Numeracy education through mobile apps

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Another year of engaging with middle years learners has begun in earnest. Building new relationships, developing new programs and focusing on involving our students in deeper and more relevant learning; all in a day's work for a middle years educator. The 21st century skills – ‘The 4 Cs’, communication, collaboration, critical thinking and creativity - integral to learning today, provide a valuable basis when working with our middle years learners, and in my view, are a major consideration when developing any program of learning for young adolescents.

A journal, such as this, supports educators in that quest. It provides important research, informs of successful programs implemented by colleagues and encourages others to take some risks, consider innovations and to simply ‘have a go’; the ultimate aim, to make the learning more significant and provide the skills and access to knowledge that will enable success both in the learning at school, as well as our student’s futures.

This edition of the Australian Journal of Middle Years of Schooling offers some innovative ideas and valuable examples of programs being implemented in a number of schools across Australia. The Focus on Schools section presents articles that explore learning structures, from physical, social, emotional and academic viewpoints. One particular article outlines the success experienced by students (and their teacher) when engaging in Gaming. The extent of learning and excitement is clearly palpable; the 4 Cs abound. 21st century skills continue to be a theme in this section, with additional articles showcasing a unit of work where invention and design is fused with real world issues, and another that highlights a teacher’s leap into project based learning with her photography, design and art unit.

Useful articles relating to Maths and numeracy are presented in this edition, one in our refereed and the other in the non-refereed section. Both present research that support a need for focus on teaching and learning approaches in the middle years and provide some ideas for guidance in this critical area.

The research presented in our refereed section is timely. Dowden’s paper provides some useful research and review of curriculum integration (CI), particularly for secondary school teachers, where a departmentalised culture often creates barriers to its successful implementation. It provides much food for thought and some clear ideas for guidance in this critical area.

I challenge our readers to share these with colleagues to spark meaningful conversations and development of programs that focus on engaging the young adolescent learners in our care.

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Journal Editor
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The views expressed in this journal are those of the individual contributor and do not necessarily reflect the views of the Publications Sub-committee or the Middle Years of Schooling Association (MYSAS)

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Abstract
There is widespread agreement at the policy level that systems of education should be inclusive of an increasingly diverse student population; yet research indicates this to be a deficit area in teaching and learning practices. This research paper employs the sociocultural concept of ‘funds of knowledge’ to consider how teachers draw upon their unique experiences to frame student diversity, particularly related to student ability. We interview four teachers in middle years teaching roles and use content analysis to reveal the ways in which the teachers recognise and name student ability and how this impacts on their practices in relation to teaching and learning. Findings reveal that the teachers describe student ability in ways that reflect their funds of knowledge including aspects of their past, present and future notions of self. Two of the teachers drew upon institutional categories of student diversity that reflect a traditional approach to teaching and learning in order to describe their present practice and to envision the future – an approach to practice that they would have been enculturated into and which serves as their frame of reference. The other two teachers, both of whom are recently educated in the ways of their craft, constructed student diversity in terms of their own pedagogical practice. For them, practice draws on their recent university studies and on past experiences of self to envision a more egalitarian future for themselves and for their students. This research provides an insight into a promising future in addressing the challenge of enacting truly inclusive practices to meet the needs of our diverse student population. Furthermore, it reveals that teachers’ funds of knowledge shape their understandings and practices in ways that can be either limiting or enabling, and that this range of diversity of teacher views is currently being played out in classrooms.
Introduction
There is widespread agreement at the educational policy level that systems of education should be inclusive of an increasingly diverse student population. UNESCO identified a focus on ‘Education for All’ and the importance of access to quality education by developing inclusion guidelines (UNESCO, 2009). Over the past few decades educational researchers have devised schemes to describe different learning styles, learning modalities, and approaches to study among students. However, evidence collected from various countries (Fullarton & Lamb, 2002; Hallam, Ireson, & Davies, 2004) has indicated that teachers seldom incorporate recognition of student diversity in their everyday teaching practices except in terms of levels of achievement or ability. This focus is supported by the implementation of state, national and international testing of student achievement and the increasing availability of national and international benchmarks. Schools and school systems have sought to develop school improvement agendas identified by researchers that deliver different outcomes in terms of student literacy, numeracy and science achievement (Maltese & Hochbein, 2012).

This focus on student diversity as level of achievement was reaffirmed in a landmark, large-scale, observational study of classroom in Queensland, Australia (Education Queensland, 2001) more than a decade ago that resulted in the development of the Productive Pedagogies framework. This framework was used to assess practitioners’ alignment to 20 pedagogy items arranged into four dimensions: intellectual quality, connectedness, supportive classroom environment, and valuing and working with diversity. Importantly, evidence of all four dimensions in classrooms is considered to provide optimum conditions for enhancing learning (Lingard et al., 2001). Of the dimensions, ‘valuing and working with diversity’ was the ‘one aspect of the model that has been the source of much debate … [as] very few of the items that make up this dimension were observed in classrooms to any great extent’ (Mills et al., 2009, p. 70). Since 2001 the Productive Pedagogies framework has been used extensively in a range of other research projects. In 2008 it was used again to establish a benchmark for teaching and learning in the middle phase (Years 4 to 9) in Queensland schools (Goos et al., 2008). Again, this study confirmed that ‘[i]n all year levels the lowest scores were found in the valuing and working with difference dimension’ (Goos et al., 2008, p. 7). The study noted that teachers did not lack commitment to valuing students’ difference, but that ‘at times they were afraid of getting it wrong’ (Mills et al., 2009, p. 70). This level of teacher concern that subsequently carried through to deficits in teaching and learning practices related to working with difference serves as a major imperrus for our study.

Difference as ability
Recent policies in many countries that require the comparison of student performance on tests across schools and districts have accelerated the trend for teachers to reduce considerations of diversity to levels of ability. Recently this approach to diversity has been privileged even further in Australia. It is characterised by reductive notions of learning underpinning neo-liberal managerialist practices that are becoming increasingly evident in both policy responses and the everyday media (K. D. Gutierrez, Azaro, Santos, & Cotton, 2002). For example, in early 2007, the Queensland government proposed to mandate streaming of students in Year 8 in order to improve learning outcomes in mathematics and science (Livingstone, 2007).

The policy push for ability groupings at Year 8 is noteworthy. Year 8 fits in the centre of the range of years typically termed the middle years, inclusive of students aged 10 to 15 years. There has been considerable discussion of late about the connection between diversity, teaching practices, and student disengagement from learning. For instance, the Melbourne Declaration on Educational Goals for Young Australians identifiers ‘enhancing middle years development’ as one of eight areas for action. In the declaration the importance of the action is explained as follows:

[M]iddle schooling is an intentional approach to teaching and learning that is responsive and appropriate to the full range of needs, interests and achievements of middle years students in formal and informal schooling contexts (MYSAs, 2008).

Therefore, the purpose of our research has been to explore this policy–practice dilemma – a policy that recognises and indeed celebrates student diversity, but a set of policy prescriptions and teaching practices that restrict consideration of student diversity to differences in ability based upon test scores. Our broad set of aims in the research project is to document how middle years teachers recognise and ‘name’ student differences and how this flows into their pedagogical practices. In this paper we focus on the issue of ability as a dominant framing of diversity by teachers.

Funds of knowledge and agency
In researching teachers’ views of diversity, we have employed the sociocultural concept of ‘funds of knowledge’ (Gonzalez et al., 1993) to refer to historically developed and accumulated strategies or bodies of knowledge that are essential to the functioning of a community. Similarly, Moll (2000) describes funds of knowledge as the cultural artefacts and bodies of knowledge that underlie everyday activities and practices. In these studies, ‘funds of knowledge’ was used in relation to research on students’ knowledge and the knowledge resources of their communities. The focus was on how teachers can transform the practices by developing an awareness of their students’ repertoires of knowledge and that of their community. In our research, however, we focus on teachers, and how funds of knowledge are deployed in accounting for diversity in teaching practices regarding diversity. We employ funds of knowledge as a potentially productive analytical construct, while remaining cognisant of the possibility for essentialising.

We understand these funds as being dynamic, emergent and interactional (Gonzalez, 2005). What funds of knowledge are deployed by teachers? How do they vary between teachers? How do teachers take up critical stances towards and within these funds of knowledge?

The last question invokes the notion of teacher agency. In accounting for various schooling practices, teachers can adopt different stances towards the practices they might be reporting. We are interested in which funds of knowledge enable them to critique and resist the official practices and policies in dealing with diversity in their school. Edwards (2000) in her discussion of the four intertwined themes of sociocultural research, identifies agency as one of the central themes and argues that it is synonymous with a person’s way of being, seeing and responding in the world. Edwards suggests that personal agency is embedded in contexts of activity and interpretive practices. Agency draws on ‘funds of knowledge to both interpret and respond to the environment’ (Edwards, 2000, p. 199). We have adopted Edwards’ view of agency as embedded and interpretive. We included it as a key analytical focus here because teachers operate in institutional settings where their professional actions and judgements are constrained by various policies and procedures. They may or may not agree with different practices and they may (or may not) subvert official policies and procedures in subtle and explicit ways. To use the ‘master versus appropriation’ distinction proposed by Wertsch (1998): teachers may have mastered particular official ‘funds of knowledge’ and may be able to deploy them; but they may or may not have appropriated them or agree with them. We are interested in uncovering this aspect of agency and tracing its roots in different funds of knowledge deployed by teachers.

Voice
In analysing the talk of teachers with these key research questions in mind, we drew also upon Bakhtin’s (1981) notion of voice. Voices are cultural tools that are always shaped, produced, and consumed in relation to broader social and cultural conditions, and inevitably involve issues of identity for the speaker. Our data – that is, the interview transcripts between the researchers and the school teachers – contain social and pedagogical categories that are heteroglossic. Teachers are not viewed as stable and unified figures representing a set of dominant discourses. These texts
or utterances represent meeting places of a range of discursive practices, sites of heteroglossic articulations of various historical, class, and cultural interests competing for power and capital of various types. Overlapping and contradictory voices are evident in the production of institutional and pedagogic practices (Cormack & Comber, 1995). In the process of answering questions and providing accounts of classroom practices, the individual voice of the teacher and the social voices that s/he draws on are always mutually reconstituting. The unit of communication, the utterance, is not only a site where the person and the personal and the social meet, it is a point of articulation and suture between discourses and practices, which produce subjectivities and the agency of the individual to take up these practices. We are interested in the types and range of voices ventriloquiated by the teachers as they talk about their practices in relation to diversity. If there is a diminution in the richness of ways of talking about students, why is this so? Have the voices that teachers deploy been restrained or constrained by institutional practices and procedures? In analysing the teachers’ talk we consider whether they speak as a member of the institution reporting official practices and procedures or whether they adopt different speaking positions to critique the practices, and how they situate themselves in different imagined contexts of time and place (past experiences or future possibilities) in order to resist the present practices.

The study
The study theorises diversity as an aspect of institutional and sociocultural practices, rather than a set of inherent individual traits (K. Gutierrez & Rogoff, 2003). Thus, student diversity involves issues of identity and power as it is produced and situated in classrooms and schools while also being constituted and constituting the broader context and the differential status of students’ home communities (d’Abreu, 2005). This view is captured by Cobb and Hodge’s (2002) description of ‘relational diversity’, which encompasses a range of complex issues that become evident when individuals who are members of various local communities and broader groups in wider society come together and participate in classrooms.

Data collection
Four teachers from four separate schools were chosen on the basis of (i) teaching a range of middle years classes (Years 5 to 9) and (ii) catering to a community where incomes were variable and where there had been recent mobility. In eliciting teachers’ funds of knowledge regarding student diversity we interviewed each in a one-on-one situation in a quiet place at their school. We used open-ended questions such as, ‘How would you describe the students in your class?’ We were also interested in how they deal with such diversity in their teaching practices, so we included questions on whether and how they grouped children, and whether they deployed any schemes regarding different approaches to learning or study styles and modes in planning their teaching activities. The interviews were between 30 minutes to an hour in length. Interviews were transcribed in fine detail in order to facilitate the initial application of content analysis and subsequently other forms of discourse analysis.

The cases
The four teachers, with the pseudonyms Tony, Keith, Jane and Ann, came from different schools. They each had an alternative viewpoint to express but deployed quite different voices in expressing their distinctive forms of agency. We have used short labels to describe the ‘teacher identity’ adopted by the four teachers as a device to communicate some general features of their sense of identity. The four teachers were selected from a larger number of interviewees as they depict the type of polarity in the funds of knowledge and the effect of their experience on understanding student diversity.
Tony – ‘the fixer’

Tony is an experienced male teacher who has taught for what he describes as ‘decades’ in a variety of schools across different parts of Australia. Tony teaches at Hydrangea School (pseudonyms for the schools have been used throughout), a Catholic school in the northern metropolitan suburbs of Brisbane. The school caters for almost 600 preschool to Year 7 students with the majority (88%) from English speaking, middle-class families. During the interview he recalls an incident in his teaching career, stating:

‘[They needed …] some straightening out so they said “Would you (Tony) go in and do it?”’

A number of statements such as this led us to use ‘the fixer’ as a description of Tony’s identity as a teacher. As a male teacher in a predominantly male teaching profession, Tony presents himself as the teacher who is expected to manage difficult student behaviour. He also presents as a teacher concerned to bring wayward students back into the mainstream – ‘to fix’ them so they could participate in the normal routine activities of schooling. In doing this work, he.deploys local cultural resources, such as the appeal of football and sporting activities, particularly to boys, as a way of getting ‘them’ back into line.

In the first part of the interview, he talks as the institutional representative. He demonstrated a ‘masterly’ of the institutional categories used to sort students into groups at the school. He describes students in terms of gender and ethnicity as well as family structure associated with disadvantage (single parents), and deficit language resources (the English as a Second Language students). These categories have particular institutional salience because funding is tied to the number of children ascertained in specific categories. He provided no commentary on these categories. In talking about how the classroom operated, he returned repeatedly to a hierarchy based on ability. He talked about outcome levels (distributed on a five point scale) and used hierarchical terms to describe types of students in his classes, for example, middle, above middle, middle down. While he deployed these hierarchies without apparent resistance or parody, he also showed minimal personal investment in this institutional script. However, he did show some resistance to the institutional reporting format (outcomes), by revocing the parents’ view that this was a difficult format to interpret.

At this point in the analysis, Tony seemed to be comfortable in adopting the current emphasis on grouping by ability and working in hierarchical categories. In recalling an episode from his past, where he was the ‘boss’ (principal of the school), he provided a strong critique of student labelling and ability grouping. He claimed that ‘every kid deserved to start with a clean slate’. He took up a strong stance and an unpopular stance in this institutional script. The interview took place in her first year of teaching. We call her ‘the transformer’ based on her overall approach to teaching. In summing up her view of teaching and student diversity, she said, ‘I guess it’s about the formation of different kinds of learners.’

This statement captures Ann’s understanding that students are formed as different kinds of learners by the practices they encounter in schools. She works in a school where the practice of journeying was deployed as official policy. Journeying involved placing students from a cluster of same-grade classrooms into ability groups for key subjects such as mathematics and English. Ability levels are determined by tests administered at the beginning of the year. Even though journeying is official policy Ann stated bluntly that she did not follow the practice. This resistance was based explicitly on her teacher education. She describes in her interview how she had read literature research on the self-fulfilling effects of ability grouping. In response to the researcher’s question, ‘Why don’t you journey?’ Ann stated:

(Well, the literature says not to – the writings of Boiler and Slavin. We (the school) stream. Year 1. Once you are in the bottom class, you never get out of it from what I have read. We have seven Year 5 classes and they are streamed into top half and a bottom half. You will hear teachers refer to the ‘lowies’ – that is the type of language they use."

Ann separates herself from her colleagues (that is the type of language they use) by drawing upon research evidence and her confidence in specific experts. But she not only draws on evidence from experts, but also from research literature. Ann can also give an account based on her experience as a teacher. In the interview, she comments that not all students are able to cope with her inquiry and group work approach to teaching. Two new students who were moved to her classroom from another teacher, were described by Ann as self-assured learners who are comfortable and competent doing algorithms and worksheets, but unsure of how to participate competently in inquiry modes of learning. Ann’s understanding of diversity is relational and contextual. Diversity is framed by her as an aspect of pedagogy. Difference is produced through classroom practices rather than being a pre-condition that has to be taken into account.

