Differentiating the curriculum: A lot of effort for little gain

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The Learning Federation (TLF) project employs emerging technologies to produce online curriculum content to encourage student learning and support teachers in Australian and New Zealand schools. Teachers and students in 20 schools participated in a field trial of a differentiated curriculum model that incorporated online curriculum content and associated assessment components. Teacher and student interviews were conducted to collect information in accordance with the study aims, which were to ascertain the extent to which the Differentiated Curriculum model resulted in increased knowledge by the teacher of individual student achievement; increased knowledge of the next appropriate activity for teaching and learning; increased knowledge by the student of their content understanding; and increased knowledge by the student of the next appropriate activity for learning.
The Differentiated Curriculum model used a Learning Management System (LMS) for delivery. Upon commencement, each student completed a pre-test conducted as a diagnostic tool. On the basis of the pre-test results, the student progressed through an individualised learning pathway, culminating in the completion of a post-test.
The data reported in this paper is qualitative in nature, reflecting teacher and student perceptions of the value of explicit and immediate feedback on student understanding against specified learning outcomes. This paper reports on initial findings and how they are being used to inform the technical and educational design principles for production of digital assessment resources.

Keywords: assessment, differentiated curriculum, learning pathway, diagnostic, LMS

Introduction

The Differentiated Curriculum Field Trials reported on here were conducted as part of a broader The Learning Federation (TLF) study, namely the *Best Practice study – impact on student achievement*, responding to the research questions: *What does a systematic observation of best practice reveal about the efficacy and outcomes of intensive learning object use?* The trials were undertaken as part of the Phase 3 TLF Assessment research project. Participating schools were from Australia and New Zealand.

Assessment in this study's context is defined as formative. Black and Wiliam (1998) use the general term *assessment* to refer to

> all those activities undertaken by teachers —and by their students in assessing themselves —that provide information to be used as feedback to modify teaching and learning activities. Such assessment becomes *formative assessment* when the evidence is actually used to adapt the teaching to meet student needs.

The Differentiated Curriculum model is one that, through the monitoring of each student's achievement as they progress through the course content within a Learning Management System (LMS), enables learning programs to be differentiated according to each student's need. This approach is consistent with that of Lee (2005) where a Diagnostic Tutorial Assessment System (DTAS) and the Intelligent Content Assessment Marking (ICAM) System provided teachers with the facility to identify the strengths and weaknesses of students and automatically prompted component lessons for remediation in weak concepts.

This information (feedback) can be immediately collated and provided to students in the online environment. Wiggins (2006) emphasises the key role of feedback so that students can make adjustments in their learning based on that feedback, and notes that 'The point of assessment in education is to advance learning, not to merely audit absorption of facts.' Scalise, K & Gifford, B (2006) note the potential of a computer-based platform for 'powerful scoring, reporting and real-time feedback mechanisms for use by teachers and students.' Similarly, Beale, I (2005) promotes the exploitation of the affordances of intelligent (adaptive) learning environments to individualise the instructional process in response to information provided by the behaviour of the individual learner in the learning environment'

or applying the concept of scaffolding through 'integrated assessment of the learner's performance' as an 'essential component of scaffolding algorithms… when used to provide assessment information to both the learner and the teacher on an ongoing basis.'

Is this potential reached? Did the students and teachers participating in this study perceive that learning was enhanced by the provision of immediate feedback? Is the time, effort and cost associated with developing a differentiated curriculum model justified? Are there implications for future development of digital assessment resources?

Further aspects drawn from the research data will be reported in subsequent papers, including a consideration of quantitative data measuring student achievement based on pre-test and post-test results.

