Technics proved to be the most popular.

With each visit of the Mobile Classroom, teachers were requested to complete a simple evaluation form. Verbal feedback was in all cases very positive, but written evaluations reflected a reluctance of teachers to commit pen to paper. Of an approximate exposure to 250 teachers, only forty-two written evaluations were received. Scanning these, a pattern in responses emerged. Typical comments included:

- Children thoroughly enjoyed the experience. They were creative and investigative. It was easy to question them and get good responses. They were willing to develop problems. Excellent opportunity; and

- The activities were excellent. Children were fascinated with the Plasma Sculpture. They worked independently and enthusiastically in all sessions. I most definitely intend using the (Mobile) Classroom over and over again.

In all cases over the year, the schools' responsibility in taking care of the equipment was exceptional. This indicated a sense of ownership and a commitment to the project, and a preparedness to maintain an ongoing involvement. Again, much of this can be traced to the involvement of schools in the development and exploration of the Mobile Classroom during its early stages of implementation and evaluation.

ANALYSIS

The reason why I thought LEGO kept the children interested the longest, and, was the most popular, was because with LEGO children can make so many different things. Children have a chance to be creative, use their imagination; they can have fun pulling it apart then putting it together. They can watch what other children are doing and they can try to make the same thing. It gets children talking to one another about what they are making and comment upon how good it is. Activities that were less popular ... [did not allow] children to be creative, to experiment; these activities are too set. In a way, you could say that these activities have one answer only. You can only do the same thing over and over again which does not provide any stimulation needed to keep children interested ... The children need an activity to provide variety which LEGO, role playing and shopping provide, because each time they can be played differently according to how the children want. Overall, the purpose of the activities was to develop the children's manipulative skills (both fine and gross motor skills), and some role playing, which helps children to socially interact.

In referring back to the activities, I must mention that some activities were dominated by the one sex, for instance, the building blocks and the [climbing] tunnel was dominated by males. This is sad because it is at this age where children should be encouraged to do everything ...

This analysis does not concern a Mathematics class in a local primary school. Rather, what is described is a Pre-school free-play session. The author, Carmela Pappalardo, a second year Teacher Education student, was not concerned with identifying the early patterning of gender roles in concept formation (towards Mathematics and Science). Carmela's task was to simply select a venue where play occurred and to describe accurately and faithfully what activities and interactions unfolded. That she found clear differences in gender (and later in her report, ethnic) responses to activities should come as no great surprise. What is particularly striking is her sense of the structure of concept formation developed by pre-school children, and its later implications for repetitive tasks that often informs the approach to concept formation perceived and delivered

by adults. What Carmela is describing are the cognitive structures of children articulated in the problem solving situations they create, and the type of resources and tasks they find most appropriate for their creative, open-ended, conceptual and physical development play.

What she reveals with skill, subtlety and with powerful insight, is the fact that the social constructions of knowledge by children are purposeful, functional and relatively gender neutral however, adults deny that concept formation process by creating cognitive structures (a curriculum) that delivers constructions of knowledge perceived by and appropriate to adults, to replace the natural learning processes of children. What Carmela describes is how educators and policy makers steal from children a process of problem solving and concept formation that works, and replace it with a body of theory called educational psychology and a particular practice, namely a curriculum. Is it the task of the Mobile Classroom to effectively reverse or to untangle that original theft?

Despite the statements of intent, outcome and policy, all couched within the frames of reference of a particular strategy called the Mobile Classroom, the project described in this paper, in conjunction with the two other WESTCAP (school-industry links) projects, is ultimately concerned with the types of personal and institutional redefinitions that are required to reverse existing patterns in mainstream Mathematics and Science Education with a view towards schooling girls in such a way that what happens in school corresponds closely with a workplace that provides opportunity and equality. That reversal concerns identifying the cognitive consequences of schooling and particular school programs, and in a longitudinal sense, establishing a curriculum base for generating human, economic and political capital. That is a lot to ask of a school-industry links project.