Jane – ‘the discussant’

Jane is also an inexperienced teacher in her first year of teaching. Her pre-service professional experiences involve teaching in classrooms with large numbers of Samoan, Tongan and Aboriginal students. Although the school where she currently works, Begonia High School, now has a diverse student population, by comparison she claimed that there was a ‘severe lack of diversity’ – that this was a homogenous community – ‘a very white Australian school’ with two percent of students coming from families where English is an additional language. Begonia High School is located in a provincial region of Queensland, south of Brisbane. It has a student population of just over 1,400 students with the majority from English speaking, middle-class families. In her interpretation of diversity she revoiced the category of both ethnicity and socioeconomic diversity, but neither was seen as problematic or as something to be fixed. Indeed, her view of diversity was very positive and it was constructed in terms of a variety of resources to be drawn on in the classroom.

Managing diversity for this teacher was about pedagogy, not about sorting and streaming students. Interviews with other teachers at this school reveal that there has been a schoolwide focus on re-engaging students. This voice is appropriated enthusiastically as Jane reflects on her pedagogy and her desire to engage the students. ‘I also try to get them more involved rather than just me just telling them, so that it’s an exploration of their own knowledge.’ She emphasises the importance of class discussions, group work and individual work. Naming Jane as ‘the discussant’ summed up her view of the ways she engages students and her teaching style, ‘I’m more or less a discuss it kind of person. That’s the type of thinking. Class discussions are a way of constructing knowledge and engendering intellectual quality. She identified leading discussions as a strong point in her teaching, as evident in the comment:

‘I find my questioning in the leading trains-of-thought or extending trains-of-thought much more beneficial than getting them to write down their stuff, and then being able to then use and, like answer, to then lead into something else.

Her flexibility in meeting her teaching objectives also reveals the strong centered approach that she takes. She is prepared to go with the students and is not tied to teaching objectives sequentially. Thus, her view of students was not based on fixed traits, based on individual differences like ability, but on providing ways of participating in the classroom, very much like Cobb and Hodge’s (2002) description of relational diversity. This was also evident in her response to a question about her use of frameworks, for example, multiple intelligences. She talked about these frameworks as useful devices for identifying different thinking processes rather than identifying students as having different ways of thinking, and talked about the processes required for teaching to come through the thinking.

Ability grouping was not the way of talking about diversity used by this teacher until it was brought up in the interview, and then she did talk about the range of abilities in her

Tony’s experience in another time/place enabled his agency here. There is more than mastery of institutional categories in this account of his past. He took a stance that placed him at odds with his colleagues, and the stance was informed by an explicit moral stance, expressed in the comment, ‘every kid deserved to start with a clean slate’.
class. She indicated that the school does have a remedial class for the ‘lower kids’, which provides kids with ‘closer attention’. She did not take up the teacher’s stance other than by describing the students as ‘lower kids’, who, she said, were capable of achieving. With support students could achieve; ‘lower kids are made aware of what is necessary to get to that A’. Ability is not viewed as a fixed trait but as a corollary of pedagogy.

The school population is comprised of students from diverse socioeconomic groups. Jane constructed these differences in terms of the kind of support parents were able to give their children, as noted in the following comment:

For Jane, the relationship between teacher and student is central to her work as a teacher, and like many teachers, identifies teaching as one of the ‘caring professions’. Like many of those in caring professions (e.g. nursing, social work) she revoirs the mantra of ‘maintaining a professional stance’, by keeping one’s distance in relationships with students in order not to get hurt. Like Ann, Jane’s understanding of diversity was relational and diversity was framed as an aspect of her pedagogy – difference was produced through classroom practices and pedagogy. This view she attributed to her personal experiences as a pre-service teacher in ethnically diverse schools and also her experience of being an Aboriginal person.

Keith – ‘the old school’

Keith is an experienced male teacher of science and mathematics who has taught for over 10 years in the senior years of schooling. He teaches at Marigold High School, a government funded Year 8 to 12 school in the suburbs of the Gold Coast. The school caters to 1,000 students largely from English speaking, middle-class families. At the time of this interview, Keith, was teaching Year 8 students because of the philosophy of the school in which he was now teaching. This is explained in the comment:

I am mainly senior science but a small school philosophy is why the principal believes that all teachers must teach in the middle school at some stage. You might not teach them all year, but you should do your time there.

The term, ‘do your time’ implies Keith’s stance to the school and his reluctance to teach in this area of schooling. An area where he has had some issues, for example he recalls an incident in the teaching where a Year 8 student expressed fear of him. He stated, ‘I am old school, bit more traditionalist. I try to have the discipline well-structured and I might bark occasionally.’

Statements such as this led us to use the phrase ‘old school’ as a description of Keith’s identity as a teacher. As a traditionalist, Keith sees students in terms of ability and supports grouping students by ability because it allows him to transmit curriculum knowledge more adequately:

I actually favour that because I am a bit of an advocate for putting kids into like-ability groups. Um, mainly from the point of view that you know the level, you know the target of your kids, and you can prepare adequately for what they need.

One consequence of favouring this view of diversity is that Keith sees issues related to student ability such as ‘attention span’ as being problematic to his transmission of curriculum content and as requiring him to spend time changing modes of instruction in each lesson. This is evident in the following comment:

But diversity is like you use the textbook and puzzles and do oral questioning and you can talk to the kids about particular issue that involves maths, so you really do need to change your strategy, change your tack periodically at least to keep them a little bit interested and focused, they won’t last long and you have got to appreciate that the kids with the less ability or haven’t had the confidence or the success turn off quickly in some areas they don’t understand, that’s it.

This use of time is seen by Keith as being ‘worrying’ as it takes quality teaching time away from ‘high ability’ students who are the future and deposits it with the ‘low ability’ students who are seen as being ‘needy’:

[I]n general I think the kids that are at the upper level with the ability to learn quickly, and that can process things are left out in the mainstream, they are just not looked after, and that’s what that is what worries me. These are our future and yet we are focusing on the kids that are more needy.

As a male teacher with a predominately traditionalist approach to teaching, Keith presents himself as a teacher who has expected to manage the transmission of curriculum knowledge to a broad range of students in his Year 8 class. He also presents as a teacher concerned to bring a focus on ‘high ability’ students back into the mainstream of schooling, so they could work towards securing Australia’s future.

In doing this work, Keith took up a professional teacher voice by describing his use of a variety of teaching resources such as textbooks, puzzles and oral questioning techniques as a way of keeping students focused on the task of processing curriculum knowledge. Although he demonstrated mastery of this voice, his stance indicated little support for this way of teaching as he indicated that by using these techniques, he was disadvantaging the ‘high ability’ students in his class.

In the interview, Keith talks as an institutional representative. He demonstrates a ‘mastery’ of the institutional categories used to sort students into groups at the school. He describes students in terms of ability, gender and family structure (e.g. single parent families). Keith not only endorses streaming, but goes on to advocate a strong moral stance that proffers ‘high ability’ students as being ‘our future’. In talking about how his Year 8 classroom operated, he returned repeatedly to a hierarchy based on ability. He talked about ‘ability’ as being the pivotal point in the relationships that he had with his students, a point that determined for him what it meant to ‘prepare adequately’, to provide work that was of a ‘suitable standard’ and was the basis for establishing criteria whereby progress in learning could be measured and made ‘more satisfactory’. For Keith, this approach to teaching was well accepted by ‘high ability’ students, but became problematic when he was required to manage learning relationships with ‘lower ability’ students who saw this approach to teaching as being ‘a bit abrupt’ and ‘frightening’.

As such, Keith’s experience as a ‘traditionalist’ teacher of senior school mathematics and science enabled his agency in his Year 8 classroom. There is more than mastery of institutional categories in this account of his teaching. Through his appropriation and endorsement of this way of managing students, he took a stance that placed him at odds with his ‘lower ability’ students and their parents, and the stance was informed by an explicit moral stance, expressed in the comment, ‘These (high ability kids) are our future and yet we are focusing on the kids that are more needy.’

Discussion

The purpose of our research was to explore the funds of knowledge that teachers draw upon to frame student diversity in the middle years of their schooling. The aim of this paper was to document how four middle years teachers (Tony, Ann, Jane and Keith) recognised and ‘named’ student ability and how this impacted on student learning. This documentation was enabled through employing the sociocultural concept of ‘funds of knowledge’.

The funds of knowledge employed by Tony to described student ability, those from a more traditional sense of teaching that employed hierarchical categories such as low, middle and high, and those from a more relational sense that refer to student confidence and wellbeing, display Tony’s mastery of institutional categories that teachers use to talk about student diversity. However, Tony was not an advocate for grouping students by ability nor did he support institutional accountability mandates that require teachers to report on a myriad of outcomes that a student may achieve in the classroom. As such, Tony, although displaying mastery has not appropriated institutional ways of talking about student diversity. For Tony, it is the teacher-student relationship that impacts on student learning – a relationship that is built on the
premise that ‘every kid deserves to start with a clean slate’. This framing of student difference in terms of ‘positive beginnings’ locates the agency in the relational activity of the classroom. However, unlike Tony, the funds of knowledge that Ann draws upon to understand diversity, professional literature and teacher expertise, are also contextualised around her pedagogy. Difference, for Ann, is produced through classroom practices rather than being a pre-condition of students that needs to be ‘fixed’. For Ann, students formed in different kinds of learners by the practices they encounter in schools, an understanding of the teaching-learning relationship encapsulated in her statement, ‘I guess it’s about the formation of different kinds of learners.’ This framing of student diversity in terms of pedagogical practice allows Ann to resist the ‘journeying’ philosophy of her school and provides a sense that teaching for Ann is about ‘transforming’ students, that is, that teaching is about extending student diversity in terms of ability. For Keith, the funds of knowledge that the teachers featured in this paper draw upon to describe student ability reflect aspects of their past, present and future notions of self. For teachers that were educators some years ago such as Tony and Keith, it is not surprising that they draw upon institutional categories of student diversity that reflect a traditional approach to teaching and learning to describe their present practice and to envision a future – an approach to practice that they would have been encouraged into. For teachers who have been more recently educated in teacher education such as Ann and Jane, it is noteworthy that student diversity is constructed in terms of their own pedagogical practice. For them, their present practice draws on their university studies and on past experiences of self to envision more egalitarian futures for and themselves. This approach aligns with the UNESCO vision of ‘Education for All’ (UNESCO, 2009) and a broader notion of inclusion beyond that of ability. Our findings suggest that teachers will employ funds of knowledge that focus on the relational aspects of the teaching-learning relationship as long as these funds of knowledge are supported in their school communities. It is our observation that, for some teachers, the framing of student diversity in terms of ability is a consequence of perceived accountability requirements to standardised testing regimes, a repertoire of practices that rarely permits teachers to manage student diversity in a manner that promotes the development of teaching practices that go beyond the traditional. It is hoped that some of these teachers will follow Ann’s and Jane’s example and use aspects of Productive Pedagogies to work with and value difference in their classrooms, even though it is regarded as a challenging aspect of their teachers’ work. This is an imperative that must be achieved if the goals of the Melbourne Declaration are to be achieved (MCEETYA, 2008). How teachers may be assisted to address this focus in their teaching is of interest for future research.

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References

Challenging, integrated, negotiated and exploratory curriculum in the middle years of schooling: Designing and implementing high quality curriculum integration.

Dr Tony Dowden

Abstract

The concept of curriculum integration (CI) has been repeatedly recommended as a curriculum design for the middle years of schooling but the extant literature is confusing, ambiguous and generally difficult to make sense of. In particular, the literature provides insufficient practical guidance and direction for teachers who want to implement CI in their classrooms. Teachers’ knowledge and understanding about CI is often hazy with the result that despite the best intentions, design and implementation of CI can be haphazard and ineffective. This article critically reviews the relevant literature of CI with an emphasis on identifying typical pitfalls and explaining political influences. By drawing on theories about the nature of knowledge, it explains that designs for CI need to consider the ways different subjects are organised and taught. It investigates teachers’ beliefs about CI in two middle schools in Tasmania. The article argues the case for a pragmatic approach to CI design and implementation in the middle years in Australian contexts, with a view to developing a robust network of shared knowledge and understanding about CI. Based on research evidence, it concludes by making several recommendations for designing and implementing high quality CI programs.
Introduction
The Position Paper of Middle Years of School Association (MYSA, now Adolescent Success) states that teachers should implement ‘integrated and disciplinary curricula’ for young adolescents (10 to 14 years old) that are ‘challenging, integrated, negotiated and exploratory’ (MYSA, 2008). The Position Paper recommends CI but it does not offer further guidance or supporting detail about appropriate curriculum design. Over the last two decades, middle schooling advocates in Australia, and elsewhere, have made steady progress on improving school environments, developing productive and inclusive pedagogies, and creating authentic assessment that young adolescents respond to (Pendergast & Bahr, 2005, 2010). Progress on developing pedagogies suited for the middle years has been especially encouraging (Darling-Hammond, 2008; Haley, Mills, Christie, & Lingard, 2006; Jackson & Davis, 2000; Newman & Associates, 1996). However, even the best pedagogical practices and assessment approaches are ineffective in isolation and should be aligned with well-conceived curriculum designs that respond to the developmental needs of students and support high quality learning (Beane, 2004).

Accordingly, if the ‘message systems’ (Bernstein, 1977) of curriculum, pedagogy and assessment in the middle years are to be aligned effectively, increased attention needs to be given to curriculum design. Progress towards developing a coherent framework for curriculum design has been modest due to the diffuse, bottom-up nature of middle level reform (Merfield, 2007). As a result, the current ‘curriculum message’ in the middle years of schooling in Australia is weak and dispersed. CI has been mooted as a coherent curriculum design suited for the middle years (Carrington, 2006; Chadbourne, 2001; MYSA, 2008; Whitehead, 2005)), but confusion and ambiguity in the CI literature means that aggregated curriculum messages about CI are unclear. In the interests of clarifying the curriculum message, research needs to resolve questions about the messages CI middle level teachers receive and believe, and how teachers implement CI in ways that respond to the developmental needs of young adolescents while satisfying concerns about excellence and rigour.

This article argues the case for an informed and pragmatic approach to implementing CI in the middle years of schooling in Australia. It draws its data from two sources. One source is teachers’ perceptions of curriculum messages from a study of middle Years teachers in two independent schools in Tasmania (Dowden, 2007b). The other source is derived from an extended review and analysis of the research literature. The intention of this article is to provide sign-posting for those who intend to implement CI and, in the process, open a conversation about the nature and purpose of CI in the middle years with a view to developing a coherent and focused curriculum message about CI.

Literature review
The concept of CI has been long advocated as a curriculum design for the middle years of schooling in the United States of America (USA) (Beane, 1990, 1991; NMSA, 2002; Vars, 1987, 2001). In favourable circumstances, CI confers greater flexibility to local curriculum designs and provides diverse student needs (Beane, 1997). Unfortunately, CI is a difficult and murky concept, thus many teachers and educators hold misconceptions that lead to ineffective practice (Gatewood, 1998).

The literature of CI is fragmented and unclear, which has resulted in the proliferation of a bewildering range of terms and definitions (Dowden, 2007b). The terminology of CI is confusing and ambiguous with many terms appearing (and disappearing) including: fused curricula, interdisciplinary curriculum, multidisciplinary curriculum, thematic units, correlation, trans-disciplinary curriculum, integrated curriculum, curricula integration, curriculum integration, integrative curriculum as well as curriculum integration. Other recent articles in this journal that discuss specific issues relating to terminology and definitions in greater depth are Dowden (2010) and Pendergast, Nichols, and Honan (2012). For the purposes of this article, CI is defined broadly as:

A collective term for curricula where meaningful learning activities are designed by crossing discipline boundaries and/or using multiple disciplinary perspectives with the purpose of helping students to create and enhance knowledge and understanding.

Subject centred curriculum integration
The strongest criticisms of CI have been reserved for thematic units where subjects are organised according to a theme (Beane, 1997; Gatewood, 1998). The main source of criticism has arisen when subjects are artificially forced into an overarching theme. For instance, in a Queensland study of cultural transformation in middle schools, Main (2009) found that tensions in teacher teams were largely connected to the ‘complexity’ of CI (p. 467). Related to this issue, the ‘cross curriculum priorities’ in the Australian Curriculum signal that some subject correlation is expected, yet the rationale for cross curriculum connections seems ill conceived (ACARA, 2014). For example, correlating elements of physics and cultural anthropology is of questionable value and, as recently reported in the media, has raised the ire of subject teachers in the senior secondary years.