Methodology

Design

The design for this Differentiated Curriculum study called for the involvement of 20 classrooms across the participating education jurisdictions, totalling about 500 students. The sample was selected so as to be representative of the general population (demographics and student ability levels). The curriculum areas selected were Science (Lunar Cycles) at Year 6 and Mathematics/Numeracy (Introduction to Algebra) at Year 9. Each class in the study was allocated to one of these two curriculum areas. Teacher and student questionnaires were administered, with teachers responding to questions relating to two aspects of the study: *Implementing the Differentiated Curriculum Model* and *Reflection on the Differentiated Curriculum.*

Program structure and workflow

The main components of the Lunar Cycles and Introduction to Algebra course structure are the pre-test and post-test assessment instruments and an associated teaching and learning program incorporating diagnostic assessment instruments, learning objects (interactive multimedia teaching and learning resources) and additional activities addressing the learning objectives.

The course structure for Introduction to Algebra is described further here to indicate the granularity of the content and the nature of the assessment components of the differentiated curriculum model.
The identification of groups of appropriate learning objectives was the initial and critical stage in constructing associated assessment components and learning materials. Four sets of learning objectives - A, B, C and D (Table 1), with sub-outcomes - were judged (against the key curriculum documents) to reflect the logical development stages for the understanding of algebra at Year 9.

Each assessment item (question) constructed for the assessment components (pre-, post- and diagnostic instruments) was mapped to one of the learning outcomes (Table 1).

The three assessment instruments for each learning objective contained 'parallel' sets of assessment items. For example, within 'Patterns', Q1 of the Pre Test addresses the same learning objective as does Q2 of the Post Test and Q1 of the Diagnostic questions (quiz). These parallel items were developed to be of similar difficulty and were validated through the conduct of a field trial of the items.
Item response format were limited to multiple-choice, fill in the blank and short answer items.

In addition to the assessment instruments, the other component of the course was the learning activities completed by the students. The learning activities were matched to the same learning objectives as those in Table 1. These components (assessment instruments and associated learning activities) were situated within an open source LMS (http://moodle.com.au/). TLF customised the LMS for the purposes of the Differentiated Curriculum study so that the sequence in which course content was delivered to students was dependent on their performance on integrated assessment components. The workflow diagram shown in Figure 1, provides an overview of the possible individualised learning pathways for the Introduction to Algebra course. Depending on the results of the pre-test, the modified LMS (referred to as 'Moodle' below) presents the students with a list of related learning activities to complete, addressing areas of underperformance. The sequencing of course content was adaptive, as illustrated by the following example for a particular student.

Table 1: Structure of learning objectives across assessment instruments

Section title	Learning Objectives	Pre Test Questions	Post Test Questions	Diagnostic Set Questions (Quizzes)
Patterns	A.1: Students identify and extend spatial and number patterns	Q1, Q2, Q3, Q4, Q5	Q1, Q2, Q3, Q4, Q5	Patterns Quiz Q1, Q2, Q3, Q4, Q5
Pronumerals	B.1: Students identify and extend spatial and number patterns *(using algebraic notation)*	Q6, Q7, Q8	Q6, Q7, Q8	Pronumerals Quiz 1 Q1, Q2, Q3
	B.2: Students use the transitive property of equality to find the relationship between three variables.	Q9, Q10	Q9, Q10	Pronumerals Quiz 2 Q1, Q2
Functions 1 (Linear functions)	C.1: Students use tables and graphs to create formulas and explore relationships between tabular, graphical and algebraic forms	Q11, Q12, Q13	Q11, Q12, Q13	Linear functions Quiz 1 Q1, Q2, Q3
	C.2: Students interpret and compare graphs showing different relationships between specified variables	Q14, Q15	Q14, Q15	Linear functions Quiz 2 Q1, Q2
Functions 2 (Non linear functions)	D.1: Students use tables and graphs to create formulas and explore relationships between tabular, graphical and algebraic forms	Q16, Q17, Q18	Q16, Q17, Q18	Non-linear functions Quiz 1 Q1, Q2, Q3
	D.2: Students create and interpret graphs that represent the relationship between quantities and show the rates of change	Q19, Q20	Q19, Q20	Non-linear functions Quiz 2 Q1, Q2
Total No. Items		20	20	20

