The Positioning of Mathematics in an Environmental Thematic Curriculum

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With a crowded curriculum, many primary schools attempt to integrate their key learning areas. One primary school in a large regional city has taken this a step further. Using the "environment" as the overarching theme, the key learning areas are interwoven into the teaching of the environment. This has presented some issues when attempting to teach English and Mathematics. These issues and the way the school and teachers solve them are documented in this case-study.

In a large regional city in Australia, a primary school has taken an integrated approach to teaching, using "the environment" as the overarching theme. The year four combined classes of around fifty students are physically isolated from the rest of the school. This is not the only way these students are separated. They have different clothing. "Enviro" clothes, which allow easy movement outside (within the environment), include gumboots, strong leather walking boots, trackpants, shorts, polo shirt and rugger top. The classrooms are open plan with large amounts of window which view the outside areas. A verandah area facilitates outside activities even in wet weather. Adjacent to the building is a very large section of fenced garden area, a smaller covered propagation tent, several compost bins and a worm farm. A garden shed holds a range of tools, buckets, hoses, nets and other implements used by the class.

Deakin University staff were approached by the school's principal with a view to record and document the progress of the "enviro" program across a school year. A team from Deakin, consisting of three researchers, became involved. Initial discussions took place with the teaching staff to negotiate their level of participation. It was envisaged that this could possibly be collaborative action research however the teachers did not want this level of personal engagement. The early discussions, held months prior to the start of the school year, allowed the participants to become more familiar with each other. At these meetings, the terms of contact were negotiated. Approval was reached for regular access to the site, all documents, the teachers, other staff, parents and children (assuming individual permission was given by all participants)

Methodological Considerations

The researchers were seeking to develop an understanding of an educational program, using an approach to help explain what was happening in the classroom as well as describing the events around the students' learning and the teachers' actions. Case study methodology was chosen to accommodate the complexity of this classroom situation. Within the classroom, there is a microcosm of attitudes, beliefs and aspirations, of both the teacher and the students. Case study methodology actively engages the changing dynamics of the classroom and its social settings (Campbell, 2000).

> Case study is a generic term for the investigation of an individual group, or phenomenon…(it) requires an in-depth investigation of the interdependence of parts and the patterns that emerge. (Sturman, 1999, p103).

The methodology "fits", and according to Rob Walker (Personal Communication, July, 1995), a leading international exponent of case study, if there is a good fit between the research problem/application and the methodology, then this is sufficient reason for choosing it.

> The case-study approach is particularly appropriate… because it gives the opportunity for one aspect of a problem to be studied in depth within a limited time scale. (Bell, 1999, p10)

The school setting could be considered a "bounded system" in a number of ways. It is physically isolated, students have their own uniform and the curriculum is unique. The time-table is developed to reduce the intrusion of other specialist areas. Additionally, the program is funded differently and separately from other school areas, to allow greater flexibility and to ensure that resources are readily available. Theoretically, it is a bounded system as the case-study was undertaken over a one-year time frame, the amount of time each cohort of students remains within the "enviro" year.

Stake (1988) discusses the value of case study methodology in such circumstances.

> The case study focuses on a bounded system, whether a single actor, a single classroom, a single institution, or a single enterprise - usually under natural conditions - so as to understand it in its own habitat. ... It is a complex dynamic system. We want to understand its complexity. (in Jaeger, R. 1988 p. 256)

The investigation, while focusing on the bounded system, was intended to clarify the range of inextricably linked educational, social and personal elements. The research methodology needed to be sensitive to the constraints and opportunities that presented within the research project; hence case study methodology was chosen. McTaggart (1987, p7) states that case study "is sensitive to particular contexts" and "could provide a better knowledge of educational phenomena in general" Walker (1980), who has defined case study as the examination of an instance in action, such as the study of particular events and actions, says the reason usually given for the selection of case study research is that it gives insight into specific occurrences.

> The study of particular incidents and events, and the selective collection of information on biography, personality, intentions and values, all of which allows the case study worked to capture and portray the elements of a situation that give it meaning. (Walker, 1980 p4.)