In contrast, the judicious use of cross curriculum approaches, where inquiries naturally traverse disciplinary boundaries, enhances middle level curriculum (Beane, 2004; Gatewood, 1998). For example, a Tasmanian study found that investigation of a controversial environmental issue carried out by students of sociology, and do dinosaur social studies, and do dinosaur dancing’ (Dowden, 2012a, p. 29). Dewey (1915) also critiqued the forced correlation of subjects. He highlighted the superficiality of this process by commenting that efforts to correlate studies become absurd when teachers’ resort to all sorts of devices to weave a little arithmetic into the history lesson and the like” (p. 91). The strongest criticism of developing a thematic approach across the curriculum, comes from self-reports by middle level teachers in the USA who, as Dowden (2007a) explained, greatly regretted spending many hours in intense team preparation – often in weekends and holidays – only to find students disliked the resulting units. A related problem is tensions in teaching teams that stem from differing expectations about developing units. For example, in a Queensland study of cultural transformation in middle schools, Main (2009) found that tensions in teacher teams were largely connected to the ‘complexity’ of CI (p. 467). Related to this issue, the ‘cross curriculum priorities’ in the Australian Curriculum signal that some subject correlation is expected, yet the rationale for cross curriculum connections seems ill conceived (ACARA, 2014). For example, correlating elements of physics and cultural anthropology is of questionable value and, as recently reported in the media, has raised the ire of subject teachers in the senior secondary years.

Student centred curriculum integration
Student centred CI has been recommended by American educators as an ideal curriculum design for the middle years (Beane, 1990, 1991, 1997; NMSA, 2002; Vars, 1987, 2001), but it has never been implemented at the systemic level. It encourages young adolescents to actively engage in their learning and helps them understand how the disciplines link with the real world (Beane, 1998; Breeze & Capelluti, 1995; High & Andrews, 2009). Most student centred designs for CI share a strong commitment to the democratic ideology of progressive education. Following Dewey, student centred CI is based on a democratic classroom philosophy where power is shared between the teacher and students (Beane, 1997, 2005; Dewey, 1916). This democratic orientation is revealed by the ‘bottom-up’ nature of student centred CI based on a process of collaborative teacher–student planning, negotiation and implementation that allows student voices to emerge and come to the fore (Beane, 1997). Pedagogic freedom, discipline and curriculum are closely aligned,
with a focus on generating powerful and coherent learning environments that deeply and actively engage young adolescents. Curriculum negotiation is another tool that motivates and engages students and, when applied to CI, immediately solves the problem encountered in some thematic units where students are uninterested in the topic. The notion of negotiation has had a following in Australia (Boomer, 1982), although it has only relatively recently been linked to CI (Hunter & Park, 2005).

**Politics and curriculum integration**

The curriculum is always political and CI is no exception. The literature of CI is replete with records of suppression of student centred CI by conservative interests (Beane, 2013), but the political pendulum swings in both directions. For instance, rhetoric towards the end of the 1990s suggests that democratic progressive ideology, aided by post-modernist concerns about inclusive schooling, briefly dominated the middle schooling discourse. For a short period it seemed that American middle level teachers were defined by their capability and willingness to use CI in the classroom. Beane and Brodhagen (2001) stated that teachers who adhere to the principles of middle schooling ‘adopt curriculum designs beyond traditional separate subject approaches’ (p. 1159). The 2002 NMSA Position Statement on Curriculum Integration expected teachers to implement student centred CI based on democratic principles. Using remarkable language, it challenged teachers to:

> Push themselves beyond the conventional, separate subject format and expand their use of integrated curriculum formats [from thematic units] at a basic level to more advanced implementation of full-scale, integrative programs in democratic classrooms.

Hargreaves, Earl, Moore & Manning (2001) commented on the prevailing rhetoric by contrasting single subject approaches and CI. They stated that ‘it is as if [CI] increases in professional virtue, while being unable or unwilling to let go of specialisation keeps teachers in sin’ (p. 105). The NMSA soon toned down student centred CI rhetoric and, as the conservative tide in the USA gathered strength after the election of President George W. Bush, it became increasingly difficult to access information about student centred CI from the NMSA website. After this period, the NMSA more broadly recommended a curriculum that is ‘relevant, challenging, integrative and exploratory’ (NMSA, 2010).

Due to the political context in the USA, fully developed versions of student centred CI, where teachers and students collaboratively negotiate, plan and implement the curriculum, tends to only satisfy curriculum stakeholders who share a commitment to progressive education. As a result, student centred CI is often unacceptable to other curriculum stakeholders, including federal and state governments, district administrators, teachers’ subject organisations, universities, and employers; many of whom disdain progressive education. By way of explanation, progressive education was underpinned by the ideology of ‘progressivism’, which spent itself as a political force in the first two decades of the twentieth century, and has been political poison in USA ever since then because of its presumed association with communism (Goldman, 1952).

The reality in the USA is that student centred CI has endured in only a few isolated places, such as the tiny left-leaning state of Vermont, which has a curriculum that is sympathetic to democratic education (Braze & Capelitti, 1995; Kunze, 2005), or where there is the rare combination of academic and professional leadership in the classroom (Brodhagen, 2007). As Gatewood (1998) observed, ‘few average-sized [American] public schools have come even remotely close to implementing’ student centred CI as proposed by its leading advocates; successful [exemplars] are hard to find (p.41). A general rule of curriculum implementation, that is especially pertinent to student centred CI, is the struggle for control of the curriculum among stakeholders with competing interests, thus ensuring that a curriculum design derived from a single philosophical position is rarely enacted without resistance (Kliebard, 1986). Indeed, student centred CI has regularly encountered stiff political resistance (Beane, 2013; Weilbacher, 2001).

**Australian experiences of curriculum integration**

CI has been associated with the middle years of schooling in Australia for at least two decades, but it has not coalesced into an established practice that is widely accepted and understood. Nonetheless, student centred CI in the middle years has been advocated in Australia (Chadbourne, 2001; Dowden, 2007b; Menifield, 2007; Whitehead, 2005). Dowden (2007a; 2007b) argued, from a theoretical perspective, that student centred CI along the lines of Beane’s model (1997) is superior to subject centred CI, but he did not discuss important pragmatic issues such as how teachers should deal with differing demands and expectations in primary and secondary schooling contexts. Further Australian CI research comes from a relatively extensive research program in Western Australia that investigated the subject of science with a view to integrating it with other subjects (Wallace, Rennie, Malone, & Venville, 2001).

Data from a recent large-scale research project in Queensland shows that implementing CI in the middle years results in positive learning outcomes that are superior to single subject approaches in some measures (Pendergast et al., 2012). Pendergast and colleagues found that CI resulted in respectful and supportive classroom environments where young people were highly engaged in their lessons. Importantly, they also found that CI rated higher for the dimension of ‘intellectual quality’ than English, mathematics, SOSE and science (pp.17–18). The intellectual quality dimension, which was a component of the Productive Pedagogies model used in the project, included higher order thinking, deep understanding, and substantive conversation (Mills et al., 2009, p. 72). The dimension of intellectual quality is important in the Australian political context because it heads off concerns implied by at least one commentator that CI could lead to a ‘dumbed down and politically correct’ form of schooling (Donnelly, 2007, p. 25). The Queensland study aligns with earlier American research, which provides ‘substantial evidence’ that CI approaches are comparatively more effective than separate subject approaches ‘with regard to affective outcomes’ (Beane & Brodhagen, 2001, pp.1,169). Although the study did not distinguish between subject centred or student centred CI, it is important because it provides recent empirical evidence in favour of CI and adds to the well-established history of positive learning outcomes in the USA (Vars, 2000).
Grade 10 in Australia) but, due to resistance from teachers who were used to traditional single subject approaches, the innovation was not sustained (Nolan & McKinnon, 2003). Similarly, CI programs in Years 8 and 9 in six schools in Western Australia were not sustained for reasons relating to teacher workload, staff turnover and difficulties sourcing teachers who would commit to CI (Wallace, Sheffield, Rennie, & Venville, 2007).

A CI program in a Year 9 extension class in a Western Australian school, reported by Venville, Sheffield, Rennie, and Wallace (2008), encountered a well-known problem that Aiken (1942) referred to as the ‘vicious divisions’ between the disciplines where, due to prevailing social mores and different ways of doing things in subjects, subject central CI did not exist and was implemented effectively (p. 53). In this instance, a thematic unit on midges, involving collaboration between science, mathematics, SOSE and English teachers, collapsed when the science teacher seized control of the unit. The non-science teachers reported that they were excluded from planning and the sole assessment item was a biology test (Venville et al., 2008). A conclusion that can be drawn from this study is that secondary teachers, who are educated as subject specialists, tend to be less sympathetic towards the aims of CI compared to primary or middle school teachers who are usually educated as generalists.

**Summary of review**

CI is a concept worthy of scrutiny in the middle years of schooling despite a history of sporadic implementation. Vans (2000) reviewed over a hundred studies of CI and concluded that ‘almost without exception, students in any type of interdisciplinary program do as well, and often better than, students in a conventional single subject program’ (p. 87). There is little doubt that young adolescents need to have access to the data by observing examples of CI in the classroom. The study had ethics approval and was classified as minimal risk. Participation was voluntary and identities were kept anonymous. The identities of the two schools were not disclosed. The community of educators in Tasmanian independent schools is small, thus particular care was taken in this article to avoid identifying participants via descriptors.

**Method**

The participants in this study were middle years teachers in middle schools housed in two independent schools in Tasmania. Teachers’ beliefs have been long regarded as fundamental to the efficacy of classroom practice (Kagan, 1992), thus qualitative methodology was used to investigate participants’ perceptions and beliefs about curriculum messages in the middle years. Data was gathered via a preliminary online questionnaire, followed by in-depth interviews. This two–pronged approach is recommended for the qualitative investigation of beliefs and understandings (Creswell, 2009). A similar approach is being used in an ongoing longitudinal study of teaching and learning in Queensland state schools, where classroom observations are augmented by interviews to ascertain teachers’ knowledge and understanding about the relationship between curriculum and pedagogy (Koons et al., 2008).

In the preliminary phase of the study, an online questionnaire with open-ended questions was used to survey the teachers in the participating middle schools to gauge their attitudes, identity trends, and determine the parameters for the interviews. The questionnaire was completed by 30 self–selecting participants (16 in one school and 14 in the other). The results were used to inform the interview schedule. The main phase of the study involved conducting interviews with four participants from each school. Participants were selected on the basis of availability, their leadership role and representation in terms of subject experience and gender. Interviews were conducted by the researcher using open-ended questions and in-depth interviewing techniques (Creswell, 2009; Rubin & Rubin, 2005). The first part of the interview, which investigated teachers’ beliefs about classroom pedagogy, was reported on previously in Dowden (2012b). The second part of the interview explored participants’ beliefs about: (a) curriculum design in the middle years, and (b) implementing CI in the middle years (Appendix 1).

The researcher checked transcripts by listening to audio files of the interviews. The data were analysed using a ‘brief’ process of inductive and deductive thematic analysis (Fereday & Muir–Cochrane, 2006) and sorted according to emergent themes. Representational interview data were selected to illustrate the themes so that participants’ beliefs about curriculum messages could be directly represented (Rubin & Rubin, 2005). A limitation to the methodology of this research was the reliance on interviewing. If time and funding had allowed it would have been preferable to triangulate the data by observing examples of CI in the classroom. The study had ethics approval and was classified as minimal risk. Participation was voluntary and identities were kept anonymous. The identities of the two schools were not disclosed. The community of educators in Tasmanian independent schools is small, thus particular care was taken in this article to avoid identifying participants via descriptors.

**Results**

The participants emphasised that students should be productively engaged in classroom learning activities. One participant demonstrated an intuitive understanding of the need to align curriculum, pedagogy and assessment:

> Every now and then you will have every single kid totally engaged ... because everything lines up. The kids’ interests, the way you’ve presented the topic, the interaction ... Engaging kids is what teachers [should be] constantly striving to do.

Another participant was frustrated by traditional approaches to assessment that hampered alignment:

> Testing [dominates] and this is the most frustrating thing as a teacher ... [It] reduces the capacity of a [student] to pursue an idea ... [We’re essentially saying:] ‘We don’t want you to know about that even though you’re interested in it and it’s going to teach you the big picture.’

Some of the participants intuitively understood that the middle level curriculum needs to be responsive to young adolescents by including elements of student centred design. One participant yearned for a curriculum design that would promote deep understanding:

> Look, it all boils down to this idea of meaning–making: where the [students] are in terms of ... their capacity to contextualise, or to recognise that several things in conflict with each other can be true at the same time.

Another participant explained that in the middle years young adolescents need to experience a developmentally responsive curriculum that articulates with their world:

> They need to be engaged with the curriculum ... [and] their environment ... That’s a developmental thing in the sense that students at this age are making their own stamp upon the world and want genuine relationships, genuine engagement, genuine tasks and activities.

The eight participants believed that CI equated to thematic units, thus they had a subject centred understanding of CI. They did not conceive of student centred CI but, paradoxically, they were in favour of types of pedagogy and assessment that naturally align with student centred CI. When the participants were asked about CI, two typical responses were:

> [CI] is looking at an essential thematic question from several different perspectives.

The participants were acutely aware that their schools expected students to develop a sound grasp of the academic disciplines. They were willing to consider subject correlation in the humanities but this did not extend to science or mathematics. One participant described an instance of unplanned correlation:

> English and SOSE ... cross over quite a bit ... In Grade 8 they’re doing human rights and ... [reading] ‘To Kill a Mockingbird’.

In most cases the classroom curriculum was planned by teachers without input from students. One participant stated:

> [Curriculum design] asks essential questions and works backwards to what students actually need to know ... We look at this with our curriculum planning ... [It makes] teachers think about ... the real purpose behind [learning activities].

One participant described a limited process of curriculum negotiation:

> I’m sometimes staggered by what the kids want to do, ‘Mr ... I don’t really like these ideas, I can see they’ll be okay but I’ve got the idea that I’d like to build a replica of this, this and this. Can I go with that?’ And I say, ‘Yes, but I want a written piece that goes with it, to describe what you’ve done.’
Discussion and recommendations

The participants impressed as being highly committed to their students and professional in their practice. They confidently discussed their personal pedagogical philosophies, but were noticeably reticent when responding to queries about middle level curriculum design or specific questions about CI. Here it should be noted that in Tasmania, the ill-conceived CI promulgated by the defunct ‘Essential Learnings Curriculum’ of 2000–2006 (Rodwell, 2009), which neglected to adequately describe or locate the traditional subjects, may have disposed the participants against notions of student centred CI. All the participants conceived of CI as subject centred, which aligns with Queensland research that found middle level teachers understood CI in terms of thematic units (Rumble, 2010). The participants were focused on preparing students for academic success in the senior years, thus they indicated CI should be reserved for the earlier middle years and the humanities. This aligned with Pendergast, Nichols and Honan’s (2012) Queensland study of CI that found that study schools did not incorporate science or mathematics in CI in Years 8 and 9, whereas SSOE and English were commonly correlated in these years. In summary, the participants had little knowledge about CI and, in a variety of ways, subly expressed their reluctance to explore curricula that might undermine students’ future academic success in high status subjects. In another Queensland study, Rumble (2010) similarly found that middle level teachers felt they had to ‘take risks’ to implement CI (p. 199).

Research shows that student centred CI can be spectacularly successful in the middle years (Kuntz, 2005), thus it seems puzzling that the conditions needed for implementation of CI can deteriorate so abruptly. The lack of relevant ‘curriculum knowledge’ among middle level teachers – described by Shulman (2007, p. 118) as an important sphere of teachers’ professional knowledge – provides an incomplete explanation for reluctance to implement CI. Venville, Wallace, Rennie & Malone (2002) provided a cryptic clue to the puzzle by suggesting that ‘it is the nature of the subject that seems to us to hold the key to understanding curriculum integration’ (p. 43).

The middle years sit on the cusp of primary and secondary schooling. Thus, advocates for the middle years need to understand both of these cultures if middle level reform is to be effective. History shows that it is ‘wise’ for implementation of CI in the junior high school years ‘to respect the status of the single subject curriculum’, but this advice can be strengthened by considering of the social contexts of schooling and the nature of knowledge (Dowden, 2012a, p. 29).

