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digital learning objects**

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Students' perceptions of the characteristics of "good" and "poor" digital learning objects

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Abstract

This presentation reports on one component of an on-going evaluation of an online curriculum program: The Learning Federation (TLF). TLF is charged with creating online curriculum content in priority curriculum areas and making the content available to all education authorities in Australia and New Zealand. TLF's curriculum materials take the form of learning objects (LOs), which aim to capitalise on the potential of digital technologies to enhance learning, and which are potentially stand-alone interactive learning activities, integrating a variety of media (text, audio, animation, graphics). This presentation reports on an analysis of interviews with 300 students concerning their interactions with a total of 30 LOs. The themes identified in the students' talk were used to identify characteristics of "good" and "poor" LOs. The findings will be of value not only to developers of online content but also to teachers having to make decisions about using digital content in their classroom practice. It is a common assumption that young people will be engaged with any use of new technologies in classrooms. The results of this study contributes to a more complex understanding of students' engagement with LOs, as well as other ICT applications.

Students' perceptions of the characteristics of "good" and "poor" digital learning objects

This paper reports on one component of an on-going evaluation of an online curriculum initiative: The Le@rning Federation (TLF). TLF is an initiative of the federal, state and territory governments of Australia and the government of New Zealand. It is charged with creating online curriculum content in priority curriculum areas and making the content available to all education authorities in Australia and New Zealand. TLF's curriculum materials take the form of learning objects (LOs), which aim to capitalise on the potential of digital technologies to enhance learning. LOs are stand-alone interactive learning activities, often integrating a variety of media such as text, sound, animation, and graphics. They are accessible from digital repositories, and are referenced, located and accessed using metadata descriptors. LOs are designed to be reusable in multiple settings and for multiple purposes; and are potentially usable in classrooms as components of units of work accompanied by other digital and non-digital materials. Similar national and international initiatives aimed at building large repositories of LOs exist elsewhere, including CELEBRATE in Europe (celebrate.eun.org/eun.org2/eun/en/index_celebrate.cfm), Curriculum Online in the UK (www.curriculumonline.gov.uk/default.htm), eduSource in Canada (www.edusource.ca/), and the National Science Digital Library in the US (nsdl.org/).

Prior to its formal release, each new LO is subjected to field trialling in classrooms, and critiqued by teacher and researcher groups. In addition, TLF has undertaken cycles of evaluation designed to monitor and enhance the quality of its educational products (see Freebody 2005, 2006; Freebody, Muspratt & McRae, 2007a; for a summary of these reports, see Freebody, Muspratt & McRae, in press). The evaluations report on teacher and student surveys, site visits to observe classroom use of LOs, and, in the most recent report, the results of an initial field experiment aimed at testing the effects of use of LOs on students' learning outcomes. TLF, now in its fifth year of operation, has more than 3000 LOs available for use in Australian and New Zealand schools. In this paper, we report on interviews with 300 students concerning their interactions with TLF LOs.

REVIEW OF RELATED RESEARCH

Increasing investments in ICT by educational systems around the world over the last decade have been accompanied by a growing body of research attempting to evaluate the efficacy of these investments and to explore how to use ICT more creatively and effectively for learning and teaching. The authors of many of these reports share a concern that the effort and expenditure in making ICT available to school systems is not reflected in the uptake and creative use of ICT in educational settings (see for instance, Jamieson-Proctor, Burnett,

Finger & Watson, 2006; Smeets, 2005; Nichol & Watson, 2003). It has been argued that one of the problems is the lack of digital content, sufficiently sophisticated that it can be used in both technology-rich and technology-poor classrooms, and by teachers with varying levels of ICT experience and skills (Ilomäki, Lakkala & Paavola, 2006). During the last five or so years, with the move of the LO model from post-compulsory education into the P-12 years, LOs were seen as a solution to many of the problems of ICT usage in classrooms (Gibbons, Nelson & Richards, 2002), and have been enthusiastically embraced by education systems; indeed, Nurmi and Jaakkola (2006a) claim that the level of enthusiasm directed towards the LO model is almost unique in the field of educational technology. Amidst the promises and claims for the LO model, there were others urging caution. For instance, Butson (2003), claiming that advocates for the LO model were being overly optimistic, stressed that much of the development of the LO model had been in the hands of technologists, and argued that:

The simplicity with which technologists ... have mapped out a conception of learning may seem intuitive and reasonable, but it may also signal nothing more than naïveté. (p. 668)

Similarly, Lambe (2002), concerned that the LO model can never keep pace with the transitional nature of knowledge and learning, argued that "We don't need reusable knowledge objects. We need disposable ones" (p. 23). Others, however, claim a middle ground. With the development of large repositories and portals to access and distribute LOs, researchers claim that the LO model does offer possibilities to improve educational practice, but argue for the need for ongoing research to investigate the practical, strategic, and theoretical problems that accompany the LO model and to offer possibilities for overcoming them (Nurmi & Jaakkola, 2006a; Parrish, 2004; Polsani, 2003).

