# An ability approach to within-class curriculum differentiation using student response systems and Web 2.0 technologies: Analysing teachers' responsiveness

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**Abstract.** This paper examines teacher responsiveness to an ability approach of within-class curriculum differentiation using technology. Teachers were guided through a series of four workshops designed to enhance their capacity to differentiate the curriculum using Web 2.0 technologies and Student Response Systems. Anderson & Krathwohl's (2001) Taxonomy of Learning, Teaching and Assessing was used as a framework for the within-class ability differentiation. As a result of the project there was a discernable focusing of teachers' conceptualisations of differentiation and its value. There were also improvements in teachers' self-reported ability to differentiate the curriculum, ability to integrate technology into the classroom, and enjoyment of using technology. Considerable variance in teachers' capacity to differentiate according to student ability using technology was observed, indicating that a differentiated approach to supporting teachers' development in this area may be required.

**Keywords:** Differentiation, student response systems, Web 2.0, mixed-ability, revised Blooms

## Introduction

This study investigated teachers' responsiveness to a professional development program aimed at supporting them to differentiate the curriculum on the basis of student ability using Web 2.0 technologies and SRSs, and Anderson & Krathwohl's (2001) Taxonomy of Learning, Teaching and Assessing. A vision of 21st century knowledge and skills for all students requires that teachers can appropriately integrate technologies to support learning and teaching (Abourbih & Witham, 2007). At the same time teachers are under increasing pressure to create differentiated learning pathways in order to cater for the diverse needs of students within their classes (Tomlinson, et al., 2003).

When used together, Student Response Systems and Web 2.0 technologies have the potential to effectively facilitate curriculum differentiation by supporting the diagnosis of student ability levels and the provision of alternative learning pathways for students (respectively). Student Response Systems (SRSs) are a contemporary handheld technology that support learning by enabling teachers to collect student responses to multiple choice questions (Beatty & Gerace, 2009). This provides teachers with a valuable viewport into students thinking for diagnostic purposes (Johnson & McLeod, 2004). Web 2.0 technologies are a relatively new range of open online technologies that enable simple publication and sharing of content through sophisticated yet easy to use interfaces (Alexander, 2006). This allows teachers and students to upload, share and review each others' work as part of a learning community (Karabulut & Correia, 2008). Thus SRSs can be used to diagnose the various levels of student ability in a class, and Web 2.0 technologies can be used to provide appropriately pitched learning tasks based on the different student ability levels.

Educators cannot assume that the use of these technologies will in and of itself result in improved student engagement or learning outcomes; rather it is the way that these technologies are used that determines the quality of learning (Anthis, 2011; Bennett, Bishop, Dalgarno, Waycott, & Kennedy, 2012; Byrne, 2009). Nor is transforming teaching practice so as to integrate technologies such as SRS or Web 2.0 tools a simple undertaking (Hughes, Guion, Bruce, Horton, & Prescott, 2011; Kolikant, Drane, & Calkins, 2010). Moreover, within class curriculum differentiation based on ability is rarely reported within the literature (see review below) and thus there is a scarcity of examples upon which to ground practice. Thus professional learning plays a valuable role in supporting teachers to effectively use technology to differentiate the curriculum according to ability. This paper responds to this deficiency of research in this area by investigating how a professional learning program impacted upon teachers' capacity to apply an ability approach to curriculum differentiation using technology.

## Web 2.0 tools to support student-centred collaborative learning

Web 2.0 technologies advance on the previous static Web 1.0 platform by enabling user initiated publishing, social networking and formation of online groups (Rosen & Nelson, 2008). Web 2.0 tools provide the potential for seamless transfer of information, collaborative as well as individualized learning, and active participation by all members of a class (Karabulut & Correia, 2008). The social dimension of Web 2.0 technologies enable teachers and students to create communities of learners that can transcend the traditional boundaries of the classroom (Vaughan, Nickle, Silovs, & Zimmer, 2011). These social learning networks can then support student self-regulated learning processes such as help seeking and comparative self-evaluation (Kitsantas & Dabbagh, 2011).

There are numerous case studies across a range of disciplines and levels expounding the benefits of using Web 2.0 technologies in the classroom. For instance, weblogs (blogs) and podcasts have been used to enhance delivery of school level science education (Barlow, 2008). Blogs and an assortment of other Web 2.0 technologies have been used to replace Learning Management System interaction at university level (Churchill, 2011). Collaborative use of wikis has been used to support the development of students' abductive reasoning capabilities (Glassman & Kang, 2011). The multi-point distributed access of Web 2.0 technologies means that they could effectively facilitate project work and thus group reflection (Kim, Hong, Bonk, & Lim, 2011). Web 2.0 tools such as wikis and blogs have enhanced literacy learning by enabling students to more easily share and co-construct digital texts (Fahser-Herro & Steinkuehler, 2010). Online annotation has been used to improve critical thinking and literacy through shared examples, practices, reflection and collaboration (Mendenhall & Johnson, 2010). A wide range of Web 2.0 tools and approaches have been identified to support mathematics learning (Thomas & Li, 2008).

Part of the vision for 21st century teachers is that they can appropriately utilise Web 2.0 technologies in the classroom (Regazzoni, Bonesana, Djaékov, & Mattiuz, 2007). One of the main benefits of Web 2.0 technologies is that they provide a valuable impetus to rethink pedagogy (Adcock & Bolick, 2011; Albion, 2008). However, there is often a discord between the affordance possibilities of Web 2.0 technologies and the ways in which educators use them (Dohn, 2009b). Teachers often use Web 2.0 technologies to simply replace or amplify traditional instructional approaches rather than utilising the potentials of Web 2.0 tools to transform pedagogical practices (Hughes, et al., 2011). Part of this may be due to a narrow conception of how technology can be used (Keir & Elizondo, 2010). Simply utilising Web 2.0 technologies within a learning experience does not mean that students will find the task

relevant or worthwhile, and students may not have as much experience with or enjoyment of Web 2.0 usage as teachers sometimes assume (Bennett, et al., 2012). As well, the way in which Web 2.0 tools are used in and out of classrooms is markedly different, which can lead to a "digital dissonance" whereby students are not directly comfortable or familiar with the use of Web 2.0 for learning purposes (Clark, Logan, Luckin, Mee, & Oliver, 2009). The manner in which students engage in Web 2.0 tasks can also have a critical influence on the learning that takes place, for instance students may simply copy and paste material from another website for a collaborative wiki task rather than truly synthesising and constructing new knowledge (Dohn, 2009a). The teachers' ability to effectively manage the integration of Web 2.0 technologies is therefore critical to the success of the learning experience (Churchill, 2011). As one example, instructor intervention during online project based group reflection was shown to result in improved group performance (Kim, et al., 2011).

The uptake of Web 2.0 technologies such as blogs, social networking and wikis by teachers in classrooms has been less than pervasive (Conole, 2010; Pan & Franklin, 2011). A nationwide survey in the United States found that in-services teachers generally report low teacher self-efficacy in the use of Web 2.0 tools as well as low frequency of utilisation (Pan & Franklin, 2011). This may in part be due to the fact that integration of Web 2.0 technologies into teaching practices can be demanding, and a change in teacher mindset towards openness to pedagogical exploration may be required (Mathew, 2012; O'Connor, 2012). Some educators conjecture that institutional strategies are required in order to effectively use Web 2.0 as a change agent for shift in teacher practice (Schneckenberg, Ehlers, & Adelsberger, 2011). Educator uptake of Web 2.0 technologies has been shown to correlate with teacher beliefs about how these tools can impact upon learning, their ease of use, their ability to meet student expectations, and education self efficacy in their use (Sadaf, Newby, & Ertmer, 2012).