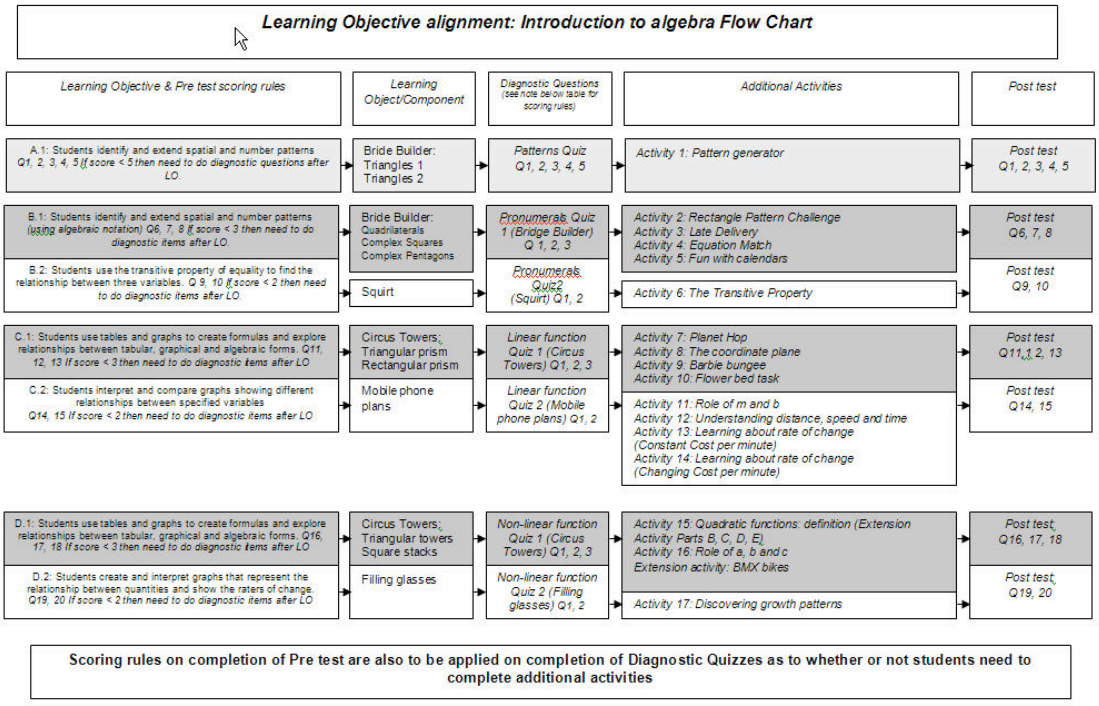

Figure 1: Introduction to algebra workflow

The pre test results identified linear and non-linear functions as being areas of weakness for the student rather than patterns or pronumerals. Then if the student successfully completes the Linear function quiz 1, but not linear function quiz 2, Activities 11, 12, 13 and 14 would be activated within the system and so on (Table 2).

Table 2: Learning activities matched to learning objectives

Learning Objective C.1	Linear functions Quiz 1 Q1, 2, 3	Activity 7: Planet hop Activity 8: The coordinate plane Activity 9: Barbie bungee Activity 10: Flower bed task
Learning Objective C.2 Mobile phone plans	Linear functions Quiz 2 Q1, 2	Activity 11: Role of m and b Activity 12: Understanding distance, speed and time Activity 13: Learning about rate of change (Constant Cost per minute) Activity 14: Learning about rate of change (Changing Cost per minute)
Learning Objective D.1	Non-linear functions Quiz 1 Q1, 2, 3	Activity 15: Quadratic functions: definition (Extension Activity Parts B, C, D, E) Activity 16: Role of a, b and c Extension activity: BMX bikes
Learning Objective D.2	Non-linear functions Quiz 2 Q1, 2	Activity 17: Discovering growth patterns

Active web links direct the student to the appropriate content based on the quiz results. The learning activities were generally of two types: tasks online tasks and offline worksheets (sometimes incorporating a practical investigation).

Teacher notes are provided to assist teachers to guide their students through these learning activities. Students complete a post-test upon completion of their individualised (that is, 'differentiated') course. Further quantitative data analysis was undertaken to measure gains in student attainment of the learning objectives as a consequence of completing the course and will be the subject of a later report.