At the core of the LO model is the notion that the materials are searchable and reusable. Enthusiasts for the LO model see in reusability the potential to transform education; offering individually adapted instruction and education in a cost effective way. However, the searchability and reusability aspects of the LO model are more complex than they might at first appear.

That teachers can search for LOs within repositories or portals means that metadata descriptors and search engines need to match teachers' expectations, but there are conflicting searchability issues. First, there are issues to do with granularity (or the size of an LO). Recker, Dorward & Nelson (2004) report that teachers are more likely to use LOs that can be incorporated into existing teaching programs, and as a consequence, teachers preferred smaller LOs, or as they put it: "whose granularity is smaller than a typical class lesson" (p. 102). Similarly, McCormick and Li (2006) report that teachers prefer modular LOs, which focus on one idea or topic, rather than integrated LOs, which electronically link a number of ideas. If teachers used large, complex and integrated LOs, they would lose some control over pedagogy and students' pace and progress. Thus teachers prefer to search for

LO according to 'topic'. Second, there are issues to do with the technical capabilities of metadata descriptors and search engines. The functionality of search engines attached to LO repositories or portals are no match to commercial search engines such as Google (McCormick & Li, 2006). So despite teachers' preference for searching by 'Topic', it proves to be an unhelpful way to search. Teachers using a 'Topic' search find, at times, no returns (because they used a specific term not used in the metadata descriptors), and sometimes, too many returns (because LOs are categorised with many keywords). McCormick and Li report that many teachers resolved the conflict by adopting the time-consuming approach of browsing the LOs returned by a 'Subject' search.

Reusability means that LOs can be combined in different ways, and different combinations can be used to meet different needs (Lambe, 2002). Furthermore, the notion of reusability is compatible with teachers' preferences for topic-based LOs – modular LOs are easier to combine and recombine to suit different contexts and learning situations (Nurmi & Jaakkola, 2006a). However, there are technological and pedagogical issues associated with reusability. The technological issues, that LOs should be operable on different operating systems and that the different computers on which an LO is to operate meet minimum specifications, are relatively straight forward to resolve.

The pedagogical issues are more controversial and less easily resolved. There are two pedagogical sites - the pedagogy embedded in the LO and the pedagogy operating in the different learning environments. But as Nurmi and Jaakkola (2006a) argue, reusability ideally requires an LO to be independent of pedagogy:

in order to maximize reusability, the design of LOs cannot be based on particular pedagogical decisions or methods that could restrict the way the materials are used (p. 272).

Rather than thinking in terms of 'pedagogy residing in an LO', McCormick (2003) encourages developers and users of LOs to think in terms of 'pedagogy surrounding an LO'. Pedagogical decisions are made by the teachers – they construct the learning environments, and thus create meaningful environments in which the LOs reside. There is evidence reported in the evaluations of the CELEBRATE initiative (Ilomäki, Lakkala & Paavola, 2006; McCormick & Li, 2006; Nurmi & Jaakkola, 2006a) and the TLF initiative (Freebody, 2005, 2006; Freebody, Muspratt & McRae, 2007, in press) of teachers using LOs in pedagogically different ways, and using them with various other digital and non-digital resources. Of course, it is an illusion to think that an LO can be independent of pedagogy, but whatever pedagogy is embedded in an LO, however explicitly or implicitly it is built into the LO, it should not constrain teachers' ingenuity and abilities to adapt LOs to suit their teaching environments.

There has been little empirical investigation of the educational effectiveness of LOs, and the results from the few studies that have been conducted are equivocal. The two studies that

we are aware of employed a quasi-experimental, pretest-posttest design; the experimental groups using the LOs and the control groups covering the same content as the experimental groups in traditional classroom settings but without the use of LOs. Thus they compared the gains made by students in the two learning conditions.

The first study, using TLF LOs (700 students from 41 classrooms) (Freebody, Muspratt, McRae, 2007, in press), investigated the gains in two maths topics (chance and arithmetic) in year 5 and 7 classrooms over a six week period, and found no effect for arithmetic, but a significant effect for the chance topic: LO classrooms showed significantly higher gains than traditional classrooms. The second but smaller study, using LOs available to the CELEBRATE initiative (seven classes of students) (Nurmi & Jaakkola, 2006b), investigated the gains in the topics of fractions, grammar and electricity after a single session with the LOs, and found no effects for fractions and grammar, but significant gains for the electricity topic. Further, there were three conditions used to investigate the gains in the electricity topic: a laboratory condition in which students built real circuits; an LO condition in which students built circuits on the screen; and a mixed condition in which students worked with the LO first then moved to the real circuits; and it was the mixed condition that showed the largest gains particularly for lower ability students.