In high schools, the organisation of subjects into departments is a foundational element, recognised as ‘the one fortress that [has] proved virtually impregnable’, despite a century of reform (Kliebard, 1986, p. 269). As Beane (2013) observed, ‘rare is the [American high school that strays from the single subject approach’. The specific pedagogical content knowledge that secondary teachers need about subjects like mathematics makes the implementation of CI increasingly problematic in the junior high school years because this pedagogical content knowledge does not cross over to other subjects (Dowden, 2012a). When CI is poorly implemented, students end up with gaps in their knowledge and understanding. For example, a Western Australian study of students who had participated in CI in Grade 6 to 9 found ‘many instances of naïve scientific and mathematical understandings and an absence of remedial teaching to address such deficiencies’ (Wallace et al., 2001, p. 12). It should be axiomatic that CI designs ensure the content and skills of the official curriculum are taught and gaps are filled, for example by running separate mathematics lessons alongside CI (Dowden, 2012a).

Sociologists have argued that the knowledge and structure of the different disciplines means that each subject develops its own subculture and that specialist teachers teach differently. Young (2008) explained that each academic subject has its own complex network of codes and practices that students need to learn. In addition, the nature of subjects like mathematics or physics means they are taught in an ordered, incremental and hierarchical manner that does not support a flexible approach likely to be needed in CI (Bernstein, 2006). Although teacher teaming to collaboratively design and implement CI is valuable, to the extent that synergies are found and each teacher’s knowledge augments the others’ knowledge, a tipping point tends to occur in the junior high school years when teachers decide they need to prioritise the agenda of their specialist subject and they become unwilling to make what they perceive to be compromises that will affect students’ academic progress. In summary, when designing and implementing CI in the junior high school years it is necessary to carefully seek a ‘balance’ between meeting the developmental needs of young adolescents and ensuring that the development of disciplinary knowledge, skills and understanding is rigorously maintained (Main & Bryer, 2007, p. 101).

Contemporary political currents are not always favourable towards reform of the middle years of schooling (Bahr & Crosswell, 2011). The danger is that at some point, in the not too distant future, CI will be quietly dropped from curriculum policies. Middle schooling advocates in Australia, and elsewhere, need to adopt a pragmatic approach towards implementing CI instead of arguing a case for a perfect model of CI in a non-existent Utopia. Professional development for CI should be holistic and include thorough knowledge and understanding of young adolescents’ developmental characteristics, should develop the skill set needed to align pedagogy and assessment with curriculum design, and – crucially – should develop a rationale for CI that is widely understood and accepted by local school communities. This builds cultures that support CI and allows teachers to innovate but in agreed frameworks. Like any innovation, CI should also engage the energy, enthusiasm and leadership of the principal (Snapp, 2006).

This article has argued that middle level advocates and educators in Australia need to collaboratively develop a ‘curriculum message’ about CI that is content and focused. In the meantime, the nature and purpose of CI recommended in the Position Paper of Adolescent Success (MYS, 2008) needs clarification so that teachers understand what ‘challenging, integrated, negotiated and exploratory’ curriculum design means. The following guidelines for CI design and implementation are indicated:

- establish a clear rationale for implementing CI
- develop a case for implementing student centred CI to help students achieve personal developmental goals and build social connections (especially Years 5 to 7)
- before attempting to implement student centred CI, ensure that teachers know about young adolescents’ developmental needs (Caskey & Antara, 2007)
- avoid subject centred thematic units that lack a strong rationale
- implement subject centred CI in instances where two or more disciplinary perspectives are desirable and will lead to deep learning
- be aware of the need in the junior high school years (Years 7 to 9) to rigorously prepare students for academic success in their senior years
- avoid CI if it does not ensure students will build strong disciplinary foundations.
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Numeracy education through mobile apps

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Numeracy achievement of Australian school children is a national priority according to the Australian Curriculum. There is increasingly compelling evidence that numeracy needs to be a focus in all curriculum areas, not solely in mathematics (HCWG, 2008). At the same time, there is an ever-increasing scope for the use of mobile technologies to enhance learning and teaching. This article examines how numeracy and mobile learning work together as teachers in the middle years are mentored to use iPad applications (apps) effectively in their own curriculum area to enhance the learning of numeracy for children in their classes.
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This paper reports on a professional development learning community’s initiative among school teachers aimed at enhancing numeracy outcomes in the middle years of schooling using iPad apps. The initiative included teachers in lower and upper primary classes and followed an action research intra-school model of professional development. The growing presence of Information and Communication Technologies (ICT) in education implies that pedagogies based only on print-based resources need to concede space for teaching and learning with electronic materials and the use of mobile devices, also known as BYOD (bring your own devices) tools (Digital Education Advisory Group, 2013). This study portrays the efforts of a group of teachers attempting to integrate numeracy and mobile technologies across the curriculum.

Background
Numeracy is an area considered as high priority at the national level. This is as a consequence of Australian students’ low academic performance as reported in recent international studies such as the Trends in International Mathematics and Science Study (TIMSS) ((Australian Council of Educational Research) ACER, 2012; Thomson, 2011).

In analysing the TIMSS 2007 results, the ACER noted that that Australia’s overall performance in Year 8 mathematics was average within an international standpoint: The result for Australia is similar to 2003 but achievement scores have decreased since the first administration of TIMSS in 1995. Increases in scores achieved by students from England, the United States and Lithuania, in combination with a decrease in Australia’s score, resulted in those countries significantly outperforming Australia in 2007. Overall, Australian students performed poorly in the areas of geometry and algebra. (Thomson, 2009, p. 3)

More recent results outlined in the latest 2011 TIMSS show that Australian school students are underperforming in Year 8 maths. According to the ACER (2012), In Australia, 89 per cent of students achieved the Low benchmark, however 37 per cent failed to achieve the Intermediate benchmark and thus the proficient standard expected’ (p. 26). ACER also highlighted that:

- Fourteen per cent of Year 8 students in the Australian Capital Territory and 13 per cent of students in New South Wales reached the ‘advanced’ benchmark but in all other states the proportion at this level was less than 10 per cent.
- The other end of the achievement distribution shows that a worrying 56 per cent of students in the Northern Territory and 51 per cent of students in Tasmania did not reach the ‘intermediate’ benchmark.
- In the other states this proportion ranged between 39 and 42 per cent in Western Australia, South Australia and Queensland through to 26 per cent in the Australian Capital Territory.

These results suggest a need to enhance academic performance in numeracy in the middle years of schooling if we want to improve the achievement of Years 11 and 12 students.

Motivation to focus on maths in the middle years
The middle years have been identified as crucial in maintaining student interest in their further years of schooling (Pendergast & Bahr, 2005). In particular, it is of paramount importance to foster the development of students’ numeracy at an early age. This should increase their interest and confidence in taking up maths and science subjects to Year 12 and maths related careers at the end of their schooling (ACARA, 2011).

Research has shown that at this age mathematical understandings across the range of student abilities begins to increase in diversity with significant gaps developing in less mathematically able students (Doug, 2005). Consequently, it is important to ensure achievement gaps in secondary maths education are identified and dealt with before students move to more advanced levels (Marshman, Pendergast, & Brimmis, 2011). Clearly, the declining trend in the number of Australian school students undertaking maths and science subjects in Year 12 (Chubb, Findlay, Ds, Burmester, & Kusa, 2012) should be addressed in earlier stages of schooling, such as the middle years.

Development of new pedagogical – technological skills in numeracy
Being numerate is the ability to use mathematical ideas to make sense of the world in a ‘real’ context and beyond the classroom. Numeracy can also be defined as the capability to make decisions about everyday issues involving mathematical ideas. It also empowers students to be critical in regard to the quantitative information surrounding them every day (Handal, 2013). As such, numeracy is a skill that needs to be explicitly taught across all areas of the curriculum with the Australian Curriculum defining numeracy comprehensively as encompassing the ‘knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations’ (ACARA, 2012, p. 5). As mathematical concepts are embedded in all aspects of life, they should not be perceived by students as being constrained to the mathematics classroom. Additionally, the NSW Department of School Education and Communities (2007) asserts that ‘numeracy requires an understanding of mathematical ideas, skills and techniques along with the capability to know when to use mathematics, to choose which mathematics to use and to critically evaluate its use’ (p. 2).

Like literacy, because numeracy is such an important learning element in the curriculum all kindergarten to Year 12 teachers share the responsibility to implement appropriate instructional experiences in their own key learning areas. Likewise, the National Numeracy Review Report (HCWG, 2008) recognises the necessity to include the teaching of numeracy across the curriculum:

That all systems and schools recognise that, while mathematics can be taught in the context of mathematics lessons, the development of numeracy requires experience in the use of mathematical ideas beyond the mathematics classroom, and hence requires an across-the-curriculum commitment (p.7).

If numeracy is to be a focus in curriculum areas beyond mathematics, professional learning opportunities are vital in assisting teachers in the process of developing their pedagogical skills related to mobile learning technologies in numeracy (Handal, Campbell, Cavanagh, Petocz, & Kelly, 2013). Ongoing research at the University of Notre Dame Australia is developing examples of numeracy activities mapped across the curriculum where mobile learning technology can be used.

The professional development program outlined here is being trialled at a Sydney primary school to assist teachers in delivering those activities using iPads. These activities intend to support student numeracy skills development in the middle years (Stages 3 and 4). Examples of numeracy activities are spread across ten learning areas: English, Geography, History, Languages, Maths, Music, Personal Development, Health and Physical Education, Science, Technology and Visual Arts.

In general, the urgency in investing in numeracy programs has been recently highlighted by the Gonski Report (Gonski et al., 2011, p. xxii) aiming at ensuring that ‘at least 80 per cent of students in reference schools are achieving above the national minimum standard’ across all the states and territories through innovative programs ‘reflecting changes in modes of delivery through classrooms and the use of ICT’ (p. 65).

Mobile learning
The advent of new learning technologies brings new challenges and possibilities to the traditional way some teachers have been delivering the curriculum (Churchill & Churchill, 2008). Carington (2006) calls for a more prominent use of ICT in the teaching and learning in the middle years of schooling. Specifically, mobile learning, the latest addendum to the continuous process of innovation in educational technology, brings a technology that is ubiquitous in nature. It is highly portable and endowed with multimedia capabilities offering a new dimension to curriculum delivery. In fact, mobile learning, due to its ubiquitousness, makes learning accessible ‘anywhere, anytime’ (Handal, Campbell, et al., 2013). There are an impressive number of educational mobile learning apps that teachers need to appraise before integrating them into the classroom. To make this assimilation process more effective in 21st century classrooms, teachers need to collaboratively engage in the process of developing instructional activities around maths apps in any curriculum area.

Educational apps can be classified into three broad groups based on the purpose for which they are used. Explorative apps are designed to explore and demonstrate mathematical models or concepts through manipulating objects that mimic complex physical situations, for example animations and simulations. Productivity apps allow students to measure and graphically represent objects or concepts in two or three dimensions, collect data, make complex calculations, or create multimedia materials. In turn, instructive apps engage students in practising content through...
drill exercises, acquiring new skills through questions and answers (tutorials), or retrieving factual information only (Handal, Khoury, Cavanagh, & Campbell, 2013).

In general, the implementation of mobile technology in learning and teaching in the middle years seems to be inadequate (Marshman et al., 2011). A questionnaire study by the University of Notre Dame Australia on integrating content, pedagogy and technology was conducted among 125 NSW schools with 280 school teachers participating in the survey (Handal, Campbell, Cavanagh, Peto, & Kelly, 2012). To the item ‘I am able to use mobile devices (e.g., iPad, smartphone) in teaching’ NSW teachers scored an average of 53% representing the third lowest score among the thirty survey items (Handal et al., 2012). Lack of access to mobile devices, particularly tablets, seems the defining element in teachers’ adoption, or not, of those learning technologies in schools. Although this study surveyed teachers of junior secondary mathematics, and considering that numeracy is a cross-curricular concept, the findings indirectly highlight the reality of ICT teaching skills in an Australian context.

Methodology

This action research study sought to explore the use of numeracy applications across the curriculum by providing a ‘real’ context for teachers in a learning environment. The central question of this research was, ‘How do teachers learn to integrate mobile learning into the teaching and learning of numeracy?’ Action research is a methodology that has been found to be valuable as a problem-solving tool (McNiff, 2013). It offers a unique collective vehicle for reflection, improvement, and enhancement of teaching. In action research the cycle of plan, act, observe, reflect will be used to continuously review the process of development.

Through this type of research methodology teachers are encouraged to share educational experiences and reflect on practice. The community created through this type of interaction can ultimately promote improved understandings of practice. In this action research project teachers were empowered to interact, communicate and collaborate to support and enhance learning through the exploration of numeracy applications (Cohen, Manion, & Morrison, 2011).

Data was collected using the two main action research instruments, namely, workshop observation and reflection. A limitation of this study was the lack of classroom observation, which would have provided information on the interactions occurring between teachers and students as they went together through activities related to the teaching and learning of numeracy using mobile devices.

Eight teachers from a Sydney primary school participated in the professional development program through three whole-day workshops spread throughout the year. iPads were provided to participating teachers to ensure they experienced, personally and at their own pace, how the devices operate during and after training.

A set of selected apps were uploaded directly to each iPad prior to them being provided to participants at the workshops. The apps highlighted a variety of instructional designs to encourage analysis and comparison. Some well-designed apps were included and some poor ones as well. This provided a basis for discussion and comparison on which were superior and inferior from a pedagogical perspective. This way, teacher participants practised appraising educational apps and their relevance to numeracy across the curriculum. The criteria for appraising quality educational numeric applications were outlined in a checklist developed by Handal, Cavanagh, Campbell and Dave (2013, in review).

The participants went through four pedagogical wraps initially prepared in the areas of English, Visual Arts, History, Science, and Health and Physical Education. As a result of their interaction and input the wraps underwent a significant transformation from their original format. The teachers’ input was extremely valuable as they were able to position the sample wraps in the context of their practice and examine what would work and what would not work in class, given their individually specific contexts. Teachers were able to examine the pedagogical affordances of the apps and look for substitutes at the Apple Store and on the internet.

Likewise, participating teachers were encouraged to use their iPad tablets to generate their own units of work, known as ‘pedagogical wraps’. These so-called ‘wraps’ are learning activities built around numeracy-relevant apps. Pedagogical wraps are small lessons comprising (a) curriculum theme/content, (b) instructional approach, (c) numeracy, (d) suggested follow-up activities and learning outcomes. Learning objectives are purposively aligned to the Australian Curriculum (ACARA, 2011).

Prior to their professional learning activities, ‘wraps’ samples were designed in order to provide a model for participants for analysis and discussion. During the three workshops participating teachers held conversations and discussion among themselves as to how they might identify numeracy themes across the curriculum, select and evaluate quality numeracy apps and design educational ‘wraps’ for teaching and learning numeracy.

Teachers’ wraps

The participants went through four pedagogical wraps initially prepared in the areas of English, Visual Arts, History, Science, and Health and Physical Education. As a result of their interaction and input the wraps underwent a significant transformation from their original format. The teachers’ input was extremely valuable as they were able to position the sample wraps in the context of their practice and examine what would work and what would not work in class, given their individually specific contexts. Teachers were able to examine the pedagogical affordances of the apps and look for substitutes at the Apple Store and on the internet.

During the workshops teachers improved their vocabulary and discourse around the role of apps in numeracy education (e.g. explorative, productivity and instructive apps). Participants were also able to differentiate apps among the three categories. Teachers were able to go through the broad variety of apps in the instructive category in each workshop. The fact that participants could identify an app
because of its instructional role was very encouraging and certainly a step forward in associating the peculiarity of each mobile application to specific learning objectives. The remaining two apps groups will be addressed as the program unfolds. It is anticipated that distinctive pedagogical modes will emerge as these seem to be dependent on their idiosyncratic instructional roles. For instance, explorative numeracy apps are more prescriptive, leading to investigations and higher order thinking through dynamic tools like simulators, emulators and guided discovery applications. In such situations pedagogical wraps must be less prescriptive, focusing on providing thoughtful prompting prompts that stimulate highly regarded cognitive functions, such as conjecturing, analysing, predicting and hypothesizing. In contrast, instructive numeracy apps require a more explicit teaching approach as the learning situation tends to be more structured and routine based. Instructive apps typically include tutorials, drill and practice game-based applications, as well as one-way presentation of numeracy content. In general, it was observed that teachers began to associate pedagogy with technology more closely as well as discovering the synergies between them in a numeracy context. A central idea of the program was the concept of transformative professional learning. This process of transformative learning has been highlighted by various authors in explaining how rich understanding is brought about. Professional learning must be situated in the context of integrating content knowledge, pedagogical knowledge and technological knowledge (Koehler & Mishra, 2008). Meaningful knowledge occurs when learners manage to deploy technology to foster active construction knowledge using pedagogies specific to the learning situation.