One of the intentions of the case study was to explore the tensions between the rhetoric of an integrated curriculum and the reality of the treatment of specific key learning areas. Mathematics was one such area investigated.

Methods-in Practice

A number of different data-collection tools were used. These included audio-taped interviews with all stakeholders – children, teachers, parents, other staff, and the school principal. Document collection, video-taping of activities, classroom observation and informal participation were other forms of data-collection. To minimize the affect of subjective interpretation of the data, "triangulation", a system of cross-referencing, was used.

> … many texts advocate that researchers should use a variety of methods alongside each other – an approach commonly referred to as "triangulation" where multiple methods may be used. (Burgess,1985)

The data has been interpreted with respect to the integration of mathematics into the integrated curriculum.

The Integrated Curriculum?

The "enviro" program follows the intended guidelines of an integrated curriculum, in which students "make connections within and across key learning areas" (Murdoch, 1998). The benefits of an integrated curriculum have been documented by a number of authors (Hamston and Murdoch 1996, Murdoch, 1998). An integrated curriculum can provide advantages to teachers and learners by:

- providing reflection on the interdependence between aspects of life in the real world
- challenging learners to use and develop thinking skills
- catering to various learning styles
- managing a "crowded" curriculum
- making more sense of learning, as activities have stronger links
- providing students with greater control over their learning
- structuring a meaningful context for teaching and assessment
- enabling students to transfer knowledge across contexts
- skilling students to process and respond to different experiences
- linking purposes with activities more explicitly
- enriching the learning environment

(adapted from Murdoch, p. 1, 1998).

Murdoch (1998) indicates that the use of "meaningful, connected contexts" allows for the development of skills, values and understandings in children's learning. Robottom (Personal communication, November 2001) further comments that "An integrated curriculum is usually informed by constructivist principals of children's interests, engaging local topics and acknowledging learners' biographies"

An advertisement placed in a local newspaper described the program as:

> …an ambitious educational program that gives Year 4 students a profound experience in learning about the environment in addition to the core curriculum areas of literacy and numeracy. (The Geelong Independent. p9, 2002)

It became clear early on in the case-study that the Enviro program was not truly a fully integrated program. There were still discrete English and mathematics lessons. The mathematics consisted of three, forty-five minute sessions each week, which the teachers called "number" mathematics. The students were streamed into three ability groups for mathematics and each group had its own teacher. Students were tested as they moved through specific topics to determine whether they stayed within the same group or moved up or down the hierarchy. However, that said, the teachers did integrate environmental topics into the "number" mathematics and also mathematics into the "enviro" sessions which occurred during the rest of the school day. One teacher had the primary responsibility of the "enviro" theme whilst the other had the responsibility of keeping track of the students in language and mathematics.

Teachers' Views

The teachers had their own ideas about an integrated curriculum, believing that learning was embedded in the activities undertaken. Whilst they did have separate English and mathematics classes, they felt that most of the learning actually occurred outside of the formal learning process.

> People say to me, "Don't you want to structure your maths, your English" and I say "Well I could", but I think, I try to teach in a way that the kids really enjoy and love what they do, they learn it and I don't know why, or how, but they do and you know they will. (Interview PJ, 29 Jan 2002)

When asked about their program, the teachers indicated that there were several reasons for keeping some English and mathematics as separate areas. School policy states that there will be an emphasis on the core curriculum areas of mathematics and English (Interview PT, 12 December, 2002).

> … but it's not our decision anyway. I mean, to change it, we would have to change school policy… (DW speaking about the reason behind the more traditional approach to maths, Interview 13 July 2002)

Another, equally strong, reason, related to the perception of parents. In an information session carried out before the inception of the program, parents indicated that they would support the program if they could be assured that their children would not miss out on the core areas.

> The three periods of maths each week help with the parents' views that their children were not missing out on fundamentals. (Interview, PJ, 7 March 2002)

As well as these two reasons, there seems to be a reluctance on the part of one of the teachers to take a stance which is in conflict with that of the parents and school policy.