Assisting teachers to fully utilise the potential of Web 2.0 technologies is key challenge for the education field (Dohn, 2009b; Kuo & Walker, 2010). Without adequate principles and frameworks to support their thinking and practice, teachers may struggle to make more than superficial use of online technologies (Wang, 2008). As such, academics place emphasis on designing tools and approaches to support the innovative use of Web 2.0 technologies in the classroom (for instance Bower, Craft, Laurillard, & Masterman, 2011; Conole, 2010). Critical to the design process is understanding how to match the affordances of the Web 2.0 technologies to the learning requirements of the task (Bower, Hedberg, & Kuswara, 2010). Web 2.0 tasks also need to be designed with the content area ability levels and technological capabilities of students in mind so as not to cause cognitive overload in learners (Lambert, Kalyuga, & Capan, 2009). That is to say, given the different ability levels in each class, it may be necessary to design different tasks to cater to the different discipline specific and technological abilities of students.

Professional development and school administrative support have also been found to be positive predictors of Web 2.0 usage (Pan & Franklin, 2011). Researchers have proposed that successful diffusion of transformative educational technologies requires the timely intervention by change agents to facilitate the change process (Hughes, et al., 2011). Scholars argue that more research is required in order to better understand how teachers can be effectively supported to utilise Web 2.0 tools in ways that enhance learning and teaching (Greenhow, Robelia, & Hughes, 2009; Smith & Dobson, 2011).

## Student Response Systems as a means to understand student thinking

Student Response Systems (SRSs, also known as classroom response systems, audience response systems, personal response systems, and "clickers") are a handheld technology that enables students to respond to polls posed by teachers (Beatty & Gerace, 2009). After students have selected their answer to questions using their devices, a digital receiver collates responses that can then be presented back to the class. Underpinning effective assessment practices is the use of curriculum-relevant learning data to inform learning and teaching (Timperly, 2009). SRS provide an instantaneous means of capturing student data within classes in order to formatively diagnose student ability.

Teachers perceive several benefits of using SRSs, including the ease with which responses are collated, improved participation, and the ability to provide immediate feedback (Gok, 2011). Importantly, SRSs have been praised for offering teachers a viewport into students' thinking, allowing teachers to understand the individual strengths and weaknesses of pupils within a class (Johnson & McLeod, 2004). SRSs can be particularly useful to enable early identification of at risk students so that remedial support can be offered (Griff & Matter, 2008). They also have the advantage of allowing students to respond to questions anonymously so as to overcome embarrassment (Liu & Stengel, 2011) and obviating the pressure to conform (Stowell, Oldham, & Bennett, 2010).

Using SRSs has been linked to improvements in student performance in schools (Mun & Hew, 2009; Sartori, 2008) and in universities (Bain & Przybyla, 2009; Epstein, Epstein, & Brosvic, 2001; Radosevich, Salomon, Radosevich, & Kahn, 2008; Shapiro, 2009). Using such technologies to providing immediate feedback to assessment has also been demonstrated to improve retention of concepts over the longer term (Blood, 2012; Epstein & Lazarus, 2002). Such approaches that require retrieval of concepts during lessons can result deeper learning than elaborative exercises (Karpicke & Blunt, 2011). The use of SRSs in the classroom has also been shown to increase student attention and motivation (Cain, Black, & Rohr, 2009) as well as engagement (Blood & Neel, 2008). Evidence suggests that a principle reason SRSs can enhance student performance is because the presence of a response device primes students to pay more attention to the content being delivered (Bartsch & Murphy, 2011).

Researchers propose that while SRS provide a catalyst for pedagogical change towards more interactive and student-centred learning, this transformation is by no means an instantaneous or straight-forward process (Kolikant, et al., 2010). There are a range of reasons that teachers have difficulty when first attempting to use SRSs in the classroom, including their ability to operate the hardware and software, their capacity to develop appropriate questions, competing school-based pressures, and their ability to implement the formative assessment approaches in the classroom (Lee, Feldman, & Beatty, 2012). Technological malfunctions and the extra time required to design appropriate questions are also inhibiting factors (Kay, LeSage, & Knaack, 2010).

Given the numerous potential benefits of SRSs but the simultaneous difficulty in adopting them, professional learning programs in this area would appear to be a highly valuable pursuit. Professional development in the use of SRS has been correlated with more frequent use of the technology as well as utilisation of a wider array of pedagogical strategies (Penuel, Boscardin, Masyn, & Crawford, 2007). In terms of associated benefits of this type of professional endeavour, SRSs usage has even been correlated with greater levels of teacher reflective thinking (Waller & Edens, 2012).

Thus institutions and systems are challenged with how to effectively diffuse this technology throughout their educational programs. One study suggests that the pervasive use of

clickers across a Faculty can be effectively fostered through educational leaders who pioneer reform, time and resource support from executive staff, and provision of appropriate professional learning programs (Koenig, 2010). However there is a paucity of literature examining the various possible types of SRS professional development and their relative impact on teachers. Nowhere in the SRS literature reviewed was identification of different student ability levels examined in conjunction with how to subsequently differentiate the curriculum for learners.

## Differentiated learning

Increased emphasis on heterogeneous classes that may include both gifted and talented students as well as students with special needs means that catering to academically diverse learners in regular classrooms is an inevitable part of a teacher's role (Tomlinson, et al., 2003). Differentiated instruction "seeks to maximize each student's growth by recognizing that students have different ways of learning, different interests, and different ways of responding to instruction…in practice it involves offering several different learning experiences in response to students' varied needs" (Ravitch, 2007, p. 75). At the heart of differentiation is that learners are motivated and engaged by appropriate levels of challenge and choice (Belliveau-Brown, 2008; Cheng, 2006; Fogarty & Pete, 2007).

Differentiation may be in terms of the content addressed, the process applied, and the product produced (Renzulli, Leppien, & Hays, 2000; Tomlinson, 1999). Content may be differentiated in terms of its complexity, the resources used, and the learning environment (Fogarty & Pete, 2007). Learning processes may be differentiated in terms of the degree of interaction and student independence. For instance teachers may decide to utilize direct instruction, cooperative learning, inquiry learning, or other pedagogies (Fogarty & Pete, 2007). Products may be differentiated in terms of their entry points, their expressive modes, and the degree of individual accountability that a learner is expected to assume (Fogarty & Pete, 2007). When curriculum is appropriately differentiated it can result in a high standard of education where assessment informs instruction, classroom routines flexibly cater to student needs, and where students and teachers share responsibility for outcomes (Tomlinson, Brimijoin, & Narvaez, 2008).