Ruben Puentedura (2006) ‘substrate, augment, modify and redefine’ (SAMR) model characterises the process of going through developmental stages of task enhancement and transformation. Such a process describes the extent to which learners make a difference to an assigned task. Rather than being knowledge consumers, the model advocates empowering individuals to become knowledge producers. Hence, the model postulates four developmental modes in dealing with a task – substituting, augmenting, modifying and redefining it. At the lowest level of the spectrum (that is, substituting) the learner uses technology only to replace a task that can be accomplished by any other non-digital approach. In contrast, at the highest cognitive extreme (that is, redefining) the learner manages to create new experiences and end products where the original task has undergone significant transformations. At that stage not only has deep understanding been achieved, but also other users have become involved creating a small learning community where collaboration and sharing has taken place. The wrap products reaching the redefining stage are summarised graphically in the Appendix.

Conclusions

Given the rapid advances and pervasiveness of mobile technology in schools all over the world, this innovative action research project highlights the benefits of modern technologies to the learning and teaching of numeracy across the curriculum. In particular, the study highlights how teachers learn about a methodology combining numeracy across the curriculum with mobile devices. It reveals their ability to use digital devices to transform an instructional task rather than just substitute it with mere use of technology. The reported professional development shows that such an endeavour can be positively achieved when teachers are empowered to reflect among themselves on specific delivery strategies. The ‘wrap’ model described above reflects rich and meaningful professional learning driven at the school level. Furthermore, the model seems to maximise mobile learning adoption as a result of the knowledge ownership aspect by participants in the project. Such an engagement was exemplified as teachers actively maintained rich conversation among themselves in the process of developing their own pedagogical numeracy wraps.

Further qualitative research techniques would provide valuable data as to how this teaching methodology has an impact on students’ learning in the classroom and across specific areas of the curriculum.

Table of abbreviations

| ACER | Australian Council of Educational Research |
| BYOD | Bring your own devices |
| ICT | Information and Communication Technologies |
| NAPLAN | National Assessment Program – Literacy and Numeracy |
| SAMR | Substitute, augment, modify and redefine |
| TIMSS | Trends in International Mathematics and Science Study |

Appendix

Numeracy in English

1. Create an excursion to the city with your class using the three apps. Locate landmarks e.g. Sydney Opera House, Parliament House and St Mary's Cathedral in Maps+. Use the Transport info app for times and connections. Place the info in Sling Note.

2. Using SlingNote capture the location and drop them onto the right side of the page. Go to Transport Info. Write the directions, times and connections.

Numeracy in History

1. Travel back creating a timeline showing dinosaur times (historical periods) with Dinosaurs. Use TimeLine Eons to put the dinosaurs into the different periods.

2. Create your own life timeline in Timel i highlighting significant events.

Numeracy in Science

1. Create a table in TabChart and record the weather using AuWeather and Thermo over a week in Mascot.

2. Write the directions in EduCreations to Jupiter using SkyWalk.

Numeracy in Health and Physical Education

1. Create a graph using TabChart. How many star jumps, walking up the stairs, can you do in one minute? Use the StopWatch.

2. Create a tally with Tally It of the sports Australia received medals in London 2012.

3. Create your own life timeline in Timel i highlighting significant events.
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Implementing a technology-based pedagogical approach in the middle school classroom: A perspective

Andrew Landroth

Introduction

In the 21st century, education has seen a change, as many would argue, is unlike any that has gone before in the history of formalised schooling. A worldwide revolution under the guise of globalisation has resulted in a paradigm shift, which has huge implications for the teaching profession generally, and for middle schools specifically.

The transformation of the nature of globalisation away from traditional economies, of wealth and resources, to a new one of knowledge, is an essential requirement.

Authors such as Carnoy and Rhotten (2002) have observed that globalisation is having a significant impact on educational systems worldwide and that the way information is delivered in the classroom is an important aspect of knowledge production. Knowledge in the classroom context is being subtly, but ultimately, transformed by the forces of globalisation. This leads to technology being introduced to deliver higher quality education through computer-assisted instruction and the use of the internet.

Locally, pressure is being brought to bear from a number of fronts to use technology and technology-based pedagogies in the classroom. Prior to the introduction of the Australian Curriculum, the Melbourne Declaration (MCETYA, 2008) explicitly referred to the importance of technology in the classroom.

Rapid and continuing advances in information and communication technologies (ICT) are changing the ways people share, use, develop and process information and technology. In this digital age young people need to be highly skilled in the use of ICT. While schools already employ these technologies in learning, there is a need to increase their effectiveness significantly over the next decade. The Australian Curriculum, Assessment and Reporting Authority (ACARA) in their ‘Shape of the Australian Curriculum’ version 3.0 (2012) alluded to the same issue with a statement, ‘An Australian Curriculum in the 21st century needs to acknowledge the changing ways in which young people will learn and the challenges that will continue to shape their learning in the future.’

It is evident from government actions that this method of pedagogy must be considered. The federal government’s ‘Digital Education Revolution’ and the Queensland Government’s roll out of the ‘Computers for Teachers’ program are both testament to the fact that technology-based pedagogies are pervasive in the classroom, and are here to stay.

Even a cursory perusal of position descriptions for teachers on job seek websites will reveal position descriptions explicitly stating that the ability to teach with technology is an essential requirement. This underlines the necessity for teachers to be technologically literate in the 21st century classroom.

A quandary

The paradigm shift in the way information (and hence knowledge) is considered and dealt with in the educational context in general, and more specifically the Middle School paradigm, has resulted in many teachers and allied education professionals being uncertain how best to deal with, implement and use technological pedagogies.

With the average age of teachers in Australia rapidly approaching 50 (ABS, 2006), and the introduction of computers and educational software, as well as internet and intranet interactions, this suggests technology-based pedagogies can be closely aligned with at least three, if not all of the dimensions. Appropriate and best-practice implementation enhances the intellectual quality of learning by placing learning experiences in a context that students are comfortable and familiar with.

The relatively unlimited nature of technology also facilitates the inclusion of key items, such as higher order thinking skills and deep knowledge, which are considered to be the basis of intellectual quality.

Likewise, the notion of connectedness, both temporally and topically, goes hand in hand with technology in the classroom.

A supportive classroom is one where engagement, student self-regulation, student direction of activities, social support and explicit criteria are valued (Hayes et al., 2006). These values are referred to as being hallmarks of technology best-practice.

Finally, in the dimension of working with and valuing difference, technology can foster inclusivity; particularly with students of different backgrounds. Technology can enable students to participate in class activities in ways that are not verbal-spatial, for example participating in blogs and other instant messaging methods.

The influence of technology on learning outcomes

Classroom pedagogy must match the needs and abilities of middle years students. To be effective, pedagogy must be flexible, reflecting creative uses of time, space and other resources, as well as group and individual needs. It must also be learner-centred, with an emphasis on self-directed and co-constructed learning (Pendergast & Bahr, 2005). Flexibility, creativity, learner-centredness and the ability to self-direct one’s learning are characteristic of technology-based pedagogies. This suggests technology-based pedagogies can have a positive effect upon middle school learning outcomes.

Significant research has been...
conducted into both the general impacts of technology on learning outcomes and the impacts of Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2005) in the classroom. Although hard, empirical data is difficult to locate, qualitative reports on the impacts of technology in the learning context abound. Regarding the beneficial nature of technology in the classroom, Beauchamp and Kennewell (2008) identified that there is substantial evidence concerning technology’s ability to motivate learners to engage in cognitive and, perhaps more importantly, metacognitive activity.

In a study on the impacts of the use of technology in schools, Fredriksson, Jedekskog, and Plomp (2008) observed the acquisition of new competences (21st century goals), such as being able to work independently and in projects, to search for new information, to collaborate and to communicate. They summarise that technology has made a difference in several ways in schools and this includes how the students are taught and how they learn. Most of these changes can be described in positive terms. In a 2011 study, Gewerc and Montero (2011) answer the question, ‘Has technology improved learning during this process?’ Their conclusion is unequivocal. From their perspective, there has undoubtedly been a considerable enrichment.

**Technological Pedagogical Content Knowledge**

The practice of implementing technology-based pedagogies has recently been redefined into a framework entitled ‘Technological Pedagogical Content Knowledge’ by Koehler and Mishra (2005). It can be quite succinctly described, ‘TPACK is an understanding that emerges from an interaction of content (of subject area), pedagogy and technology knowledge. Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. We argue that TPACK is the basis of effective teaching with technology’ (AACTE Committee on Innovation and Technology, 2008).

![Figure 1: The TPACK model (HAMK Professional Teacher Education Unit)](image)

As Figure 1 illustrates, there are three domains of knowledge: technological, pedagogical and content. These knowledge converge into a common domain that is labelled the TPACK. The TPACK is specialist knowledge that is required for teachers to implement appropriate pedagogies in a best-practice scenario. As professionals, teachers possess high levels of pedagogical knowledge, typically acquired through a combination of an education qualification and classroom experience, and they also possess the content knowledge acquired through their first, specialist degree (e.g. in the case of science teachers, usually a science degree).

To quote Hastings (2009, p. 27), when discussing teacher training, ‘the knowledge base of technology often remains isolated from content and pedagogy’. Technological knowledge is often unregulated and left to chance, and it is this unfamiliarity with the use of technology in the classroom setting that presents a significant barrier to teachers implementing technology-based lessons.

**Literature review of the TPACK model in the classroom**

Numerous authors consider the TPACK model to be the blueprint for best practice in the implementation of technology in the classroom; to inform educators about effective technology integration into the classroom. Quality classroom technology use occurs at the centre of TPACK, in which all components – technology, pedagogy, and content knowledge – successfully interact to maximise instruction and learning (Hastings, 2009). Finding or developing a theoretical grounding in educational technology is not easy. Nevertheless, the TPACK model may serve as an appropriate model to direct technology training. The model depicts how teachers’ understanding of technologies, pedagogy, and content knowledge interact with one another to produce effective teaching with technology (Hsuah, 2008).

In recent times, the TPACK model has emerged as the pre-eminent model that not only defines technology in education, but also guides the implementation and use of technology in a manner that allows educators to function in a holistic manner with their specialist content knowledge, pedagogical knowledge and experience, and their interaction with technology.

**An example: TPACK in the science classroom**

TPACK is now an integrated component in many pre-service and in-service teacher training programs worldwide (Jimoyiannis, 2010), not only in general classrooms, but also in science classes. Jimoyiannis suggests that, ‘science education constitutes a privileged subject matter when considering ICT integration and the related issues to enhance teachers’ instructional potentials and students’ active engagement and learning opportunities’. This observation is made through the lens of the availability and inherent nature of science topics that makes it conducive to the use of ICT facilitated through the TPACK model. Tasar and Timur (2012), when commenting on the importance of TPACK have suggested, ‘Successfully integrating technology into science education heavily relies on the development of well-built, coherent professional development programs that are designed with a clear understanding of how teachers need to use technology in their class in the most effective way’. These comments and many others in the literature highlight the role and relevance of TPACK and technology in the modern science classroom.

**Key areas of TPACK knowledge in science**

Flick and Bell (2011) devised a list of key factors determining the validity and usefulness of technology in the science classroom:

1. Technology should be introduced in the context of science content.
2. Technology should address worthwhile science with appropriate pedagogy.
3. Technology instruction in science should take advantage of the unique features of technology.
4. Technology should be used in ways that make scientific views more accessible.
5. Technology instruction should develop students’ understanding of the relationship between technology and science.

These factors could be considered guidelines when considering using technology in the science classroom in order to maximise technology impact upon educational outcomes and for quality implementation of technology-based science lessons.

The following list presents the science-specific benefits of implementing relevant technology. Many of these points are of significant importance and use in the science classroom, in particular points three to six, which aid teachers in presenting and explaining concepts that may not otherwise be explicable in a traditional context.

1. Speeding up time via simulations of natural events
2. Saving time through data collection devices
3. Seeing things that could not otherwise be seen through:
A complicating issue
I suggest there is a significant barrier to implementing technology in the classroom; one that is best represented by a modification of the model shown in Figure 1 (Figure 2) – that of teacher attitudes and perceptions.

The substitution, augmentation, modification and redefinition model
If teachers are engaged in the process of using technology for teaching (for example when it is mandated by senior staff), they often progress or are encouraged to progress through a process of substituting technology for traditional teaching methods, modifying those methods to suit technology, extending the use of technological tools in their teaching, and finally developing lessons that could not have been presented using traditional methods. It is this level that represents best practice in technological pedagogy. This process has been based on the Substitution, Augmentation, Modification and Redefinition (SAMR) model by Puentedura (as cited in van Oostveen, Muirhead, & Goodman, 2011).

The SAMR model is one that offers a framework for the implementation of technology, in this case in an educational institution. It argues that participants (in this case teachers with limited technology skills) cannot go directly from a situation of no technology use in the classroom to implementing technology-based lessons at a high level, but instead must pass through a progression, beginning with substitution. While I agree with the model, I contend that the model is flawed and that the substitution level is the most vulnerable in terms of retaining participation in the process. This is the point where the teacher with limited skills may ask, “If the technology is not successful at substituting equally for traditional methods, how can it possibly be successful at the other levels of the model?”

A modified SAMR model
In the place of the SAMR, I propose a modified SAMR model (Figure 4) in which substitution is replaced with ‘scaffolding’. This is done with support from experienced, technology-capable staff, in the manner discussed in the solution at the end of the article.

Implicit with the modified SAMR model is the use of scaffolding to overcome the key issue that teachers with limited technology skill levels will never attain the higher levels in the original SAMR model. The problems, identified through observation, experience and reflection are:

- Unfamiliarity with technology in the ‘bigger picture’ (e.g. Where does it all fit in? Where is data stored? how can we retrieve it? Can we assess this?) is an issue that presents a major obstacle for the teacher.

Developing teachers’ technical knowledge
In working with classroom teachers on technology projects, it is important to consider their existing knowledge base and how the project might be structured in ways that connect with their teaching approach and to be mindful of the teachers’ zone of proximal development (Vygotsky, 1978) in terms of content, pedagogy and technology (Hofer & Swan, 2009, p. 18).

It is from this perspective – and that of Hastings (2009) that many scholars’ current perspectives also view educational technology as a separate set of knowledge and skills that has to be learned – that the following project is designed; to more closely align a selection of technological tools to teachers’ current levels of technological ability, knowledge and competence.

Best practice
Best practice in the use of technology in an educational context is a concept that is presently poorly defined and there are few clear examples available in the literature. Best practice in this context refers to the previously mentioned TPACK model and the implementation of technology-based lessons in accordance with several of the models of best practice in ICT that do exist.
Ferreiro-Gravie (2012) lists as criteria for best practice:

• Favourites relations between teachers and students. Technology enhances and diversifies the ways and modes of communication between the agents of teaching and learning.
• Foster/promotes cooperation between students. The technology allows students, under the direction of the teacher to participate in small study and work teams and collaborate on projects, not necessarily at the same time or in the same place.
• Stimulates active learning and reflection on the search for information and social knowledge.
• Gives opportune feedback. 
• Contributes to the flexibility in times and places of delivery (of lesson content) and workspaces, allows personalisation of attention to students.
• Communicates high expectations in learning.
• Respects the diverse talents and methods of learning, allowing students different ways to adapt their style of learning.

The Queensland Government lists the following schema (Figure 5) as a model for effective e-learning, in which similar themes appear, such as flexibility, communication, collaboration and personalised learning.

A possible solution

One solution that I and colleagues have trialled that is proving to be successful is the development of a ‘teacher’s technology toolkit’.

This contains a range of lesson ‘templates’ that illustrate how technology might be used for individual segments of a lesson and unit, and which act as both a beginning point and short-cut to designing lessons to be used by teachers with limited technological ability. Added to this is a list of software and technologies that are ideally suited to particular components of lessons.