The hidden aspect of the Mobile Classroom is the proposal that it can contribute to a process whereby increasing numbers of girls will participate effectively in mainstream Mathematics-Science curriculum programs, resulting in greater numbers of girls moving between primary, secondary and tertiary education, with various exit points into industry. The traditionally male dominated skills and attitudes acquired by girls would eventually result in economic development. This proposition in turn rests on the assumption that, through schooling, individuals increase those skills and attitudes essential for national productivity through generating or forming human capital.

These statements were not included in the WESTCAP projects, but they nonetheless inform the current national ethos concerning education and the form and function of schooling, and consequently underpin the rationale for nationally driven funding. The problem with all of this is that despite the human capital theory of economics that informs school-industry relationships, in conjunction with the social justice outlook that argues for an increasing involvement of women in male dominated occupations (and by implication, positions of power), that actual body of research that demonstrates how all of this may be achieved is conspicuous by its absence. Despite all the rhetoric, the

cultural and social consequences of schooling for girls are well established, the cognitive consequences are not.

Approaches to science and mathematics are still firmly in the hands of men, despite the fact that in primary schools, and to some extent secondary schools, the delivery of that information is firmly in the hands of women. Yet, the research base for ensuring that girls can enter the *rite de passage* to ensure equal participation in schooling and the curriculum and to also untangle that cultural web of relationships keeping girls on the periphery of the school-industry correspondence relationship, remains opaque and evasive. For sure, increasing numbers of monographs are discussing cultural and power relationships that are well established, and some literature is revealing the extent to which attempts to keep girls (and women) on the periphery are deliberate (on this, see Bleier, 1984; Harding, 1986:58-78, 111-26; Clarricoates, 1987:155-65, Valli, 1987:189-210; Wallace, 1987:237-52; Williamson-Fien, 1987:51-62), but again, the cognitive consequences of intervention within the school system remain inconclusive; and the data base for making decisions about intervention does not provide clues for points of entry. That Mathematics and Science have been selected as points of entry must be put in a spatial and temporal context before cognitive outcomes can be accurately predicted.

The Mobile Classroom (project) has had to contend with these limitations concerning a viable data base, accurate points for intervention and associating cognitive consequences with anticipated cultural milieu. An outcome has been that the project team has had to take responsibility for collecting, organising and presenting data and findings in order to inform future action and, importantly, to provide accurate advice to school communities. The findings to date have been encouraging in terms of providing evidence for redefining approaches to mainstream Mathematics and Science Education. The cognitive consequences for using LEGO, for instance, are quite clear cut and can be briefly listed:

- LEGO Technic is used as well and as creatively by boys as girls; however, the normal time span for classroom activities based on this material needs to be extended. For instance, where 30 to 35 minutes would be an appropriate length of time for nine and ten year olds to be working on mainstream Mathematical problems (e.g. sums), around 60 to 70 minutes is required for Technic, and the level of concentration amongst this age group remains unbroken throughout that period;
- it was found with one group of eleven year old children, who were quite capable of carrying out long addition, that the same group were unable to grid information using LEGO Duplo. The implication of this was that although long addition requires children to "see" a grid (to determine place value, carrying and the overall function of addition), these children had great difficulty putting together and seeing a non-numerical grid; yet the material required a recognition of pattern, order and counting;

- the complexity of mathematical and technological understanding required by children to use LEGO Technic is much more advanced than the problem solving in mainstream Mathematics Education; counting, "mental" subtraction and addition, visual discrimination, and complex processes of matching three dimensional objects with two dimensional illustrations, were all required to carry-out what appeared to be "fun" activities. Again, the concentration level of children exceeded standard time frames suggested by cognitive theory.

In terms of Science, one major but crucial finding was apparent throughout the year: children (boys and girls), teacher education students and primary teachers wished to have nothing to do with experiments and observations that required the use of Science kits, particularly in the areas of Physics, Electronics, Chemistry and Solar Energy; while secondary Science-Mathematics teacher education students were uncomfortable with anything that did not look like a textbook handling of problem solving. A proposition that can be put forward after twelve months is that the cognitive structure of children does not comfortably match the curriculum structure of mainstream Mathematics and Science, and moreover, attempts by educators and educational planners to consider a matching are minimal. For instance, a recent Mathematics text book, for Year 3 and 4 children by a leading educational publisher had a photograph of a LEGO city on the cover, without a hint of an equation or a number, whilst the text itself was simply full of sums, figures and more sums.