Some scholars advocate differentiation by learning styles (Lauria, 2010; Sprenger, 2003). However a recent scholarly review of learning style research concluded that there is insufficient evidence to support learning styles alone as an instructionally useful concept when planning and delivering differentiated instruction (Landrum & McDuffie, 2010). Other's advocate differentiation on the basis of Gardner's Theory of Multiple Intelligences – incorporating visual-spatial, verbal-linguistic, intrapersonal-social, intrapersonal-intraspective, musical-rhythmic, logical-mathematical, bodily-kinesthetic, and naturalistic dimensions (Fogarty & Pete, 2007; Noble, 2004). Possibly the most comprehensive approach to differentiation is provided by Tomlinson, Brighton, Hertberg et al. (2003), who recommend a model of differentiation based on students' readiness (i.e. pitch), interest, and learning profile. However, they provide no pedagogical framework to guide differentiation on these levels. Only rarely have studies proposed differentiation of the curriculum by cognitive processes such as those in Anderson & Krathwohl's revised Bloom's Taxonomy, and in one case when this was attempted this type of differentiation was interleaved with other forms of differentiation (see Noble, 2004).

In many cases differentiation is used synonymously with ability streaming. International research supports the conclusion that having high-ability/high-achieving schoolmates/classmates is associated with increased achievement (Hallinan & Kubitschek,

1999; Schofield, 2010). However the same research also suggests that ability grouping with curriculum differentiation increases the achievement gap (Schofield, 2010). For this reason classes are often not streamed, and the teacher is challenged with how to make the curriculum relevant and meaningful for a diverse range of student abilities within a class.

Historically, few teachers make significant changes to learning and teaching approaches in response to the different needs of learners in their classes (Tomlinson, et al., 2003). Research and theory on change in schools indicates that the scope of the change makes differentiation of a school curriculum profoundly difficult, requiring persistent and sustained leadership to support the change (Tomlinson, et al., 2003). Teachers have been shown to perceive an inherent value in differentiating the curriculum in order to promote quality of learning for all of their students (Petersen, 2008). However, teachers can be concerned about the lack of time and resources available to differentiate the curriculum (McGarvey & et al., 1996).

A key question, then, is how to best support teachers to differentiate the curriculum. Professional development aimed at improving teachers' ability to differentiate their lessons has achieved mixed results. For instance, regression analyses in one study revealed that teachers' levels of differentiated instruction training were not positively related to teachers' knowledge of differentiated instruction, but there was a positive relationship between teachers' familiarity and use of content, process, product, and differentiated instruction strategies (McMillan, 2011).

Professional development in differentiating the curriculum for gifted and talented classes can result in teachers more often selecting differentiated strategies such as grouping practices, use of prompts of depth and complexity and teaching universal concepts and big ideas (Sellers, 2008). However other research in this area indicated that factors related to professional development opportunities did not influence the degree to which teachers transferred depth and complexity prompts to differentiate content for gifted learners (Park, 2008). This potentially exposes how the nature of the professional development may be critical in determining the impact of professional learning opportunities on teachers' classroom practice. In any case, the aforementioned strategies relate to teaching gifted classes of children, and say nothing about how to differentiate the curriculum for different levels of students within a class. Yet this is a principle challenge confronting most teachers who everyday attempt to effectively cater to a wide range of ability levels within their classroom.

Early studies examining the use of technology to support differentiation suggest that teachers are somewhat comfortable with the idea that technology may be used to differentiate the curriculum (Nicolino, 2007). Students of every ability level can be motivated to complete projects that use technology creatively, and the degree sophistication with which students apply the technology can in and of itself provide a degree of differentiation (Bergen, 2002).

## Anderson & Krathwohl's taxonomy as a framework for ability differentiation

One of the challenges of differentiating the curriculum based on ability is determining how to distinguish between ability levels, both during the diagnostic and learning design processes. Anderson and Krathwohls' (2001) Taxonomy of Learning, Teaching and Assessing incorporates a Cognitive Process dimension that enables differentiation of ability level based on the level of thinking required, either 'remembering', 'understanding', 'applying', 'analysing', 'evaluating', or 'Creating'.

Based on a modification of Bloom's (1956) Taxonomy, the levels form a hierarchy in so far as for a particular topic or concept students require the thinking capabilities at lower levels in order to adequately perform tasks at the higher levels (Anderson & Krathwohl, 2001). Thus it is suitable within a class to have students with lower prerequisite knowledge and skills complete the lower level tasks, as attempting higher order tasks straight away would most likely result in failure. While differentiating the curriculum for a class with six learning pathways within a class may not be practical, differentiating using three levels is more achievable, and thus the approach to differentiation adopted in this study was to define three levels:

- 'Remembering' and 'Understanding' – establishing concepts and learning about them
- 'Applying' and 'Analysing' – using the concepts and perform more advanced interrogation of them
- 'Evaluating' and 'Creating' – making qualitative judgements about concepts and forming new meaning from them.

These levels could then form a pedagogical framework to both diagnose the level of students' ability within a class and create differentiated learning pathways for them.

Using Anderson & Krathwohl's (2001) Revised Bloom's Taxonomy with Student Response Systems and Web 2.0 technologies is a novel approach within the literature. While the Revised Bloom's Taxonomy has been previously used to differentiate for different levels of student ability (see Noble, 2004), the integration of SRS and Web 2.0 technology has not previously been documented. Moreover, the collation and analysis of teacher responsiveness to such approaches has not been addressed. Thus this paper provides a unique insight not only into how technology can be used to enhance curriculum differentiation but also into the potential impact of professional development in this area on pedagogical thinking and practice.

## Method

Teachers from four schools in the Western Suburbs of Sydney were invited to participate in the professional learning experience aimed at improving their ability to differentiate the curriculum for students. The professional development program included four sessions with two weeks between each:

- A 2-hour evening workshop focused on Web 2.0 learning and teaching strategies (introduction to Web 2.0 tools and discussion of ways that they can be used to enhance learning) with resources posted online.
- A 2-hour follow-up evening workshop to provide guidance for teachers on how to diagnose student understanding of a topic and subsequently provide differentiated learning pathways depending on student ability.
- An optional 2-hour individual mentoring session to support teachers who felt the need for more individualised support.
- A 2-hour follow-up session to review what individuals and teams had achieved and to provide feedback about the process.

Prior to the program teachers had completed small group training sessions to familiarise them with the Keepad TurningPoint SRSs being used and the teaching approaches they enable. For the large majority of teachers this was the only experience that they had with

using SRSs. The expectation of the current program was that based on the instruction and guidance provided in the first three sessions the participating teachers would design a lesson that used Student Response Systems and Web 2.0 technologies to create and potentially implement an alternative learning pathways lesson. The Moodle Learning Management System was used to structure the program, disseminate resources, facilitate design, and enable collaboration between participants.

The Web 2.0 tools used in the first session were weblogs (Wordpress, see http://wordpress.com), social bookmarking (Diigo, see http://diigo.com), and wikis (PBworks, see http://pbworks.com). The pedagogical approach adopted in the session modelled the sort of approach that the program was aiming to develop. That is, the facilitator (Chief Investigator) presented questions relating to each tool at different levels of cognitive ability and ask teachers to respond using Student Response Systems. Individual teachers would then be encouraged to complete different learning activities based on their performance in the pre-quizzes. The second session commenced with a brief presentation about how Anderson & Krathwohl's (2001) Taxonomy of Learning Teaching and Assessing could be used as a way of differentiating learning pathways on the basis of ability. The majority of time in this session was then dedicated to teachers designing their differentiated lessons on the course website (drafted on a Moodle wiki). Teachers were encouraged to structure their design using three sections 'Outcomes', 'Questions' and 'Activities', and to differentiate the 'Questions' and 'Activities' sections of their learning designs using the three levels 'Recognise and Understand', 'Apply and Analyse', and 'Evaluate and Create' (as had been modelled in the initial Web 2.0 session). At the conclusion of the session teachers were encouraged to refine, create and implement their designs in their classes at some stage over the next four weeks.