Results

The qualitative results available to date are presented from the teacher perspective. Implications for the production of future digital assessment resources arise from the results and these are referenced to Table 3 throughout the text.

Teacher perceptions of increased knowledge by the teacher of individual student achievement
From the perspective of **implementing** the Differentiated Curriculum model, teacher perceptions were generally positive in terms of the ability of the LMS system to provide a view of the students' results on tests and quizzes, with 74% of respondents rating this feature as helpful or better.
From the perspective of **reflection** on using the Differentiated Curriculum model, teacher perceptions were positive in helping students progress in their factual content learning with 70% of respondents rating this aspect as good or better. Similarly, perceptions were positive for progress in conceptual understandings, with 70% of respondents rating this aspect as good or better. Perceptions were less favourable for the value of transfer and application of knowledge to new areas (45% of respondents rating as good or better) [Table 3: C1].

The degree to which teachers perceived the student test and diagnostic results to have assisted them in determining students' level of conceptual understanding and/or uncovering misconceptions varied. Some respondents indicated that this information provided a 'snapshot' of students' understanding of the topic. However, a number of respondents felt that this data should be used in conjunction with other sources of information about student progress.

Perceived limitations of the model related to literacy levels of students [Table 3: C2], technical issues encountered and the requirement for additional teacher support (including whole class teaching) of the specified content.

Teacher perceptions of increased knowledge of the next appropriate activity for teaching and learning
Teacher perceptions of how the student regarded the various methods of feedback on their progress were generally positive. It was noted that although the students liked the diagnostic quizzes they may not have used the information provided effectively to direct their learning progress. If the next steps in learning are to be made more explicit, it would appear that students need to be further supported by tools within the LMS system to make sense of their quiz results [Table 3: W1].

Teacher perceptions from the perspective of reflection on using the Differentiated Curriculum model were mixed in terms of whether teaching the allocated topic via discrete learning pathways (as established by the pre-test and diagnostic quiz results) provided any perceived advantage for learning over other topic areas likely to be taught at the same year level. Positive comments indicated that advantages included pinpointing gaps in learning, knowing what individual students needed to do next, automatic marking and allowing students to work at their own pace.

Some limitations to knowing the next appropriate learning activity included that the topic was too difficult (Lunar Cycles), the reading level was too high (Lunar Cycles) [Table 3: C2, S4], and disengagement [Table 3: S1, S2, S3, S4] at Year 9 (Introduction to Algebra).

Table 3: Implications for digital assessment resource development

Model component	
Content	C1 Assessment materials should be carefully matched to the nature of the content material. C2 Teacher-review of the age-appropriateness of targeted learning objectives and of the literacy levels required to assess those objectives should be undertaken.
Structure	S1 The presentation mode of the assessment resources should match that of the learning objects. S2 The elements of learning design underpinning the learning objects should also underpin the development of the assessment resources. S3 The number of opportunities for students to demonstrate evidence of learning should be maximised. S4 The structure of some assessments should be adaptive, in that student responses are automatically taken into account by the software so that the next appropriate level of content is provided to the student progressively.
Workflow	W1 The results of the assessment must be readily accessible and understood by both teachers and students.

Preliminary conclusions

Based on the perceptions of the teacher respondents, in general, the tools and structure provided by the Differentiated Curriculum model were successful in terms of improved student learning outcomes. In particular:

- Learning was enhanced by the use of the Differentiated Curriculum model for most students.
- Increased knowledge of individual student achievement was a positive outcome of participation in the trial.
- Teachers increased their knowledge of the next appropriate activity for teaching and learning through the students' interaction with the course materials as presented via the LMS environment.

As noted in the Introduction, this report is qualitative in nature and is a preliminary report, aiming to provide insight into the value of producing assessment resources that explicitly report on student achievement against specified learning outcomes. Based on teacher perceptions, the time, effort and cost associated with developing a differentiated curriculum model appears to be justified. However, an evaluation of quantitative data is needed to confirm this finding.

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