> You have to go against the philosophy; it goes totally against the philosophy. I honestly, in a practical sense, just think it's easier to have the three structured (maths lessons) and then integrate the others where we can. (Interview, DW, 13 July 2002)

However, apart from the set lessons, there appears to be a large amount of mathematics integrated into the activities undertaken by the students. It was observed during some of the activities that children were collecting "worm juice" (the wet material that drains from the bottom of a wormery) and measuring the quantity obtained. When speaking with one of the teachers, he commented on how mathematics was integrated using the wormery as an example:

> …in recording the worm juice, the boxes and the cans so that's being recorded for the whole term and then next week they're going to have to graph that information and make some statement about why the difference. (Interview, DW, 13 July 2002)

He went onto explain how the students then sold the worm juice to the school community for fertiliser. In doing so they had to work out from the cost per litre, just how much to charge for different sized containers and had to handle and calculate the money received. This money was then used to support an environmental project of the students' choice.

In discussing the integration of the mathematics into the curriculum, one teacher indicated how the other teacher handles it without putting a mathematics slant onto the task. He commented "So he doesn't see it as a Maths lesson… So he will do that quite

naturally…" (Interview, DW, 13 July 2002). Other observations within the classroom indicated that the children were taking measurements of the fishtank and trying to determine the amount of water needed to fill it. They calculated the amount of timber needed to make bird boxes and then applied these measurements to the task of making the boxes (with parental assistance). There were many other instances of the children being involved in informal mathematics through comparing, collecting and sorting, measuring, estimating and problem solving.

At the end of the first year of the program, one of the teachers undertook a standardised assessment of the students to determine their level of mathematics' knowledge and understanding (Interview, DW, 7 March 2002). From this, and by comparison to previous cohorts of year four students, he was able to draw the conclusion that the students were in fact, not missing out on any formal mathematics concepts.

Students' Views

Not surprisingly, when asked about the mathematics they did, all students commented on the three mathematics lessons within class time. Not one mentioned the mathematics integrated into the other activities. Comments included:

> …we do drama and maths… (Interview, Child A, 13 June 2002)
>
> We do maths but it's mainly to do with stuff that we need to improve and we do a test each time to see if we go up a grade or go down. (Interview Child A, 13 June 2002)
>
> In maths we learn fractions at the moment. (Interview, Child S, 13 June 2002)
>
> Last year… …we did two sessions a week I think and they went for an hour. These sessions are smaller but they go for 45 minutes… (Interview, Child S, 13 June 2002)
>
> We recycle paper and make it again and sell it (Interview, Child H, 13 June 2002)
>
> …we made a map… (Interview, Child H, 13 June 2002)
>
> We just did a map of the "enviro"… (Interview, Child S, 13 June 2002)
>
> …and I measure the sun flowers all the time now … (Interview, Child S, 13 June 2002)

The students had a very narrow interpretation of mathematics, accepting that it meant the formal mathematics of their three sessions a week. Despite asking students to expand their explanations of the mathematics they did across a day, they did not seem to recognise the informal mathematics undertaken during "enviro" tasks.

Parents' Views

Overall, the parents who responded to the surveys, who participate in class activities and who have discussed the enviro program with the researchers both formally and informally, have given sound approval to the way the program is set up. They see the benefits in that their children have a broader interest in the environment and have a deeper understanding. They approve of the way children are given some autonomy and are required to be more self-disciplined. They also comment on the life skills and technological skills children are gaining throughout the year.

As mentioned earlier in this paper, parents' views have been largely instrumental in shaping the way mathematics has been retained partially as a separate area within the "enviro" program. In keeping mathematics as separate lessons, the school is acknowledging the strong accountability it has to parents and to parents' satisfaction levels.