Primary data sources for this project included teachers' contributions throughout the program (to the course website and to discussions during workshop sessions) as well as teachers' responses to pre- and post- program surveys. The pre-questions related to teachers' understanding of alternative learning pathways, the importance of them, difficulties experienced in implementing alternative learning pathways including the teachers' ability to provide them. The pre-survey also included some questions relating to teachers' general perceptions of using technology (their ability, confidence and enjoyment). The post-survey was identical to pre-survey except it included some additional questions relating to teachers' perceptions of the professional development program. The pre-survey was administered at the beginning of the first session and the post-survey was administered at the completion of the final session in order to objectively gauge changes to teachers' perceptions surrounding the creation of alternative learning pathways for their students. Teachers' designs of alternative learning pathway lessons that they composed on the course wiki were analysed to interpret teachers' ability to create diagnostic questions and differentiated activities to cater to individual students' learning needs.

A criterion-based framework was devised to analyse teacher conceptions and gauge improvements. This framework was based on a grounded theory approach to categorising the themes emerging from teacher descriptions of alternative learning pathways and quantifying their prevalence. Pertinent and representative quotes were also used to provide rich primary sources of evidence of teachers' conceptualisations throughout the analysis phase.

There were 24 teachers who volunteered to attend the first session on Web 2.0 tools, 17 attended the second session on differentiated learning pathways, 8 attended the third optional support session, and 14 attended the final debriefing session. Correspondence received from discontinuing participants as well as feedback from the Assistant Principal

indicated that attrition was primarily due to the pressure of meeting other teaching demands. There were 20 participants who volunteered to complete the pre-survey and 14 participants who volunteered to complete the post-survey. While qualitative analysis considered the responses of participants who did not complete the post-survey, all statistical analysis is based on the 14 participants who completed both the pre- and post- survey. For Likert scale items, statistical analysis was based on assigning a numeric value to response stems ('Strongly Disagree' = 0, 'Disagree' = 1, 'Mildly Disagree' = 2, 'Neutral' = 3, 'Mildly Agree' = 4, 'Agree' = 5, 'Strongly Agree' = 6). T-tests were used to compare pre and post treatment responses in order to account for the small sample size (less than 25 people). The average prior teaching experience of the 14 pre- and post- survey respondents was 9.1 years with a standard deviation of 6.9 years. This wide spread of teaching experience was also represented in the range of years prior teaching experience (from 0 to 25 years). Observations during the initial session indicated that the majority of teachers were novices at using Web 2.0 technologies.

## Results

### *Teachers' designs*

There was a wide variety in the ability of teachers to design lessons that differentiated using technology. Some teachers were able to create diagnostic questions at three different levels of cognitive challenge followed by appropriately pitched activities for students at each level, while other teachers struggled to conceptualise how they might attempt to differentiate their lesson. In-situ observations and participant feedback indicated that the main areas of difficulty appeared to be:

1. Conceptualising how Anderson & Krathwohl's (2001) Taxonomy could be used to differentiate the curriculum
2. Understanding the precise meaning of the different Anderson & Krathwohl (2001) cognitive process levels
3. Disecting the curriculum content to create diagnostic questions at each of the levels which students could complete using the SRSs
4. Creating appropriate activities for each of the levels of student ability
5. Designing activities that leveraged Web 2.0 technologies to provide the alternative learning pathways.

An example of a differentiated learning lesson in its elementary design phases is shown in Figure 1. Note that the design is not yet fully elaborated and that to some extent there is a blurring of the diagnostic SRS phase and the subsequent differentiated learning pathways. Other teachers were able to design more detailed and differentiated tasks for their students, creating learning designs that evidenced advanced pedagogical capabilities aimed at scaffolding students towards higher order thinking in their respective subject areas. For instance, Figure 2 illustrates formative questions composed on one teacher's wiki page as part of a learning design aimed at developing students' persuasive writing capabilities. The questions demonstrate the ability to unpack the different levels of thinking surrounding persuasive writing, from 'remember' and 'understand', to 'apply' and 'analyse', to 'evaluate' and 'create'. The design provides a clear indication of the sorts of skills required in the area of persuasive writing, and the questions enable the students and the teacher to diagnose ability levels from basic understanding of the concept of persuasive writing to being able to evaluate the quality of persuasive writing.

**Outcome:**

Student is able to identify a picture and match to beginning sound.

**Formative assesment**

Complete the assessment using keepad technology to guide where explicit teaching is to occur.

**Activities**

*Understand/remember*

1.Using Keepad to match a sound to a picture

*Apply/analyse*

*2. Create Keepad to select a picture out of 4 choices to match a beginning phonetic sound.*

*Evaluate/create*

*3. Student is adding a missing word in a spelling activity.*

**Figure 1. An example of a differentiated learning lesson in its elementary design phases**

## What are your learning outcomes?

Students will identify the elements of persuasive texts, analyse and evaluate the effective/ineffective nature a number of persuasive texts and create their own persuasive text.

## What formative questions can be used to assess student understanding? (levels of ability)

**Remembering/Understanding**

1) Which definition below best represents your idea of the term persuasive?

a. Pleasing in personality or appearance b. Something that tries to convince others of a point of view on a certain subject. c. intended or having the power to induce action or belief d. deviating from what is considered moral or right or proper or good

2) Which of the following phrases is an example of persuasive language?

3) Which of the following is a persuasive text?

4) Watch they youtube clip http://www.youtube.com/watch?v=zyZRDL8nm-A select any of the stratiegies below which Adora mentioned.

**Analysing/Applying**

1. What message does this text send to Indigenous Australian Women?


2) Read Severn Suzuki's **Address to the Plenary Session, Earth Summit, Rio Centro, Brazil 1992**.

http://www.sfsf.com.au/econews/econews_story_severin_suziki.htm

Which of the following lines is used to persuade a change in lifestyle?

**Evaluating/Creating**

1. Select the advertisement you consider the most persuasive.

2. Reread Severn Suzuki's **Address to the Plenary Session, Earth Summit, Rio Centro, Brazil 1992**.

http://www.sfsf.com.au/econews/econews_story_severin_suziki.htm and decide which grade best suits this persuasive text.