For example: Mindjet Mind Manager is ideally suited to students to demonstrate the connectedness of concepts in a topic, while website building apps such as Weebly or Wix, in which teachers can embed video screencasts, are ideal for developing aspects of flipped learning.

Conclusions

Ultimately, the success or failure of a technology program, particularly in the middle school, will depend on the buy-in of the teaching staff. The pro-technology teachers are not the answer, neither are the anti-technology staff. It is the third and potentially largest group who hold the key to success: those who would like to implement technology in the classroom, but do not have the skills or confidence to do so.

There is a vast gulf between using a computer for checking emails or making a slide presentation, and using it to teach a class of tech-savvy Generation Z middle school students. Enabling this group of staff will have a flow on effect that will help to unite staff in the effort to implement technology in a best-practice manner to engage young adolescent learners.

Being aware of the TPACK model and the implications of teacher preconceptions, in conjunction with the use of the SAMR model with modifications as a framework for teacher mentorship, may prove to be an effective catalyst to facilitate technology implementation in an otherwise technology-hostile environment.

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Deadly numeracy – teachers as researchers

Kate Stassen and Tegan Baumgart

Introduction
‘Deadly Numeracy’ was an independent school’s ‘Teachers as Researchers Project’ undertaken during 2013 at Clayfield College Middle School. The purpose of the project was to use an action research framework to research and develop quality pedagogy for teaching numeracy, specifically to improve outcomes for Indigenous students.

Clayfield College Middle School has 307 students in Year 6 to 9. Ten students identify as Indigenous. All of the Indigenous students, except for one, are enrolled in Years 8 and 9. For the purposes of this project, all middle school mathematics classes were involved in data collection and professional development, regardless of whether they were currently teaching students participating in this project. Clayfield College Middle School is proud of its continuous improvement of pedagogy and of incorporating effective differentiation in the teaching and learning processes.

Review of related literature
Action research learning can be defined as a collaborative learning experience where a community of practitioners come together to critically reflect on ways to improve their practice and to determine approaches to teaching and learning that are professionally relevant, personally meaningful, and effective in facilitating improved performance for students (Fletcher, 2005). This cycle of reflection, effective approach research and application of quality teaching to improve student outcomes formed the basis of the Deadly Numeracy Project.

Strategies for improving numeracy outcomes for Indigenous students

Learning from existing research into effective teaching and learning of numeracy for Indigenous students was a critical part of the Deadly Numeracy Project. It was found that the role of oral language is very important in the understanding of numeracy for Indigenous students, particularly if students are ESL learners (Warren & deVries, 2009). Teachers must be aware of the language needs of their students and, that in some cases, individuals may be grappling with new language, new concepts and the vocabulary of mathematics simultaneously. Mathematical language may hold different meanings for different students. For example, Western notions of quantity – more or less of number – may be at odds with a culture that focuses instead on the qualities and apparent relations. The work by Warren and deVries (2009) into actions that assist in engagement in numeracy for Indigenous students also found that hands on, activity-based learning best helps young Indigenous students to engage with mathematics.

The literature strongly links self-efficacy or self-concept to student achievement. Self-efficacy can be defined as people’s judgements of their capabilities to organise and execute courses of action required to attain designated types of performance (Bandura cited in Warwick, 2006). Four main sources can influence a person’s self-efficacy:

1. Performance experience, such as participation in past assessment tasks.
2. Vicarious experiences that students base their evidence of competencies on in comparison with the attainment of others.
3. Social persuasion, such as feedback from teachers or adults.
4. An individual’s physiological states, for example, when anxiety may affect judgments of capability and strength.

Interestingly, research has found that while targeting general components of self-concept, like increased self-esteem, may result in increased happiness, these efforts do not necessarily translate into attaining desired outcomes in specific domains of learning. Instead, domain-specific academic self-concepts (for example mathematics self-concept) had the strongest predictive link to outcomes (especially grades and aspirations) for both Indigenous and non-Indigenous students (Bodkin-Andrews, O’Rourke, & Craven, 2010). Therefore, efforts by teachers to enhance specific domains of self-concept in mathematics, such as by enabling students to achieve academic success, could be very effective in achieving better outcomes.

Traditional deficit models developed in early Indigenous education research have focused on ethnicity as an assumed cause for inequalities in outcomes between Indigenous and non-Indigenous students. In his research, Harrie found that instead of ethnicity, other student factors such as self-perception and engagement are more strongly linked with student achievement (as cited in Bodkin-Andrews et al., 2010). Importantly, Gay (as cited in Bodkin-Andrews et al., 2010) found that when teaching is more responsive to student culture, learning becomes more personally meaningful and subsequent learning processes occur more fluidly and with a greater depth. This should ultimately result in engagement, and attainment, and provides the foundation for an increased self-concept in education.

Learning about students’ ‘Lived Culture’

In researching ways of making the mathematics curriculum more culturally inclusive, the Deadly Numeracy researchers learned about the ‘8 Way Aboriginal Ways of Learning’ model (Yunkaporta 2012). A way of teaching languages in schools. Tyson Yunkaporta, who developed the model through Indigenous research in western New South Wales and in collaboration with the Bangamalanha people, worked with the Deadly Numeracy researchers and provided some interesting insights into how to best ensure a school’s mathematics program is culturally inclusive.

Models such as ‘8 Way’ cannot just be applied anywhere as there is the danger that they will be used too simply and are of a different culture. ‘They are best looked at to see what’s possible’, Yunkaporta recommends. He encourages schools to reflect on and develop their own pedagogy that is culturally responsive to the students of that school and classroom. To do this, teachers should spend time to reflect on what is mathematics, what is culture and what is Aboriginal. ‘They need to be honest and understand their own beliefs and attitudes. They need to self-reflect and understand the things that are usually unexamined and bring them to the surface’.

Yunkaporta encourages teachers to think about the role of culture in teaching mathematics and find out what is the real ‘lived culture’ of the students. We should ask questions to find out about what attitudes, beliefs and past experiences our students bring to the mathematics classroom. From there, we can link the mathematics concepts with the student’s home reality ‘using lived culture as metaphors’ for what is taught.

We also need to shift our understanding of what culture is for the purposes of education. Material culture (i.e. didgeridoos, dot painting, dance, bush tucker) is very important, but arguably is the least productive aspect of our culture to include in curricula. The more productive side of culture is the intangible, the unseen, the previously unexamined. We’re talking about the genuine lived reality of our students here. (Yunkaporta 2012)

In ‘8Way Maths’, there are eleven suggested questions that teachers can use to elicte the ‘lived culture’ of their students in relation to mathematics. A few of these are:

- What is their attitude towards money? What do they believe about luck and patterns? Do they habitually respond to fortune in the world around them? How do they compare things and assign value? (Yunkaporta 2012)

With this knowledge teachers can ensure connectedness in their practice.

Yunkaporta explains the effectiveness of this approach through the work of Dr Chris Matthews and the schema approach to learning mathematics. From concrete, real world experiences, learners can substitute with symbols and perform manipulations in the abstract world of mathematics before bringing their understanding back to their world to ensure deep understanding. An effective mathematics program teaches strategies and processes that are worth remembering.’ This will lead to an enriched mathematical experience for all.

Data collection and actions
Various methods of data collection were employed to inform the Deadly Numeracy Project. Ten middle school mathematics teachers, two learning support teachers and ten Indigenous middle school students participated in the data collection. Actions were carried out in response to the data collected. The planning for further
actions as a result of the project will be ongoing.

Teacher data and project actions
At the commencement of the Deadly Numeracy Project, participating middle school mathematics teachers were asked to complete a survey of their confidence levels and experience with differentiating their teaching of mathematics for Indigenous students. Fifty-eight percent of teachers reported feeling ‘quite confident’ in knowing how to differentiate their teaching for Indigenous students, 33% felt ‘somewhat confident’, and one teacher reported feeling ‘not at all confident’. When planning for differentiation in teaching for all students, whole class teaching was rated the area found to be most challenging by 67% of teachers. Differentiating assessment, working with individuals or small groups, and sourcing resources were nominated as other areas found to be challenging. Teachers were also asked to comment on what they find most challenging in differentiating their teaching in middle school mathematics classrooms. Comments included ‘the huge gaps in basic maths skills’, ‘identifying past experiences and expertise on which to build’, ‘having the time and physical environment to work one to one’, and ‘catering to all needs while meeting the expectations of the curriculum’.

The primary action applied in the Deadly Numeracy Project was the provision of professional development for the participating teachers and learning support staff. This professional development comprised learning and reflection sessions, collaborative planning time, and opportunities to develop resources to be used in the classroom.

Much of the professional support provided to the teachers came from working with Professor Tom Cooper from the YuMi Deadly Centre at Queensland University of Technology. During these sessions teachers learned about quality teaching pedagogies that not only assist in teaching mathematics to Indigenous students, but also to the wider student population. Example concepts included the benefits of seeing mathematics from a ‘whole first, part second’ approach, the importance of being able to reverse in mathematics operations to instil deeper understanding, seeing the world algebraically (‘write me a story that is 2 x 3’), and how to effectively teach place value sequentially.

A collaborative professional development session was organised to allow teachers to reflect on ways that they can learn more about the lived culture of students, as recommended by ‘8 Ways Maths’. The teachers were asked to work in groups to find out about students’ attitudes and beliefs about mathematics and break down the eleven suggested questions into several ‘student-friendly’, contextualised questions to prompt discussion and activity in the classroom. This process was very effective in encouraging teachers to see the value in learning about the lived culture of their students.

Collaborative planning time was provided for teachers to focus on improving their current term planning for mathematics to include differentiation, particularly through the development of hands-on, engaging activities and teaching pedagogies that were culturally inclusive. Further opportunities were provided to develop resources to support the planned curriculum. These resources have been compiled to form a reference tool for teachers of mathematics in middle school at Clayfield College.

### Student data and project actions

The Cognitive Diagnostic Assessment Tasks (CDAT) were developed as part of a cross-sectoral project in Queensland to assess students’ mathematical understanding for the purposes of informing the teaching and learning process. This tool was chosen for the Deadly Numeracy Project to assess students’ current achievement levels, specifically in number. The participating students completed Type A tasks, which focus on structural knowledge and Type B tasks, which focus on the representational knowledge, both at an intermediate level. Competence for each aspect of number was graded as ‘achieving’, ‘developing’ or ‘not evident’. This data, coupled with students’ in-class assessment results, allowed the Deadly Numeracy researchers to identify students of the ten who would be particularly supported and encouraged throughout the project and would receive additional tutoring.

Tutoring for these seven students took place over a one-term period. Tutoring was implemented in the form of a short session of direct instruction intervention, followed by work to support the learning taking place in the students’ mathematics lessons. The use of direct instruction method came about through a desire to ‘catch up’ our target students’ basic maths skills. Direct instruction aims to provide clear, concise teachings strategies to assist student learning and has risen in popularity as a way to close educational gaps between groups of students (Ewing, 2011). Most students in the ‘Deadly Numeracy’ tutoring group responded quite positively to the use of direct instruction and seemed eager to challenge themselves to complete each ‘lesson’ with few or no errors. However, some students appeared bored with this type of teaching.

To assist us to analyse the effectiveness of the direct instruction method, advice was sought from Professor Tom Cooper of the YuMi Deadly Centre at QUT.

My problem with direct instruction is that it does not teach the mathematics content in an approach that I believe empowers learners. It is OK for rote learnt facts and procedures that enable rote learnt tests to be passed, but I want students to understand mathematics as a structure, a language and a tool for problem solving. This requires students to construct the big ideas of mathematics and to fit this into their own unique frameworks, and this is not possible by direct instruction.

Some of the literature about direct instruction expresses concern that practices central to its use have been found to inhibit student engagement with mathematics (Ewing, 2011). These practices include didactic teaching styles, rote learning and memorisation, and are more likely to be associated with high reliance on textbook use in the classroom (Ewing, 2011). The risk that the textbook, rather than the needs of the students, drives teachers is a hurdle that the researchers in the Deadly Numeracy Project wish to overcome. Therefore, it has been determined that while the direct instruction method may have provided our students with some benefits, the use of this type of teaching and learning strategy is ultimately not in keeping with the aims of our middle school curriculum and the Deadly Numeracy Project’s endeavours to improve pedagogy.

At the culmination of the project participating students were once again tested on the same CDAT activities. Results were analysed comparing the students’ results with those completed five months earlier. It was found that on average students had improved their competency score by an average of 1.6%, with one student achieving a 25% improvement in results.

Student self-efficacy data

The ten participating students were asked to complete a self-efficacy survey, designed by Dr Rhonda Farkota at the beginning of the project and again five months later. Students were asked to reflect on given statements and determine how true or not true the statement was for them. These statements were grouped into ‘value placed on mathematics’, ‘interest and attitude towards mathematics’, ‘resilience towards difficulties experienced in mathematics’, and their own ‘self-concept in mathematics’. Students were also asked two open-ended questions about whether they liked maths or not, and how maths classes were different now for them compared with their primary school experience.

On both occasions, the levels of positivity or negativity varied greatly among the students. Unsurprisingly, their scores of positivity or negativity about mathematics usually correlated with their achievement in mathematics. As stated through both their CDAT scores and academic results in the subject of mathematics. Three students in particular, who achieved high CDAT scores and high grades for mathematics in class, also gave highly positive responses in the self-efficacy surveys. Comments by these students included, ‘I like it [maths] because I like a challenge, I enjoy working things out and getting them correct’ and ‘I really enjoy maths because I think it’s fun. I have improved a lot since primary school’. Comments by other students included, ‘I like it, but when it gets too hard for me I dislike it and feel down. I miss that my godmother used to help me in class (primary school)’; ‘I like it when we do things that interest me’, ‘When it’s hard I block everything out’, ‘New units are harder. I like it because I know how to solve problems and I understand it better than I did in primary school’.

For each student, the initial self-efficacy survey was compared with the same survey completed five months later. The three students who initially demonstrated very positive views of mathematics once again scored highly for positivity and, in fact, two scored higher than in the initial survey. Among the other students, only two rated mathematics more positively than they had in the initial survey. When comparing the total responses of the students for each of the four domains, the two areas that had improved the most were ‘resilience’ and ‘self-concept’, while the total ‘value’ for mathematics had decreased.
To understand these changes in scores, three of the students were interviewed. The main reason expressed for a drop in self-efficacy for these students was that the maths had become harder throughout the year. One of the students explained, ‘I used to like maths, but it got difficult every time so I give up. It’s very hard and I don’t have anyone there to talk to me in my language and explain it.’ The other two students spoke more positively about maths in their interviews; one stating that she was setting goals to improve her results and the other commenting, ‘every year (in my subjects) I feel I get a better because I get the hang of it. Yeah, in maths too.’ The ability of the teacher to explain concepts clearly and/or the presence of learning support staff or ESL support staff appeared to be the most influential and valuable factors to the students, even above the mode in which the concepts were delivered. One student also said that assessment was stressful and that there were too many topics in one exam or assignment.

Conclusions of the project
Through the Deadly Numeracy Project several important and inter-connecting conclusions arose. Firstly, we examined the importance of students’ self-concept in mathematics. It was found that there is great value in learning about students’ attitudes towards their learning of mathematics and, by delving deeper into their responses through conversation, we can learn more about barriers to student learning. Secondly, learning about the ‘lived culture’ of our students allows us to ensure that learning becomes more personally meaningful, resulting in student engagement and an increased likelihood of experiencing attainment and improved self-concept. Finally, the project made clear that we must continue an emphasis on improving the quality of our teaching through personal and collaborative reflection, student-centred planning of culturally inclusive mathematics, and teaching in a way that engages our students, such as by ensuring clear communication. It is logical that these actions will result in the improvement of outcomes for all students.

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References

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An exhilarating era for middle schooling at Brisbane Boys’ College

Natasha Podoliak

Brisbane Boys’ College has more than a decade of experience in middle schooling. The Middle School Precinct augments this incredibly rich foundation. The building development finalises the three school campuses (Junior, Middle and Senior) and provides a cohesive link between these through a central college heart. The purpose-built facility includes:

- Four levels, each dedicated to a specific year group. Years 5 and 6 are housed on the bottom level, and Years 7 to 9 occupy the remaining levels.
- Thirty-five contemporary spaces allowing for group work and individualised learning.
- Dedicated spaces for pastoral care activities and house meetings.
- State-of-the-art science laboratory.