CONCLUSION

The Mobile Classroom has built up quite a strong research base and the project team is in a strong position to provide advice on interactive approaches to Mathematics and Science Education. The project team is also in a strong position to advise on whole school programs that seek to integrate Mathematics and Science across the curriculum and in a manner where school-communities can be sure that the content of mainstream Mathematics (in particular) can still be delivered. The cognitive consequences of this outreach program will only be known while the team works intimately with school communities through SBCD. Research by Williamson-Fien (1986:51-64), Zeichner (1983:3-9) and Liston and Zeichner (1988) has indicated that the process of research and development pursued by projects such as this one is a legitimate and logical approach to curriculum design and SBCD. Indeed, Zeichner has posed most appropriately the proposition which this paper has argued for throughout: namely, that "only after we have begun to resolve some of those necessary prior questions related to ends" can we "effectively accomplish our goal" (1983:8). The resolution of questions is well under way, the disposition of educational planners to assume outcomes (often as goals in themselves) without the necessary research and development will be a constant hindrance to establishing a sound research base for effecting sustainable change in gender related Mathematics and Science Education.

When Cummins (1986:18-36) argued for a framework for intervention in the empowerment of minority groups in education, he urged a redefinition of roles between teachers and students, so that students could control and determine approaches to learning in addition to those set by their teachers; when Carnoy and Levin (1985) repudiated earlier claims that schooling corresponded exactly with the workplace, through the potential of schools to provide equality they were suggesting that schools could be venues for transformation; and when Aronwitz and Giroux (1986: 23-46, 139-62) argued for the transformative teacher and the transformative intellectual, they were proposing mechanisms which could effectively reverse the power relationships that continue to keep key agents of change on the periphery.

That the Mobile Classroom has had to consider taking all of this on board to perceive possible solutions and points of intervention for empowering girls and their teachers in Mathematics and Science Education, is an indication of how complex curriculum theory is meant to be, and how careful curriculum researchers must be when steering a course through the seas of social justice and empowerment on the one hand, and the milieu of marginalisation that seeks to promise access and participation yet actually wishes to maintain power relationships as they have always stood.

REFERENCES

- Amodeo, L. (1982) 'The Computer Experience Microvan Program: a cooperative endeavor to improve university-public school relations through technology.' New Mexico State University.
- Aronwitz, S. and Giroux, H. (1986). *Education Under Siege*. London: RKP.
- Barthel, D. (1985). 'Women's Educational Experience Under Colonialism.' *Signs: Journal of Women in Culture and Society*, Vol. 11, pp. 137-54.
- Bleier, R. (1984). *Science and Gender*. New York: Pergamon Press.
- Carnoy, M. and Levin, H. (1987). 'Dinosaurs in the Classroom - the hidden curriculum in primary schools', in M. Arnot and G. Weiner (eds), *Gender and the Politics of Schooling*. London: Hutchinson, pp. 155-65.
- Clendinnen, I. (1987). *Ambivalent Conquests. Maya and Spaniard in Yucatan, 1517-1570*. Cambridge: Cambridge University Press.
- Cole, M. Sharp, D. and Lave, C. (1976). 'The Cognitive Consequences of Education: some empirical evidence and theoretical misgivings.' *The Urban Review*. vol. 9, No. 2, pp. 218-33.
- Crossley, M. (1983). 'Strategies for Curriculum Change with Special Reference to the Secondary Schools Community Extension Project in Papua New Guinea.' Ph.D Dissertation: La Trobe University.