**Figure 2. English persuasive writing learning design outcomes and diagnostic questions**

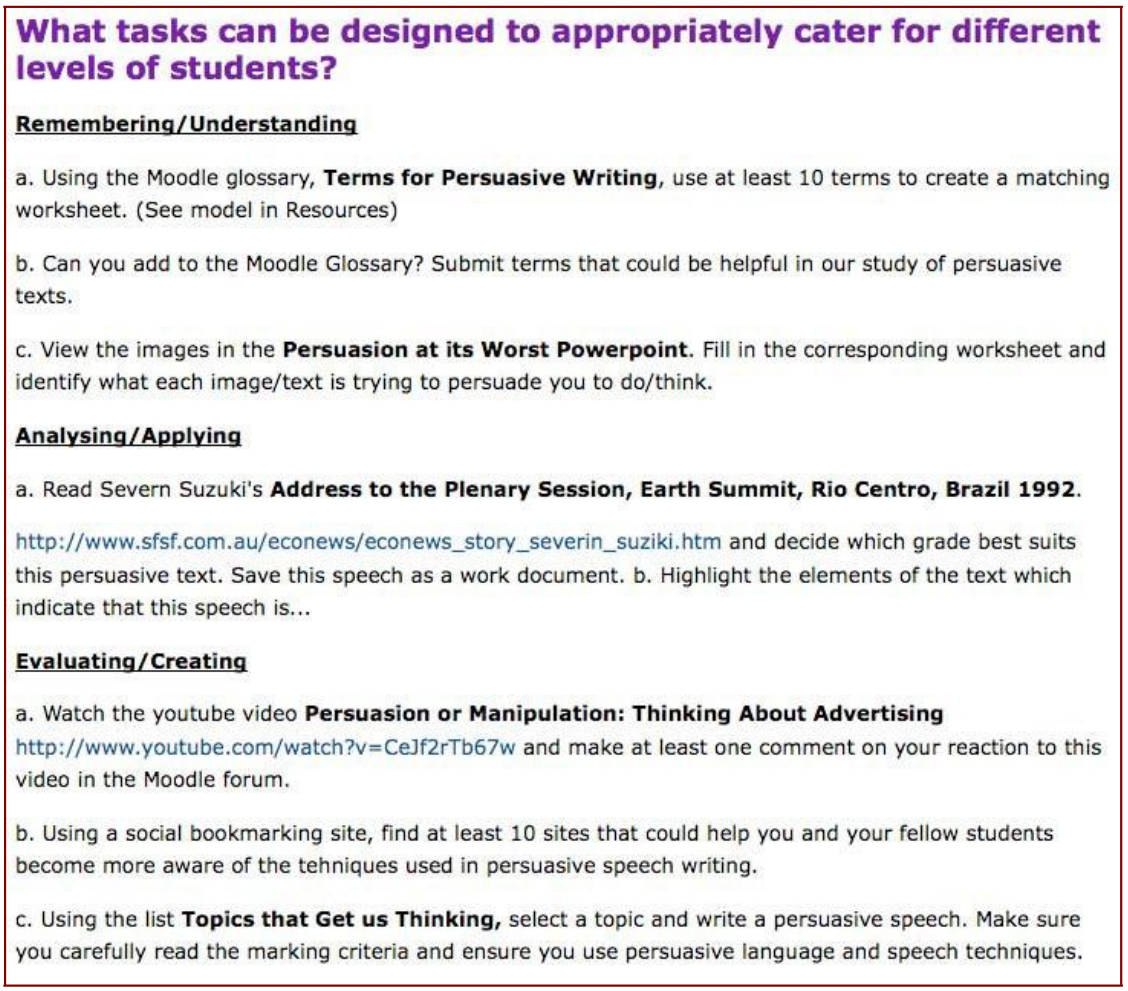


**Figure 3. English persuasive writing learning design differentiated learning pathways**

In Figure 3 the same teacher designed a range of subsequent tasks that cater to each of the different levels of ability that students demonstrate as part of the formative questioning sequence. At the elementary 'remember' and 'understand' levels students are performing matching and definition tasks using digital glossaries, online worksheets and PowerPoint presentations. Students at the 'apply' and 'analyse' levels are determining which features of an online resource are contributing to its degree of persuasiveness. The 'evaluate' and 'create' tasks have students using discussion boards to share their assessment of online videos, creating a collaborative knowledge bases using social bookmarking, and writing persuasive prose of their own. This wiki plan could then be directly translated into formative SRS questions and subsequent Web 2.0 activities.

A second example of a teacher's differentiated learning design is shown in Figure 4. The differentiated Science lesson on mangrove forests uses formative questioning to test students' understanding of mangrove plant structure, their ability to analyse how the biological design of the plant has evolved to suit its environment, and to evaluate courses of human management of these ecosystems. The level of detail for the diagnosis section is a greater still, with question stems specified. The subsequent differentiated learning pathways use social bookmarking to help students with an elementary understanding of the topic to collaboratively form a knowledge base about mangrove forests, have students with an intermediate understanding apply their knowledge to create descriptive blog posts relating to mangrove seed germination, and challenge more advanced students to solve an environmental management problem for mangrove swamps on a wiki.