The precinct is geared for 21st century learners in classroom design, learning practices and pedagogies. There has been a distinct shift toward student-centred learning, redefining the role of the conventional classroom. The precinct includes interchangeable learning areas, creating a dynamic and technology-rich educational environment. The room layouts allow for instant, physical switching of teaching modes; from the traditional method of didactic teaching and individual student work, to more collaborative small group and large group discussion modes. In each space there is ergonomic furniture, state-of-the-art classroom technologies, flexible spaces and durable flooring. Five mobile touch screens (46-55 inch) with computers (Computer On Wheels) serve both students and teachers. In each classroom wireless connectivity is available from any tablet PC to the larger touch screens for group learning.

Three main principles guided the design of the Middle School Precinct: community, flexibility and sustainability.

Our community is facilitated through nine house groups, each with its own identity and formalised sense of place and ownership. Each house is allocated three classrooms (Year 7, 8 and 9) to use for pastoral care delivery. The rooms are divided by a semi-frosted glass screen, which can be opened to a full house meeting venue, facilitating collaboration and mentoring across the year levels. The student lockers are grouped according to house allocation and are positioned outside of the rooms. The Housemaster is located in central office on each level.

The pastoral model overlays the organisation of academic delivery. For lessons, each level of the Middle School Precinct, with the capacity for nine classrooms, has been allocated to a year group. These rooms become home rooms for each of the nine academic class groups. As many walls as possible are constructed from glass, making learning visible and central to the nucleus of the precinct.

The building has been designed to be flexible in every avenue; all spaces have the capacity for more than one use. Minimal fixed joinery and furniture has been used to ensure teachers and students can explore any modality of learning in the educational environment. The technology has been designed to be ubiquitous with outdoor teaching spaces on each level to encourage flexible and relevant delivery for students.

Sustainability forms an essential pillar of Brisbane Boys’ College and the building encourages sustainable habits, and uses appropriate strategies and technologies to reduce the college’s environmental footprint. Water harvesting, passive heating and cooling, and hybrid and full air-conditioning are available; encouraging the most appropriate and energy efficient environmental controls to be used.

Education in the 21st century is experiencing significant transformation. A key facet of this transformation is the capacity for students to acquire and interact with knowledge. At Brisbane Boys’ College, we actively take responsibility for preparing our students for life beyond our educational institution, where digital proficiency and responsible management is essential. The Middle School Precinct has had a monumental impact on the delivery and application of both pastoral and academic fields for Brisbane Boys’ College. Not only has it provided an avenue to deliver best practice in the scholarly field, affording teachers and students the power to govern the pathway of their learning, it has also been instrumental in the administration of our social and emotional well-being programs; nurturing the ability for students and staff to be closely aligned. Adolescent boys can be reticent to voice their concerns. The first-hand observation of their emotions helps create a holistic picture. It is this recognition of welfare that forms the most important connection one can envision. Middle years educators acknowledge that working with young adolescents is an extremely rewarding phase of education and the precinct aims to foster and enhance every aspect of this. The endless enthusiasm of boys at this age is contagious and our remarkable facility allows us to channel their energy through every facet of our community.

A new, exciting chapter for middle schooling at Brisbane Boys’ College commenced on Tuesday, 28 January, 2014. The dawning of this day heralded the opening of our Middle School Precinct. Boys were able to begin exploring the facility that will be pivotal in their educational journey. Their looks of wonderment and awe captured the essence of this important milestone in the life of our college.

The Middle School Precinct encapsulates a project orchestrated by a team of experts; the establishment is managed by a team of experts; the organisation of academic delivery. For lessons, each level of the Middle School Precinct, with the capacity for nine classrooms, has been allocated to a year group. These rooms become home rooms for each of the nine academic class groups. As many walls as possible are constructed from glass, making learning visible and central to the nucleus of the precinct.

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The innovative nature and purpose-built design of the Middle School Precinct aims to place Brisbane Boys’ College on the world stage for the education of middle years students. The next generation of learners at the college will continue to discover who they are and who they dream of becoming. The precinct embraces the opportunity to nourish and nurture all those who pass through its doors; welcoming them as adolescent boys and releasing them as the future young men of Brisbane Boys’ College.

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Is education game for the change?

Scott Johnston

In 2010 I moved from teaching at the Willunga Waldorf School (WWS) to spend a year teaching mathematics at the Australian Science and Mathematics School (ASMS).

If the reader knows anything of the philosophy and traditions operating in Waldorf schools, you would understand the ‘whiplash’ of pedagogical and philosophical differences I experienced! And so, a series of events relating to ‘gamer’ culture ensued, with some very unexpected outcomes for me and for my teaching.

The ASMS takes on any senior high school students from across South Australia who express and demonstrate a significant interest in science and mathematics. I found it to be a wonderfully welcoming and fascinating group of staff and students. As part of my teaching duties I came in contact with a sub-community of students who referred to themselves as gamers. I had previously thought this to be synonymous with gamblers. However, gamers are those who engage in multiplayer online games such as World of Warcraft® and Call of Duty®.

The enthusiasm these students had for technology impressed me greatly, but I had an inner conflict over the nature of their pastime. I understood that these virtual world encounters had them spellbound and, that to do well required the development of many computer skills, but I was fighting the sense of pointlessness over the actual pursuit.

Back at WWS, I knew quite a few of my middle school aged guardian group were involved in online games, yet I had not connected them with the word, ‘gamer’.

Not only did the ASMS students play online games, but at that time they were actively engaged in getting a previous student of the school elected to parliament to represent the cause of gamers. Their conviction to the cause gave me cause to think again about why they would commit so much time to the doing of their pretend wars. Serendipitously, a TED talk called ‘Gamers can make a better world’ arrived in my email inbox, and I was compelled to watch it (McGonigal, 2010).

Jane categorised the motivations she isolated from observation of adolescents involved with gaming as:

- **Urgent Optimism:** the sense that as a player I can contribute to the success of an action and that difference is immediate.
- **Social Fabric:** I work in my team and I have a high degree of connection with the other members and a deep sense of responsibility for the progress we achieve.
- **Epic Meaning:** I respond to powerful ideas and meaningful goals that I see as transcending immediate difficulties.
- **Blissful Productivity:** I am built to be immersed in a challenge and to work at it in a manner that makes time irrelevant.

This is more fully discussed in ‘Reality is Broken’ (McGonigal, 2011).

A little later in the year the gamer group at the ASMS needed staff supervisors for a Local Area Network (LAN) party that they had carefully planned, using the main building of the school for a weekend. A LAN requires the students to form their own restricted kind of internet through which to share their virtual reality games.

I jumped at the chance, wondering if I would see evidence of these motivators in action. The first surprise for me was just how much cabling the students had lain out across the floor of the play area.

The second surprise was the size and capacity of the personal computers the students brought (by the boot-load) to the event. Many had hand built their machines to extract the best speed and performance to maximise their chances in combat.

**Layout of the LAN party**

Although they fought each other mercilessly through the evening the group was incredibly cohesive, and lamented defeats and rejoiced in breaks over pizza and soft drink to the persistent thump of drum-n-bass. There was a very powerful sense of community and camaraderie across the group. When they were in the game they were gone from this world and stayed ‘in character’ like the best of actors, I could see a trance of deep focus holding them to their missions. It corresponded to what I imagined to be a state of blissful productivity; they were seriously considering a 24-hour continuous session.

I was invited to play, and like a rank amateur thrust on-stage with a group of experienced actors, my efforts were, at best, comedic. They put me out of my misery quickly and repeatedly.

In her talk, Jane referred to a ‘look’ on the face of participants when they achieved an epic win. It’s a face we so rarely see on students’ faces in school, but I saw it time and again as the students (and the odd staff member) played on through the night. McGonigal speaks of how game builders intentionally throw challenges at players that are a stretch, but achievable. Gamers become accustomed to facing off against a hurdle and overcoming it, hence the optimism!

During a sortie, students formed two competing teams and, in battle against each other, had to plan victories ‘on the fly’. This was done...
using headset communication to members of their team. Listening in, I could hear tight social bonds holding the group to a strategy; praise and encouragement abounded, as well as shouts of friendly derision yelled across the room to opponents as they were taken out of the game. There was a depth to their sociability that seemed quite resilient to the cut and thrust of wins and defeats. If this is what Jane meant by social fabric, I had started to realise it was a resilient weave.

I left their realm with as much respect for the social dynamics of gaming as I had questions around how little of these motivations we typically see or tap into in our classrooms. In my mind I could feel building, a worrying mismatch between the capability demonstrated by these students in virtual action and what they brought to the reality of the classroom.

At this stage, my own involvement in virtual worlds had been restricted to bumbling about in Second Life®; observing, trying to build, and discovering programming in its C-based language (Linden Research Inc., 2014). What had impressed me was the degree to which creative individuals had populated such virtual spaces and turned their skills to imaginatively crafting whole environments and artificial life in them; computing runs in the service of art, as much as technology.

At WWS I have the responsibility of introducing computing to students at Year 8 and extending this in subsequent years. It is part of the operating philosophy in Waldorf schools that the use of computers is avoided in students’ primary years. A reality faced by Waldorf schools is that primary students tend to have computer experience from home and at an early exposure before I see them in Year 8 is very inconsistent and unplanned. I figured I needed to provide a strong computing experience that none of them would have previously had that would act to bind them together as a class.

I had previously wanted to create a virtual environment in which to teach various aspects of computing, but many online virtual worlds exclude students of middle school age (for good reason) and the cost of maintaining a virtual space looked to be too much for a relatively high risk experiment. It could easily fall short of the interest mark for my students. However, seeing first-hand how deeply affecting a virtual world could be for gamers inspired me to try establishing one at my Waldorf School on my return in 2011.

Over a dinner conversation with the people who look after the WWS internet server, I mentioned my interest in running a virtual world. By the end of the meal the team had figured exactly what software to use and how it would be set up on the school system; it helped that they were also keen to see what would happen.

Early on in 2011 I watched my computer screen intently as I chatted with these same internet folk as they remotely established and set the virtual world running on the school server. It was a stunning moment when my avatar took its first steps inside that imaginary realm.

The excitement I felt was due to the realisation that this technological step forward meant I could have a virtual world safely operating in Years 8 to 10, with every student in possession of their own avatar. I could teach computing in an immersive digital environment without the possibility of outside interference.

The software chosen was Open Simulator®, an open source clone of the same rendering and physics engines used in Second Life® (many similar). This was what I had previously wanted to teach; teaching of, by and for students. It is essentially a blank, three-dimensional environment shared by users through their avatar forms. It is a digitally rendered world, constructed from primitive objects called ‘prims’, which can be very flexibly morphed, distorted and textured. The world has to be made from the virtual ground up; unlike a game, which has everything pre-established and is then populated by players with specific roles and given tasks.

In a virtual world, every prim can be aesthetically edited to an endless degree and can also have a program embedded in it (making each prim its own state machine). This will determine how it will show life in the virtual environment. Among many other capacities, prims can listen to local chatter in the form of typed text, sense proximity of avatars and other prims, move, morph shape and form in ways both simple and complex, and be the source of light, sounds and music.

To get a sense of the breadth of programming in a virtual world (referred to as ‘scripting’), I recommend the book ‘Scripting your World’ (More, Thorne, & Haig, 2008).

It was these aspects of the flexibility that attracted me; because of the arts orientation of the Waldorf philosophy, I wanted a computer environment that inspired the imagination of my students and within which they could create as individuals and teams. I also wanted an environment that made computing fun and playful. In my humble opinion, I think we turn quite a few students of middle school age off comparing by placing before them too restricted an experience and too linear a concept of what programming can achieve.

I suspect that when a student makes the mental transition to a virtual world it is much the same as a person learning a language through total immersion in the culture. The direction they take in response to how they interpret and make use of things was soaking in and they were clearly quite autonomous.

In class, the response of students to working in the virtual environment was, from the very start, a little astonishing. Each student seems to find a way to demonstrate skill building and an ability to work with others as avatars in cooperative creative ventures (from the clever, to the beautiful and hilarious).

Watching my class I started to see ‘blissful productivity’ abound. A clear indicator of this was that at the end of the teaching slot (Friday afternoons, normally a deadly time to try to deliver anything to middle school students), I typically had to tell the students to keep and go home. When they also wanted to log into the world during lunch breaks, I realised it had their attention. I had worried that because this was not a shoot-em-up® game students would not take to it, but that worry was quickly dispelled.

Social fabric shows its presence by the way students share insights and techniques as they discover them. In moments, I hear an idea spread like a virus across the class as they work on tasks together and offer copies of objects they have crafted. Once a student has built a virtual object it can be gifted to any other avatar by just dragging it from the owner’s inventory onto the target avatar; generosity abounds.

The buzz of industry is exciting to observe and to be industrious requires each student to master quite a few graphic user interfaces, exploit build shortcuts and clever sequencing. The computer side of things was soaking in and they were excited about it.

My other concern was that I wouldn’t really be able to teach computer programming because there would be no interest.

However, when I showed how to ‘script’ prims to do things, there was immediate interest – with some sidestepping my pedestrian instruction to go online to the wiki portal where explanations are found for all available programming functions. (I add that it is a massive language.)

Third-party programs now exist that can help students construct code for use in the virtual world, including ‘Scratch for SecondLife®’ (S4SL). S4SL uses the drag and drop methodology of Scratch programming (Lifelong Kindergym. 2014). I suspect being that the programing brings life to objects in a mind-real virtual space.
I provided students with example programs and showed them where they could ‘tinker’ with them to see what happens. They quickly got used to the idea that it doesn’t matter if a program is tampered with to the point of breaking it. The virtual can be a failure free environment because nothing is really broken.

**Set the task of making an avatar bottle, students devised many variants**

Creating, experimenting and discovering is so quick in the virtual environment that this feeds a sense of ‘can-do’ optimism, a freedom that inspires what McGonigal describes as ‘urgent optimism’. When students can bring their imagination to bear in an environment so flexible and amenable to tinkering, I think they bring to life their equivalent of ‘epic meaning’.

The interested reader is referred to an Introduction to Building in an Open Simulator environment (Tuque, 2014).

I was able to identify, in the work of my students in this virtual world, the dimensions of motivation outlined in the TED talk. The next question was, could this happen outside of a computer-based learning environment and be part of a ‘normal’ classroom experience for students? If I used these motivators as ‘filters’ through which to view curriculum delivery, what would I see?

Parallel to the virtual world project, I devised a routine in my classroom in which students would stand in groups at blackboards scattered around my classroom. The blackboard project is explained in more detail in a previous edition of the Australian Journal of Middle Schooling (Johnston, 2013).

When students are immersed in this process, the sights and sounds are consistent with the conceptual state of ‘blissful productivity’, so I wondered how well this delivery process would stand up to questions about the other three motivators.

From my observations, I believe that the blackboard system taps into the ‘social fabric’ motivator very strongly. The biggest experience for me as a teacher was the rediscovery of social learning! Also, there’s an emotional high associated with a group achievement that is missing from the experience for an individual working in a predominantly isolated manner at their desk.

Evidence of ‘urgent optimism’ emerged a little later in that project when students, instead of groaning about my worksheets, would grab themselves a working group and go straight to the blackboards. They had found a way to deal with the work that made them feel more confident about starting it, and they experienced success more often because of the strength of the team.

‘Epic meaning’ is the motivation gained from the inherent nature of the field being studied. For my students this possibly lies downstream of them discovering again and again that they can crack the concepts. Then they may be in a position to connect with the beauty and depth of the subject.

I now feel that the ‘dog’ of my teaching practice is being ever so subtly wagged by the ‘tail’ of the motivators outlined by McGonigal. The computer studies aspect is currently evolving to include arduino/robotic projects, a reflection of the component of Jane’s thesis about using the skill building of the virtual to eventually find its place in problem solving in the real world.

More general questions arise for me over her findings. Are our young students retreating to gaming because their environment – family, community and school – is not providing for these motivational needs? And what would schools look like if their prime objectives were to engage students by embedding challenges and experiences consistent with these motivators?

I think this is a vital issue for middle school where students can either become engaged and love the material we present, or become switched off and alienated from it.

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The resilient middle years – what makes a successful pastoral program?

Mr Anthony Hill

Emotional intelligence, positive student relationships and fostering student engagement in the middle years promotes student motivation and ‘adolescent wellbeing’

The transition from Year 7 to 8 (and from 2015, Year 6 to 7) can be very emotional and difficult for students. At Canterbury College we found a natural way to assist in this transition within our pastoral care framework.