- Cummins, J. (1986). 'Empowering Minority Students: a framework for intervention.' *Harvard Educational Review*, Vol. 56, No. 1, pp. 18-36.
- Delpit, L.D. (1984). 'Language, Culture and Self-Determination.' Ph.D Dissertation: Harvard University.
- Dennison, J. (1986). 'Distance Education and the Community College: some questions of theory and practice.' Report to the Faculty of Education: British Columbia University. (ERIC Document No. 276463).
- Duggan, S. (1984). 'The Perception of School: future directions of multicultural education.' *The Journal of Intercultural Studies*, Vol. 5, No. 2, pp. 15-29.
- Fien, J. (1989). 'Ideology, Political Education and Teacher Education.' Paper prepared for Parliamentary Education for Teacher Educators Conference, Canberra: October 1989.
- Giroux, H. (1981). *Ideology, Culture and the Process of Schooling*. Philadelphia: Temple University Press.
- Giroux, H. (1983). 'Theories of Reproduction and Resistance in the New Sociology of Education.' *Harvard Educational Review*: vol. 53, No. 3, pp. 257-93.
- Giroux, H. (1986). 'Teacher Education and the Politics of Engagement: the case for democratic schooling.' *Harvard Educational Review*, Vol. 56, No. 3, pp. 213-38.
- Gittinger, J. (1986). 'Mobile Computer Assisted Instruction in Rural Mexico'. Paper presented to the Annual Southwest Conference for Rural Education, New Mexico, February 1986 (ERIC Document No. 266903).
- Harding, S. (1986). *The Science Question in Feminism*. Stony Stratford: Open University Press.
- Harry, R. (1985). 'Mobile Training Laboratories, Mobile Equipment and Programs Offered in Business or Industry.' New York: Wiley & Sons.
- Kelly-Gadol, J. (1976). 'The Social Relation of the Sexes: Methodological Implications of Women's History.' *Signs: Journal of Women in Culture and Society*, No. 4.
- Klinger, K. (1983). 'Women's Mobile Campus.' *Educational Horizons*, Vol. 61, No. 3, pp. 129-32.
- Lancy, D. (1983). *Cross Cultural Studies in Cognition and Mathematics*. New York: Academic Press.

- McLean, P. (1989). *Linking Industry, Higher Education and Schools in Melbourne's West. The second intern evaluation report on Westcap's Mathematics and Science Cooperative*. F.I.T.
- Pomponio, A. and Lancy, D. (1986). 'A Pen or Bushknife? School, work and "personal investment" in Papua New Guinea.' *Anthropology and Education Quarterly*, Vol. 17, No. 1, pp. 40-61.
- Prince, J. R. (1969). *Science Concepts in a Pacific Culture*. Melbourne: Angus & Robertson Ltd.
- Saxe, G. (1985). 'Effects of Schooling on Arithmetical Understanding.' *Journal of Educational Psychology*, Vol. 77, No. 56, pp. 503-13.
- Schultz, D. (1988) *PRIMITE: a program for both student teachers and primary school children*. M.Ed (Studies) thesis, Monash University.
- Tkachuk, M. (1982). 'A Study into the Possible Use of Mobile Laboratories for Junior High School Industrial Arts and Home Economics', Report to the Alberta Department of Education (ERIC Document No. 222647).
- Vulliamy, G. (1981). 'Planning for SSCEP: a case study.' *ERU Report*. No. 38, UPNG.
- Vulliamy, G. and Carrier, J. (1985). 'Sorcery and SSCEP: the cultural context of an educational innovation.' *British Journal of Sociology of Education*, Vol 6, No. 1, pp. 17-33.
- Valli, L. (1987). 'All the Big Bosses are Men, All the Secretaries are Females', in M. Arnot and G. Weiner (eds), pp. 189-210.
- Wallace, C. (1987) 'From Girls and Boys to Women and Men'; in M. Arnot and G. Weiner (eds), pp. 237-252.
- WESTCAP. (1989). *Linking Industry, Higher Education and Schools in Melbourne's West. A WESTCAP Project*. F.I.T.
- WESTCAP. (1988). *The Mathematics and Science Cooperative (MASC)*. F.I.T.
- Williamson-Fien, J. (1987). 'Women, Politics and the Political Education of Girls', in L. Lewis (ed.), *Social Education and Political Literacy*. Monograph Series No. 3, Social Education Association of Australia, pp. 51-64.
- Zeichner, K. (1983). 'Alternative Paradigms of Teacher Education' *Journal of Teacher Education*, Vol. 34, No. 3, pp.3-9.