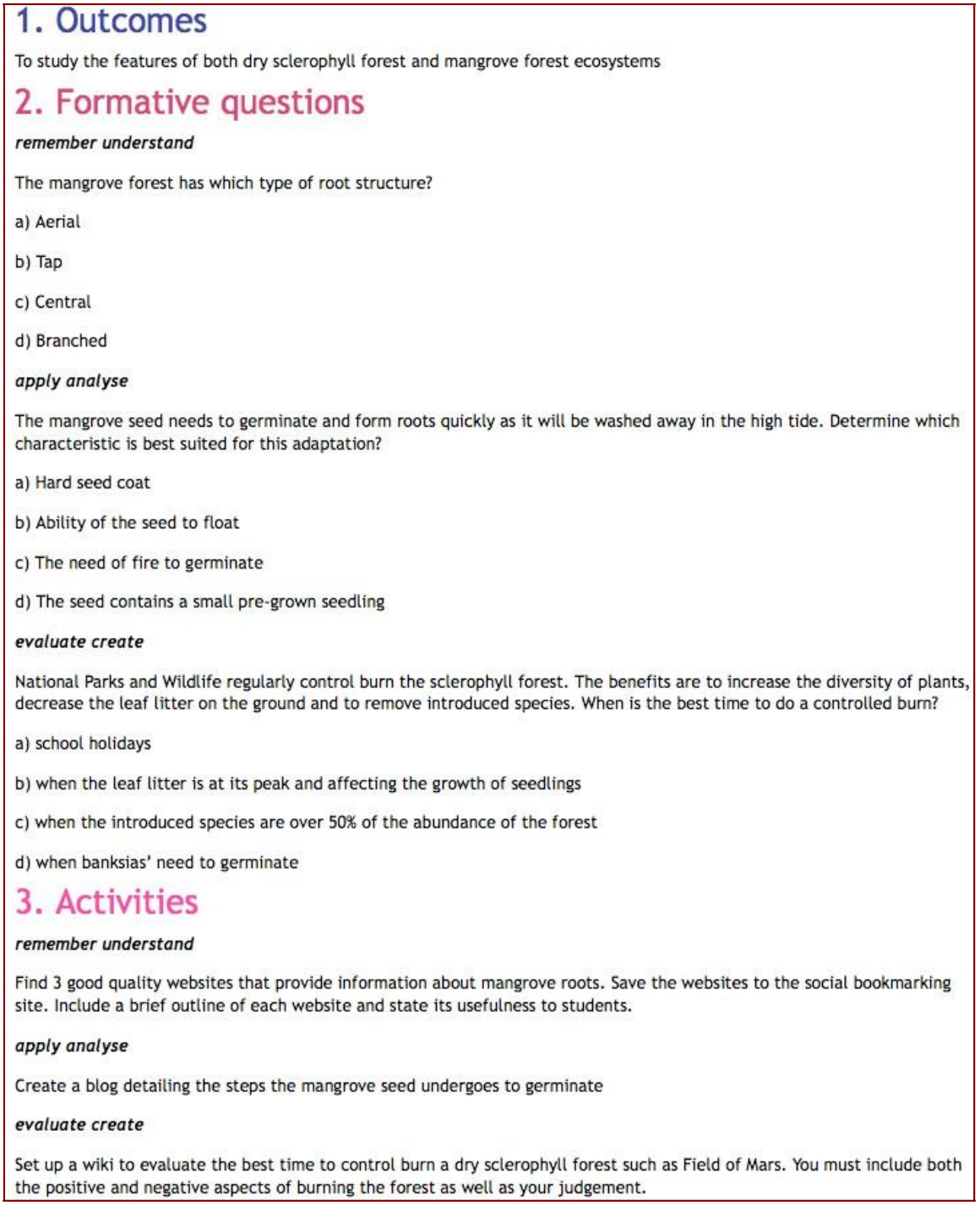


**Figure 4. Differentiated learning design in Science**

## *Teacher feedback*

### *Impact on teacher conceptions and practice*

Pre-survey responses indicated a wide range of conceptions relating to the meaning of 'alternative learning pathways'. Some definitions were broad and general, for instance, that alternative learning pathways were "additional ways to meet student learning outcomes" or "providing a different way of learning". Other respondents emphasised different elements in their definitions of alternative learning pathways, including a focus on teaching (for example, that differentiation was "Offering different ways of teaching according to the student need"), on student choice (for example that differentiation was about "options/

choices to complete tasks and learn"), engagement (for example, that differentiation meant "looking for new and unique or different ways to engage and enhance learning"), production (that differentiation meant "giving students …other ways of demonstrating their knowledge and skills"), and catering to a variety of abilities (for instance, "giving students with a variety of abilities and thinking processes the ability to access information in different ways").

In contrast, post survey responses revealed a noticeable shift in teacher perceptions towards differentiation of the curriculum as providing access to all students (three responses), and the move away from differentiating as just being about using variety (generally). Some post-survey responses also explicitly identified the role of technology as a means of differentiating the curriculum.

Pre-survey responses indicated a range of ways that teachers differentiated the curriculum for their students. This included using a variety of technologies (Moodle, TurningPoint, eBeams, laptops), integrating different modes of representation (computers vs pen & paper, providing audio and visual resources, allowing voice recordings), and ways of structuring and implementing lessons (personalised learning plans, providing support in class, explaining in different ways). One participant also mentioned that they differentiate the curriculum by considering different levels of ability (multiple intelligence, Bloom's Taxonomy). Responses to the post-survey indicated that teachers differentiated either based on the technology used or the level of thinking addressed. Post-program responses were more consistent in their descriptions of differentiating the curriculum, with greater emphasis was placed on cognition.

Post interviews indicated that there was in many cases a degree of personal transformation as a result of the program, though this took different forms depending on the level of technological ability of the teacher. One teacher felt a sense of achievement for embedding images into a PowerPoint presentation for the first time, while another had shifted his entire science curriculum to be based around a student-centred question posing and e-portfolio responses.

***Perceptions of the importance and difficulty of providing alternative learning pathways***

All but one pre-survey respondent and two post-survey respondents either agreed or strongly agreed that providing alternative learning pathways for students was important. The majority of pre-survey reasons for believing differentiation was importance related to learning styles (for instance, "Every student has different ways of learning, which need to be addressed") and modes of engagement (for example, "Not all students are capable and or willing to participate in pen & paper work"). None of the pre-survey responses related to levels of ability or prerequisite understanding.

In post survey responses several (6) of the teachers related differentiating to curriculum to ability, with an indicative comments including "students will learn and understand more, and be more engaged when they can achieve an outcome at their own pace" and "it is our job as teachers to do our best to teach all students, on all levels, with any background, at any level of learning".

Figure 5 below illustrates teachers' pre and post program perception of the difficulty of providing learning pathways that cater to individual students' needs. Whereas in responses to the previous item teachers were in general agreement that providing individualised learning pathways is important, responses to this item indicated that there was a much less consensus about the ease with which this was accomplished.

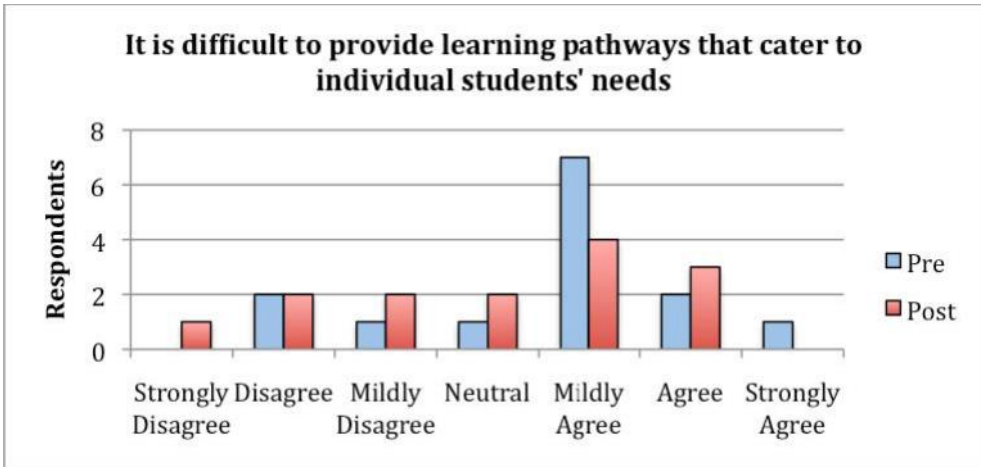


**Figure 5. Teacher perceptions of the difficulty of providing individual learning pathways**

A two-tailed paired difference t-test revealed no significant difference between teacher's pre- and post- survey perception of the difficulty of providing learning pathways that cater to individual students' needs, $t(13) = 1.67$, $p = 0.12$.

Teachers made several pertinent observations during the final debriefing session that demonstrated the evolved nature of their thinking. At various points during the discussion teachers identified how technology was enabling students to access their learning from anywhere, providing students with new modes of creative production through which they could gain a sense of achievement and accomplishment, contributing to a more environmentally sustainable society, and helping students to develop the 21st Century skills they would need to be successful in the new age. They also observed how the technology allowed them to automate some of the trivial aspects of the pedagogical process (for instance collecting and returning assignments, and marking multiple choice questions). Teachers saw how the tools could be used to shift their role from instructor to facilitator, and the benefits of these more student-centred approaches for student learning. Designing using technology not only enabled students to more easily learn from one another, but also for teachers to far more easily share and reuse one-another's learning designs. Whereas before the program 4 out of 14 teachers indicated that they did not provide alternative learning pathways for their students, by the end of the program all but one teacher indicated that they now provided individual learning pathways for students.

***Changes to teacher perceptions of their ability to differentiate learning***

Teacher self-ratings of their ability to provide alternative learning pathways for their students rose from an average of 5.6 before the program to an average of 7.1 after the program (see Figure 6).

A two-tailed paired difference t-test revealed that this was a significant difference, $t(13) = 3.86$, $p = 0.002$. Teachers' self-reported desire to improve their ability to provide alternative learning pathways is shown in Figure 7. The large majority of teachers wanted to improve their ability to differentiate the curriculum at pre- and post test. The decrease in desire to improve their ability to offer alternative pathways may have been influenced by teachers' sense that the program had already assisted them to make an improvement (as indicated in responses to the previous item).