Two major conclusions, supported by classroom observations, were drawn from these studies. First, LOs are more effective with topics that are conceptually, logistically and pedagogically difficult to teach well (i.e., probability and electricity) whereas traditional classroom environments are at least as effective as classrooms using LOs when the LOs are used in place of, or side by side with, traditional teaching activities (i.e., grammar, fractions, and arithmetic). Second, LOs themselves do not necessarily guarantee enhanced student learning, rather effective LOs require carefully constructed learning environments.

Just as there is a scarcity of empirical studies investigating the effectiveness of LOs, there is also a scarcity of studies investigating teachers' attitudes towards and perceptions of the LOs they use in their classrooms. The only two studies we are aware of are survey and observational studies conducted as part of the evaluations of the TLF and CELEBRATE initiatives. The findings from the two studies are similar. On the whole, teachers' reactions to using the LOs are positive. Teachers use the LOs in a variety of contexts, and take the view that students enjoy working with the LOs, that the LOs increase students' motivation and persistence with learning tasks, and that they help students to learn (McCormick & Li, 2006; Freebody, 2005, 2006; Freebody, Muspratt & McCrae, 2007, in press).

In addition to seeking teachers' views and opinions, the evaluations of the TLF initiative sought students' opinions of the LOs used in their classrooms; and again, students' reactions were, on the whole, positive. Students found the LOs enjoyable and easy to work through,

that they helped them to learn, and that the features incorporated into the design of the LOs (such as the interactive nature of the content, obtaining feedback on their learning performance, choice of pace and sequence, and repeating activities) were helpful (Freebody, 2005, 2006; Freebody, Muspratt & McCrae, 2007, in press).

However, these students were asked to respond to questions about features of LOs that the research team took to be relevant, pertinent and important to students. Also, students were responding with respect to the one LO that they had recently used in their classrooms, and in many instances, students had nothing with which to compare the LO. Therefore, the current study took a more qualitative approach, using interviews and open-ended questions on the surveys in which the students determined what was relevant and pertinent. In addition, so that students could directly compare LOs, they worked with four LOs that were a mixture of "good" and "poor" LOs.

CONSTRUCTION OF THE STUDY

Selecting the LOs

Though TLF has developed more than 3000 LOs, the current study was conducted in Year 6 classrooms, and therefore only those LOs designed for the upper primary years were available for selection. Also, LOs developed for TLF's curriculum domains of Business and Enterprise, and Arts, Design and Technology were not included because too few LOs had been developed for the two domains; and for LOTE because of the difficulty of locating classrooms that included the content in their teaching programs. Thus, only LOs developed for Literacy, Mathematics, Science, and Studies of Australia were available for selection. Nevertheless, the number of available LOs was still large, and thus there was a need to sample LOs from the available set.

A key element of the study was to encourage students to contrast "good" and "poor" LOs. Rather than presenting students with a random selection of LOs, LOs were selected on the basis of responses to questions contained in questionnaires that were part of the earlier, large scale evaluations of TLF's LOs. Composite scores were calculated from student's responses to a set of five items, and an LO's score was calculated by taking the mean of all students' composite scores for a given LO (later, these scores will be referred to as the LOs' Survey Scores). A high score means that, on average, students found the LO interesting and fun, easy to work through, it helped them to think about new ideas, it helped to work with a partner, but they did not need help from the teacher. Within each of the selected TLF curriculum domains, high scoring and low scoring LOs were selected, to give a total of 38

LOs designed for students in the upper primary years. It should be pointed out that the difference in Survey Scores between high and low scoring LOs were not large; indeed, all low scoring LOs had Survey Scores above the midpoint of the scale.

Participants

Sixteen Year 6 classrooms from fifteen schools located in Victoria participated in the study. Thirteen schools were located in Melbourne (inner city and suburban schools), one school was located in a regional centre, and one school was located in a rural area. The sample included two Catholic schools and one independent girls school; and included schools with large proportions of students from low SES backgrounds and large proportions of ESL students. The facilities available to teachers and students ranged from, in one school, a bank of computers located in a small and overcrowded library, to well-appointed computer labs in other schools, and, in the independent school, students having access to their own laptops. In some schools, the classroom teachers had made extensive use of the LOs in the past, but for some, their participation in the current study was their first occasion using the LOs. A total of 365 students from these classrooms took part in the study, although not all students contributed to all components of the study.