Interestingly, in discussions with some of the parents, it is always "other parents" who wish for mathematics to be kept separate. It is "the conservative parents" who still have a "traditional" idea of schooling and "still want traditional streaming" (Parent Interview, 18 November, 2002). There was a point made that in the initial meetings, before the "enviro" year started, most of the parents were very concerned that the basics of mathematics and English be maintained. However, as the year has progressed, many parents have become more comfortable with the way the whole program is running. They have acknowledged that the teachers have "the ability to incorporate those core subjects into other areas" (Parent Interview, 18 November, 2002). Having spent some time at the school, the parents have also seen that there is "even more focus this year of environmental into the core units" (Parent Interview, 18 November, 2002).

One parent commented that she thought that there should be no formally structured mathematics lessons (or English) at all. She felt that the strategies used for integrating the knowledge and skills throughout the rest of the class time were more than adequate to provide the students with provide the students with meaningful learning.

> I would like to see everything involved in the "enviro", not have separate maths at all. … I would like to see it all incorporated. … I think the children still learn through the other different methods. (Parent Interview, 18 November, 2002)

It is interesting to note that the other parents involved in that interview did not verbally concur with what she was saying. Tacit approval is given to the way in which the core subjects are currently managed.

What the Principal Says

The school principal, when asked her views of the program, indicated a high level of support for the "enviro" program saying that "learning has to be embedded in the context and enlivened by the context". She had a clear sense that the program was successful because the "extras" had been removed, but that the program still offered "strong literacy and numeracy features". She considered that the emphasis on the environment had replaced the more marginal curriculum elements rather than the fundamentals and indicated that maths and language had to be built into the program.

> … maths has been reinforced though the environment, using elements of the environment to be able to develop their concepts in maths. … nothing but strengths emerge. (Interview, PT, 12 December 2002)

She commented that it was clear from the first year that mathematics and English were not being downplayed and based this on the reports of her teachers.

In discussing whether parents had complained about the level of mathematics in the curriculum she commented the she had heard of any complaints and that she felt certain that she would have hears if there had been any difficulties.

Concluding Comments

What have we learnt from our case-study? What are the issues arising from the way the program is run?

One of the things which we noticed from our observations of the school, is the fact that all those we spoke to, or interviewed, were extremely happy with the way things were. The principal was pleased that the program appeared to be successful in generating a deeper understanding of the environment. School surveys and parent-teacher interviews provide her with this information. In other ways the program has attracted a lot of attention to the school and enrolment figures for that year level have increased substantially. The school has a commitment to the environment which is apparent in other offerings it has, most of which were in place well before the commencement of the "enviro program". In terms of mathematics, the retention of three separate lessons indicates that the school is tending to "the basics", at least in appearances. However, the principal is a highly educated teacher, who would know of the research literature relating to the benefits of a fully integrated curriculum. For a number of reasons, already mentioned, she chooses to support the model of partial integration.

The teachers, both of whom are passionate about the program and spend a considerable amount of their own time in ensuring its success, are highly motivated to provide the students with the best learning experiences they can. They are not overly concerned about the "number" mathematics sessions they have to conduct. They believe the lessons serve a purpose in keeping the parents happy which inturn allows them to continue running the rest of the "enviro' program the way they want. In addition, it gives them the opportunity to appraise students' mathematical knowledge using standard testing procedures – a form of safeguard. However, given support, both would be prepared to attempt full integration. From conversations throughout the year it was clear that they both believe in the benefits of an integrated curriculum.

The parents appear to be positive in their response to the dedication of the teaching staff, the way the program is run and the learning opportunities the children are experiencing. However, the safety of having the core subjects of English and mathematics covered in set lessons appeals to their more conservative natures. In an extreme case, in a recent telephone conversation with a parent, she expressed concern that having a minimal number of mathematics lessons may damage her child's knowledge for some years down the track. A lack of knowledge about teaching and learning is often what guides parents to accept a more familiar pathway in the education of their children.

From comments that the children made, it is clear that they appreciate the relative freedom they gain within the "enviro" year. They enjoy the hands-on approach of much of their learning and many commented on having to take responsibility for themselves (Interview, Child S, 13 June 2002).

All indications are that this is a successful program as it is. One wonders whether having a fully integrated curriculum would improve it? It would seem however, that for this school at least, the question will not be answered.

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