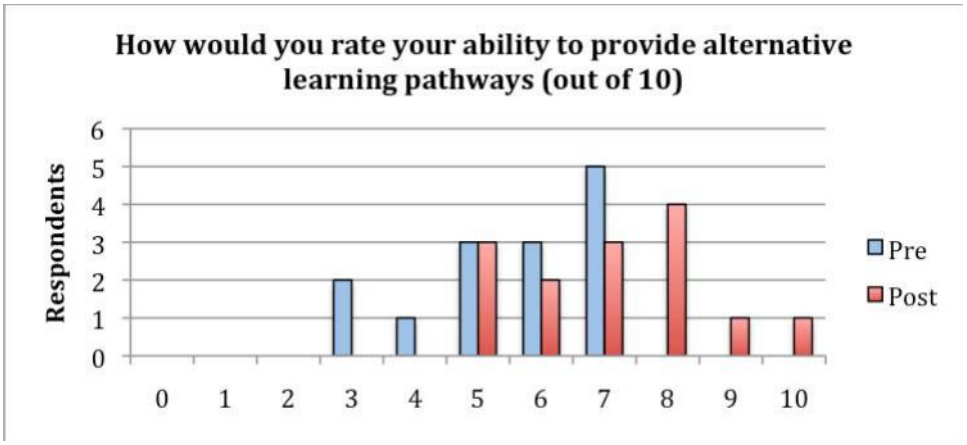


**Figure 6. Teacher self-ratings of their ability to provide alternative learning pathways for their students**

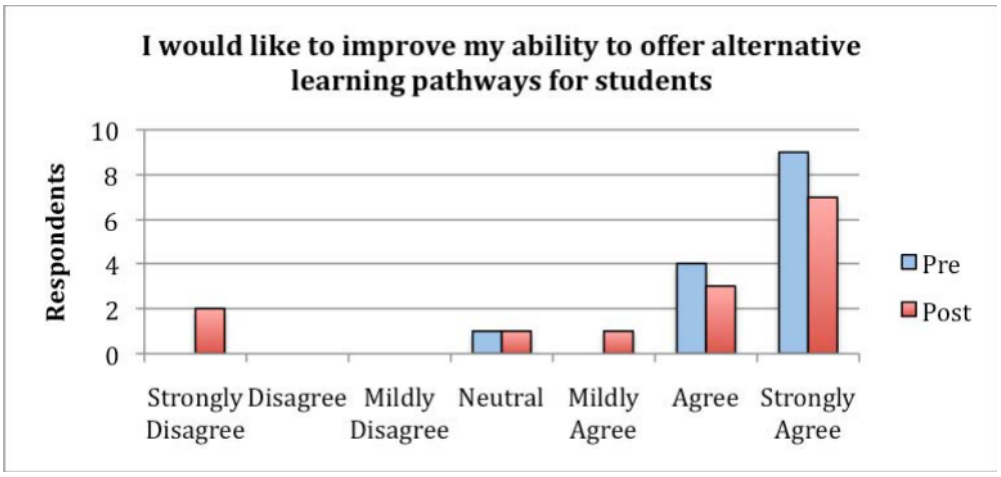


**Figure 7. Teachers' self-reported desire to improve their ability to offer alternative learning pathways**

### *Changes to teacher perceptions towards technology*

Teachers' self-perceived ability to integrate technology into their teaching increased from an average of 6 out of ten to an average of 7.1 (distribution shown in Figure 8).

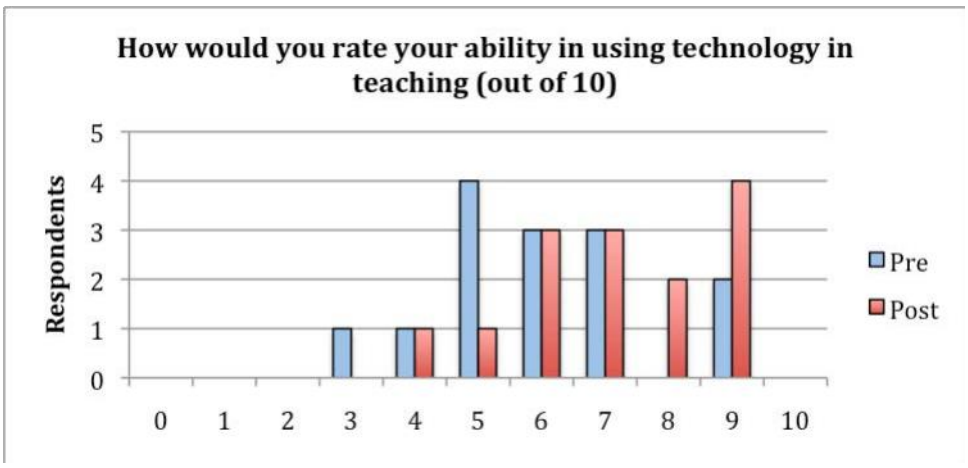


**Figure 8. Teacher self-ratings of their ability to integrate technology into the classroom**

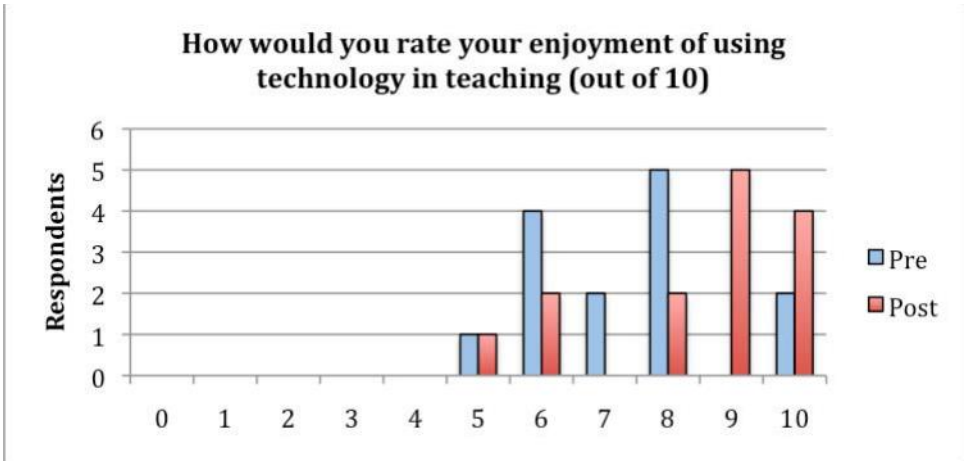


**Figure 1. Teachers' self-reported enjoyment of using technology in teaching**

A two-tailed paired difference t-test revealed that this was a significant difference, $t(13) = 3.17$, $p = 0.007$. Teachers' self-reported enjoyment of using technology in teaching increased from an average pre-program score of 7.4 to an average post-program score of 8.4 (a distribution of responses is shown in Figure 9). Again, a two-tailed paired t-test revealed that this difference was significant, $t(13) = 2.90$, $p = 0.013$.