Our students’ social and emotional wellbeing at Canterbury is an integral part of our college culture and through our pastoral program we have addressed many obstacles of student wellbeing. Every year we conduct a camp for Year 8 students. With up to 40% of our Year 8 cohort new to the college each year, the camp is an added focus on the ‘Bystander’ (Education Development Centre, 2008), an important new strategy for bullying prevention focused on the powerful role of the bystander.

The mission of our Year 8 Camp is to encourage our students to step out of their comfort zones, build resilience and make new friends.

The adventure camp allows the students to achieve these aims, incorporating the additional valuable experiences of preparing and cooking their own meals, setting up tents and being personally responsible for their organisation and time management.

The Rock and Water program uses the building blocks of self-control, self-reflection and self-confidence. Its concept is that of the tough, immovable rock attitude versus the mobile, communicative water attitude, and aligns closely to the emotional intelligence (EI) of students. As EI refers to the ability to perceive, control and evaluate emotions (Mayer & Salovey, 1997) it aligns with the Year 8 program.

As a significant part of our Year 8 pastoral structure, the program underpins all other strands of pastoral care. Some of the attributes of the program include practical anti-bullying strategies, alternatives to aggressive verbal and physical responses, increased self-respect, self-control and self-confidence, enhanced resilience skills and wellbeing, and skills to identify and monitor reactive behaviour patterns (Ykema, 2000). These strategies and the Rock and Water language are used in class by the teachers and the students.

The power of the bystander ideologies (Reach Out, 2014) complement the pastoral program by showing that all types of bystanders can play a positive or negative role in any situation. Depending on how bystanders respond, they can either contribute to the problem or the solution. Bystanders rarely play a completely neutral role, although they may think they do. Through our pastoral program we spend time, during pastoral care lessons and health and physical education classes, role-playing scenarios that students may encounter at school and in the wider community.

There is a focus at Canterbury on how helpful bystanders have the power to play a key role in preventing or stopping bullying. We discuss the types of bystanders and the effects they may have on others.

Restorative practice fits into the broader efforts of schools to develop safe and supportive environments that promote student wellbeing and connectedness to school (Marshall, Shaw, & Freeman, 2002). Restorative justice at Canterbury College encourages joint problem solving by students, creating the conditions for the students to analyse and solve their own problems through affective questioning, such as what has happened, who has been affected, what can we (each) do to improve the situation, and what needs to happen to make things right. Through this process students have an opportunity to put themselves in the position of others, consider their actions, and decide what is required to make things right. Feelings are shared and explored through these affective statements and affective questions (Wachtel, 2004). This enables conversations regarding behaviour, and students are supported in accepting responsibility for their actions.

We have incorporated into this program ‘Kindness Cards’ (Pay It Forward) for students to give to others, which allows students to demonstrate their EI by assisting them in managing and understanding emotions in a positive manner. These cards are aligned with the college values and are known as a ‘Values Passport’. This passport sized booklet includes the college’s values:

- Integritiy: Be honest and trustworthy
- Compassion: Care for others
- Respect: Do to others as you would have them do to you
- School pride: have pride and learn to live
- Community: Celebrate our life together
- Social and Environmental Responsibility: Justice for all.

The students ask teaching staff to sign off their passports as they demonstrate each of the values. The students have the opportunity to nominate peers when they see the college values demonstrated. This program is a valuable way for the new Year 8 students to learn the college values and to recognise the values in others. It also reinforces the values with our existing students. The idea of the Values Passport is to promote our values in a positive manner and reward the students for their efforts through positive discussion, feedback, certificates and small prizes.
Over a period of three years, the program has been delivered to 325 students in Year 8 and has seen the involvement of 25 staff, including pastoral and Health and Physical Education teachers. Staff members are integral to the successful implementation of the program. Following the success of the Rock and Water program in Year 8, components of the program have been incorporated into Year 7 and Year 9 HPE programs. This allows a smooth transition for the students from one year to the next, as the students can build on their knowledge and understanding.

Through Canterbury College’s pastoral program the students are exposed to various opportunities to grow, develop, and build resilience and responsibility. We believe nurturing student development in both verbal and physical forms of communication is imperative. The aim of our program is to help our adolescent students calmly choose their response to a situation with strength and intelligence, and to respond effectively to conflict and challenging behaviour.

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**References**

PhotoQuest

Nicole Heywood

Background

I am a teacher of Art/Studio Arts and Photography at Bacchus Marsh Grammar. My background includes working as a Year 9 and Vocational and Careers Education (VCE) Coordinator before taking a year of family leave. On my return I resumed the role of Year 9 Coordinator and found that it reignited my passion for working with students in the middle years.

Coming back from family leave with fresh eyes and a new position, I had the energy to reflect upon my teaching, student learning and the five-year-old Year 9 photography curriculum. Delving into literature focusing on the middle years I found many resources providing information exploring student engagement, the 21st century skills, the 4 C’s (communication, collaboration, creativity and critical thinking) and Project Based Learning (PBL). While the need to address issues relating to student engagement are not new, I did not have extensive experience working with PBL and the concepts of the 4 C’s were new to me as a teacher. I was keen to explore how I could integrate these into my teaching practices.

Catalyst for change

The catalyst for change for me was a student response during a conversation that I have with my students at the start of each semester when I pose the questions, ‘What is photography?’ and ‘What is learning?’ A bright and highly capable Year 9 student told me, her preferred way of learning was when a teacher told her what to do and told her how to get the highest marks, so she could just do exactly what was asked and no more. She was not interested in challenging herself by engaging in extra thinking or creativity; she was only interested in doing ‘just what it takes’ to get a good grade. It seemed to me that she was a classic example of a disengaged student who was willing to participate and complete the work, although the work meant nothing to her and she did not appear to have any intrinsic motivation for learning in this area.

When I reflected on this comment and examined the curriculum, I noted that it covered concepts of how to take a well-composed image and promoted skills in understanding the technical aspects of the camera. I wondered, ‘What might that mean to a 14 or 15 year-old student?’ I began to think that there was no ‘real life’ aspect to this curriculum and that perhaps this was why they were not intrinsically engaged in the material.

The change

Reflecting on this moment was a catalyst for change and I began to experiment with PBL in my classroom. I made the project ‘real’ and presented it to the students. I launched with a hook activity that involved showing the students a video about the ‘Decisive Moment’ by Henri Cartier-Bresson (various clips available on YouTube), who demonstrated the art of photography and the need to understand the camera in order to produce highly successful photographs.

The hook was followed by a class discussion, the key focus being that each student had to contribute their viewpoints. I introduced a technique whereby each student was issued three icy-pole sticks, with one stick being handed in when a contribution to the discussion was made. All sticks had to be used before more were issued. This was challenging for students. Some wanted to contribute more than their three icy-pole sticks would allow (they were nearly exploding in their chairs), while other students were pushed out of their comfort zones with the requirement that they actually participate in a class discussion.

Using the icy-pole sticks ensured that all students participated in the discussion and all were heard. The students who normally dominate the discussion used their icy-pole sticks quickly, but they understood that they had to be patient enough for the other students to have their chance to contribute. It also ensured that the quieter students participated.

The challenge

The student mentioned earlier found it extremely challenging when she realised that I was not going to provide her each step of the task and that she would need to work through the project with a group in order to address and work through a process of exploring the deep ‘driving question’.

The driving question was, ‘How do you teach someone how to take a great photograph with a DSLR (digital single-lens reflex)’? and was designed to ensure that the students learned how to take a ‘great photograph’ and how to use the technical aspects of the DSLR camera. PBL usually culminates in a product and a presentation. The broad requirements of this project were that the students actually teach someone how to use a DSLR – they had to take their own photographs to demonstrate this – but they also had to leave their ‘student’ with a product that they could take away with them to refer to when they were taking photographs on their own.

One challenge was that the students had to teach a teacher or an older student, which required them to become proficient at using a DSLR themselves in order to teach someone else how to take a great photograph. Another challenge was that the students needed to create a product that would be of genuine use to someone while taking photographs, a resource that they could quickly refer to, to ensure that they were making the best use of the camera.
Minds begin to open
The class brainstormed possibilities of what a product could look like and there were many traditional suggestions, such as an A4 pamphlet, a poster or a booklet. I challenged the students to consider themselves as being out on location taking photographs and queried if they would take out an A3 poster to refer to as a guide. I also asked them to consider what technologies they used in their everyday lives and how they would generally access information. After a long pause the students started listing web sites, e-books and apps as their preferred sources of information. When questioned why they were not considering presenting their product as a website, e-book or app, the response was, ‘We can’t!’ Further questioning revealed that the students had no real reason for not considering these options. This was their ‘ah-ha’ moment; when they realised that the project was theirs. It was up to them to decide how to teach someone and what their product would be.

The steps for this project
1 Project Launch – Includes visuals (relevant YouTube clip), discussion about what students already know, brainstorm to tease out some more knowledge and the driving question, which leaves the students with more questions to answer.

2 How to use the DSLR – This is introduced to the whole class. A hands-on task where students become familiar with the cameras and how to adjust different settings.

3 Group work – In groups of three, Shutter Speed, Aperture and Composition as specific areas are explored, one by each student. At this point the students have to answer three questions, what do we know, what do we need to know, and what do we need to do. This helps the students plan their project and the time that they would need to complete the work. These three questions are derived from the information provided by Bucks Institute for Education (Bucks Institute, 2014), which provides a wealth of information and resources for teachers planning a PBL task.

4 Individual students take photographs of their technical aspect and teach what they have learned to their group. This is their practice teaching time as the other group members question them and give them feedback on what they have learned and how to make improvements to their teaching.

5 Creating the Product – this takes a few weeks, as the students need to provide all imagery and present the product. The students learn how to use Photoshop and another program, depending on their choice of presentation. One week prior to presenting, the students lay out their work for the rest of the class to look at and provide feedback. Sticky notes are used, with each student receiving one sticky note for an ‘I like …’ statement and another for an ‘I wonder …’ statement. The ‘I like …’ gave encouragement, while the ‘I wonder …’ statement allowed for students to give constructive feedback in a positive manner. These statements are also from BIE.

6 Presentation – Students present to teachers or older students in the school and receive feedback from them about their presentation. PhotoQuest students also need to leave their ‘students’ with the completed product.

7 Reflection and evaluation.

PhotoQuest
The Year 9 photography course changed to Year 9 PhotoQuest, where the emphasis is now on how students learn and are engaged in their learning, rather than on content alone. PhotoQuest incorporates two PBL tasks, each running for eight weeks. Each project has a ‘launch’ where I ensure that the project is tantalising enough to leave the students with questions that they wish to answer. Each project requires a product and presentation in the seventh week. This allows for the eighth week to be dedicated to reflection and execution of this project in the future. The purpose of such thorough reflection is to allow the students to analyse the way they learned during the project and to highlight that they learned more than just how to take great photographs. Upon reflection, one student volunteered, that he had to learn how to manage a group member who was having a melt down over a computer program not doing as she pleased. He was delighted that he had developed his people skills, as well as his photography skills through this project.

The outcome
Through reflection, the students are provided the chance to think about their learning, consider what worked for them, what was difficult and how they addressed the difficulties. The feedback from students is sometimes surprising, and overwhelmingly positive. One student said, ‘I didn’t think it would stick in my head (how to use a DSLR) but it did!’ Other students reflected on their ability to communicate and on how well their group worked. Students are eager to find out about their next project and the room is full of energy. They are confident in their discussion with each other, and show a maturity and engagement in their learning: an atmosphere that the previous curriculum for Year 9 photography did not facilitate.

The future
PhotoQuest is only one of the new subjects that have been introduced this year at Bacchus Marsh Grammar. Others include Rise of the Machines and Embedded System Design, which focus on using the latest technological developments such as 3D printing and embedded micro processes. These new subjects place emphasis on developing student capacities and understandings of learning through the delivery of the course rather than content. They are designed to enhance student engagement. In the future, all Year 9 subjects at Bacchus Marsh Grammar will be similarly designed and delivered to ensure that we are preparing our students for life in this century. It is encouraging for us to see the students so involved with their learning and enthusiastic about going to class. It is an enjoyable and inspiring environment for all.

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Reference

Focus on Schools Focus on Schools

Focus on Schools
Machines for making sense

Natalie Lynch

... all invention begins as a daring act of imagination, and begins with a play of outlandish ideas.

Shaun Tan (2012)

A social justice machine? Outlandish!

Question: How might Year 8 middle school boys be empowered to solve global, social problems?

Answer: Pose a paradox – design a machine that will ‘fix’ it.

Classroom Challenge: To design a ‘social justice machine’, that is, a machine for removing invisible walls from society; a machine that creates ‘compassion’ and ‘empathy’ for others.

Through playing out a paradox using drawing, students can engage with mature realities bigger than themselves.

In the context of a Visual and Media Art unit entitled ‘Invisible Walls’, an innovative, new inquiry experience for Year 8 boys focused on invisible social, psychological, emotional and cultural walls that exist in our world. Students were inspired by researching machines such as the Star-On and Star-Off machine of Sylvester McMokey McBean in Dr Seuss’s The Sneetches (1976), the impossible machine drawings of Heath Robinson, and machines of the Oopsatoreum by Shaun Tan (2012) to design a machine of their own, with the purpose of producing ‘social justice’. Impossible? Humanity has designed machines to fix most other problems.

The situation informing the students’ response was a self-selected image from a resource of historic photographs depicting an event illustrating the existence of invisible walls. The images included: six-year-old Ruby Bridges being escorted by U.S. Deputy Marshals from an all-white elementary School in New Orleans, America in 1960; the Tent Embassy installation on the front lawn of Old Parliament House in Australia in 1972; and the singular ‘tank man’, armed with shopping bags, intercepting a column of mobilised tanks intended to arrest the mass protest for democracy in Tiananmen Square, 1980.

Boys were asked, ‘What if you could build a machine to remove invisible walls? What would be the machine’s input, components, energy source, output and by-product(s)?’

A diversity of responses ensued, as boys grappled with the complexities of social injustice and social impediments as a drawing and engineering problem. Comprehensive and convoluted machine drawings proposed imaginative and inventive solutions. One student believed the emission of perfume and instrumental music on a global scale could engender kindness and prosperity for all. Another believed that the production and donning of cultural skins as clothing could produce intercultural understanding and harmony.

‘I think that the most beneficial part of this unit was understanding where social walls are and how they work. They are not always physical but mental, but appearing in physical ways... it was good to understand the concept of what an invisible wall can be’, reflected Tiger Murray, Year 8.

Prior learning experiences to orientated students to this classroom task involved developing and upholding student devised rules for playing a game of handball in the classroom, casting invisible bricks with cellulose using real bricks as template forms, inferring the presence and force of invisible walls from documentary photographs and reconfiguring the visual elements in the photographs with text, to compose a Bansky-inspired graffiti design to raise social conscience. Invisible walls were experienced as protective structures, barriers and emblems and places of resistance.

Social transformation was imaginatively played out in the student’s machine designs.

‘I found the social justice machine drawing most interesting because it allowed us to use our imagination to create a make-believe machine that could break down invisible walls in society.’ William Nioa, Year 8

Asked to comment on what had been learned about society, art, social justice and the relationships between each in the process of his machine designing, William Nioa summarised in his response, ‘some people have it rough and need a social justice machine to help them... I learnt how to incorporate symbolism in my work’ and ‘social justice can’t just be cajoled by a machine, it is a serious problem, but ‘art can help social problems’.

Inspired by the social conscience of Cai Guo-Qiang (2006) in the work Head On, in the current exhibition Falling Back to Earth at the Gallery of Modern Art, the assessment challenge of designing a three-dimensional form to address social issues required preliminary inquiries that engaged the students’ imagination in ambitious visual problem solving and courageous, inventive expression. The concept of a machine seemed a simple, but creative way, to introduce Year 8 boys to the spatial complexity and structural symbolism of an art installation. Drawing, as a means to conceptually reflect and act upon the transformation of social issues, successfully addressed the cognitive and emotional skills required for the assessment task that ensued, involving the design and three-dimensional modelling of an art installation interpreting a social ‘pack’.

Question: What is an art installation?

Answer: It is like a machine that makes sense of the world. The components are space and form/s, the input – the viewer, the energy – the viewer’s search for meaning and the output – the viewer’s understanding of their relationship to the world around them.

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