## Discussion

Using Web 2.0 and SRS technology to design differentiated lessons for students is not a simple undertaking. It requires that teachers possess a conceptual framework for differentiation, are able to deconstruct the curriculum material into its component levels or skills, are able to design formative questioning to enable diagnosis of student understanding, can design activities that cater to different levels of ability or skills, and can use the technology in a way to facilitate this diagnosis and differentiation (as observed in Session 2). Teacher responses in both the pre- and post- survey indicated a wide spread of perceptions relating to the difficulty of providing alternative pathways for students, but in both the average response agreed more than disagreed that providing alternative pathways was difficult. This concurs with previous claims that curriculum differentiation within the classroom is a difficult undertaking (Tomlinson, et al., 2003), as is the integration of SRS systems (Kolikant, et al., 2010) and Web 2.0 technologies (Hughes, et al., 2011).

Teachers in this project appreciated the pedagogical value of differentiation, with 86% of pre-survey responses and 93% of post-survey responses indicating that teachers either agree or strongly agree that it is important to provide individual learning pathways that cater to individual student learning needs. This directly aligns with findings in other research (Petersen, 2008).

Pre- and post- survey responses indicated that this four-session program had a significant impact on teachers' ability to provide alternative learning pathways for their students. Teacher self-ratings of their ability to provide alternative learning pathways rose from an average of 5.6 out of ten before the program to an average of 7.1 out of ten after the program, $t(13) = 3.86$, $p= 0.002$.

Teachers' conceptions of differentiation sharpened throughout the program. At the commencement of the program teachers' conceptions of alternative learning pathways were

often broad and general (for instance, that providing alternative learning pathways was "providing a different way of learning"). There was little initial consensus about what providing alternative learning pathways actually meant, with descriptions variably relating to providing choice, finding ways to engage students, providing other ways of understanding, offering a variety of representational modes, catering to different ability levels, as well as matching the curriculum and learning activities to student needs. Post program conceptions focused more on providing a variety of ways for students of different levels to access learning. Whereas pre-program benefits of alternative learning pathways related more to learning styles and modes of engagement, post survey benefits more heavily emphasised catering to different ability levels. This demonstrates that professional development can enhance teacher knowledge of differentiated instruction, which is counter to the experience of McMillan (2011). Ways in which technology could facilitate this process also emerged in teachers' post-program descriptions, thus demonstrating that teachers were supported to develop the thinking frameworks that educators (such as Kuo & Walker, 2010; Wang, 2008) feel are required for successful technology integration.

Not only did the program develop teacher conceptions relating to alternative learning pathways but also teacher practice. Whereas 10 out of 14 teachers claimed to differentiate their curriculum before the program, 13 out of 14 claimed to differentiate their curriculum after the program. This supports findings by Sellers (2008) that professional development relating to differentiating the curriculum can increase the use of differentiation by teachers in the classroom. The ways in which they self-reported to differentiate changed from a wide variety of differentiation mechanisms before the program (varying technologies, modes of representation, lesson structures and ability levels) to a sharper focus on technology and levels of thinking by the end of the program.

There was a variety of levels of accomplishment in terms of creating a differentiated lesson. Some teachers were able to develop formative SRS questions that enabled diagnosis of student ability, and create appropriately pitched alternative learning pathways for different levels. Other teachers did not achieve this outcome, but through the program were encouraged to evolve an aspect of their practice to a new level (either technological or pedagogical). For others the program resulted in a persistent change in the way they approached learning and teaching with Web 2.0 (for instance one science teacher's student-centred collaborative blogs). The reflective processes embedded within the program resulted in several higher order discussions relating to the efficacy of technology in learning.

The program also had significant positive impacts on teachers' technological capabilities. Teachers' self-perceived ability to integrate technology into their teaching increased significantly from an average of 6 out of ten to an average of 7.1 out of ten, $t(13) = 3.17$, $p = 0.007$. Perhaps equally if not more importantly the program led to a significant increase in teachers enjoyment of using technology from 7.4 out of ten to 8.4 out of ten, $t(13) = 2.90$, $p = 0.013$. That is to say, as well as improving teachers' ability to offer alternative learning pathways for their students, this project also improved their ability to integrate technology into their teaching (as measured by self perceptions). This responds to calls that teachers should be able to effectively integrate technology into the classroom (Abourbih & Witham, 2007; Regazzoni, et al., 2007).

Teachers identified offering alternative learning pathways as a potential area to enhance their professional practice, with 93% of pre-survey responses and 79% of post survey responses indicating that they would like to improve their ability to offer alternative learning pathways. This indicates that although teachers were highly responsive to the program, developing the ability to effectively create differentiated learning pathways using

Web 2.0 and SRS technology is a process that extends beyond the scope of a short course such as this one.

While it was valuable in this study to focus on teachers' responsiveness to professional development surrounding Web 2.0 and SRS approaches to offer alternative learning pathways for students, the program did not focus on the impact of such approaches on students. Future research could examine how student learning is enhanced through the provision of alternative learning pathways. As well, this program the approach to differentiation that was encouraged was one based on general levels of cognitive ability ('remember' and 'understand', 'apply' and 'analyse', 'evaluate' and 'create'). Another potentially valuable approach would be to use concept- or topic-specific misconceptions as a way to determine which pathways students completed. This is a possible area for future development and investigation.

General caution should be exercised when interpreting the results of this project, as with any research study. All statistics should be interpreted with an understanding that the reliability of the results is limited by the small samples size. As well, the project was conducted in one educational community, with one group of teachers, and with one instructor. While every effort has been made to provide thorough description so that the project could be accurately replicated in another context, it is possible that results may have varied widely if conducted in a different place with different people. It is also possible that influences other then the professional development program affected teachers' perceptions of and ability to create differentiated learning pathways.

## Conclusion

This study has demonstrated the responsiveness of teachers to professional development in the area of technology-enhanced differentiated learning design using Web 2.0 and SRS tools. The program was able to significantly improve teachers' perceptions of their ability to provide differentiated learning pathways, sharpen their conceptions of what is meant by alternative learning pathways, and increased the extent to which they used differentiated learning approaches in their classes. The program also significantly increased teachers' perceptions of their technological capabilities, and enhanced their confidence and enjoyment of using technology in the classroom. Teachers saw differentiating learning as an important pursuit, and indicated that they would appreciate more professional development in this area.

Given the numerous benefits of differentiated curriculum and the positive impact of this relatively small-scale intervention, it appears that there is scope for schools and education systems to improve learning outcomes by providing professional development on how technology can be used to enable an ability approach to curriculum differentiation. In only several hours of professional learning teachers were able to improve their understanding of what it means to differentiate the curriculum and how to use Web 2.0 technologies and Student Response Systems to accomplish this. Applying this approach across schools and educational systems may enable students to receive more targeted instruction and teachers to better understand the abilities of their students. However, given that this was the only study found within the literature that addressed how to support teachers to differentiate the curriculum using technology, there is certainly potential for further research in this area.

The fact that there was vastly different levels of accomplishment by different teachers in this program but yet that each teacher felt that they benefited greatly from the program is in direct simpatico with the concept of differentiation. This program presented a range of

formative questions designed to help participants diagnose their current level of ability and learn about the material being considered, and then provided them with the opportunity to pursue tasks that suited their level of ability. The task of creating differentiated learning pathways using SRSs and Web 2.0 technologies was an authentic yet immensely challenging aim. Teachers at the school responded intelligently and diligently to this task at the level of their prior experience. The quality of thinking that emerged highlights the importance of having time to engage in such professional learning processes and inter-collegial exchange. Their outputs offer models and exemplars to any future programs attempting to develop teachers' ability to create technology-based differentiated learning pathways.

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