Design

With few exceptions, the students within each classroom worked with the same four LOs – two LOs with large Survey Scores and two LOs with small Survey Scores. The four LOs were drawn from any or all of the selected TLF curriculum domains. A little more than 10% of students worked with fewer than four LOs because they were absent from the classroom when the LO was being used. The design was originally intended to be more or less balanced, but due to unforeseen technical difficulties 'on the day', selected LOs had to be replaced. Also, teachers sometimes requested particular LOs. Thus the number of times any given LOs was selected varied: most LOs (24) were selected once, but a few were selected a large number of times (two LOs were selected five times, two were selected four times and another two were selected three times).

Procedures

During a one-hour block of time, students worked with one LO and then completed a questionnaire or an interview about the LO. Students were provided with a summary of the

LO before they began and were reminded to read instructions on the screen so that they knew what they would be expected to do. Students were provided with the questionnaire prior to working on the LO and encouraged to think about how they would answer the questions afterwards. This reflects common classroom practice where students are given 'rubrics' before undertaking classroom activities. In addition, students were encouraged to ask the teacher or the researcher for help if they needed it. The questionnaire asked students whether or not they liked the activity (rated on a five-point scale), if the activity was too easy or too hard (rated on a five-point scale), what they liked and disliked about the LO, and what it was about the LO that helped them to learn. In pairs, students discussed the LO with an interviewer who encouraged the students to give as much detail as possible about the LO.

During the course of some days, students worked with a total of four LOs. After completing all four LOs, students completed another questionnaire in which they were asked to rank the four LOs from least favourite to most favourite. As well, they answered questions about their least favourite and most favourite LO, including what it was about their least favourite that they did not like and how it could be improved. Depending on access to the internet, students could complete the questionnaires using an on-line facility or in hardcopy format.

RESULTS

Preliminary Analyses

The purpose of these preliminary analyses is to assess whether or not there is any consistency in three different ways in which students at different times rate the LO. The three measures are: the composite Survey Score (as mentioned in the previous section, these were obtained from the earlier large-scale evaluations); the ranking of LOs as "Favourite" and "Least Favourite"; and the degree to which students liked the LO.

Students' rankings of the four LO from "Favourite" to "Least Favourite" were used to calculate a BestWorst Score for each LO. The proportion of students who rated an LO as favourite and the proportion who rated it as least favourite were recorded (the proportions were based on the number of students who used the LO; not of the number of students in the sample). The proportions were substituted into the following expression for BestWorst Score:

$$\text{BestWorst} = P(B) + (1 - P(W))$$

where $P(B)$ is the proportion who rated the LO as "Favourite",
and $P(W)$ is the proportion who rated the LO as "Least Favourite".

The BestWorst Scores can range from zero (all students rate the LO as least favourite) through to two (all students rate the LO as favourite). LOs with large scores, that is, with scores close to two, are more likely to be selected as "Favourite" and less likely to be selected as "Least Favourite". LO with small scores display the opposite trend. LOs with mid-range scores, that is, with scores close to one, have small to mid-range proportions of students selecting them as "Favourite" and as "Least Favourite".

Figure 1A shows the 38 LOs in a scatterplot of BestWorst Scores against Survey Scores. There is a statistically significant and moderately strong positive relationship between the two sets of scores (Pearson $r = 0.56$, $p < 0.001$). The association between the two measures is not perfect but it was not expected to be; the measures assess different aspects of the LOs. Also, the methods used to calculate the two scores do not take account of the clustering of students within classrooms, that many LOs, whether completed for the earlier evaluations or for the current study, were used in just one classroom, and that the BestWorst Score for an LO could be influenced by the other LOs selected to accompany it in a particular classroom setting. Nevertheless, these crude calculations show that there is an association between the two measures; that opinions concerning interest, fun, level of help needed, and whether or not the LO helped them to learn, align with students' as yet undisclosed reasons for selecting LOs as "Favourite" and "Least Favourite".

Figures 1B and 1C show two additional associations. In the questionnaires that students completed after working through each LO, they were asked to rate the extent to which they "liked" the LO. The mean rating for each LO was calculated. The additional scatterplots show the associations between this new measure and BestWorst Scores and Survey Scores. Both associations are statistically significant, positive, and moderately strong (Figure 1B: $r = 0.57$, $p < 0.001$; Figure 1C: $r = 0.67$, $p < 0.001$). Thus, the three scatterplots demonstrate some degree of consistency in the ways different students rate the LOs on measures that assess different aspects of the LOs.

Figure 2A shows frequency distributions for the question concerning the extent to which an LO was liked. Across all responses for all LOs, the mean rating is 3.2 – close to the midpoint of the scale – but the distribution for "Favourite" LOs is shifted towards the right and the distribution for "Least Favourite" LOs is shifted towards the left. The means for the two distributions are separated: mean rating for "Least Favourite" LO = 2.7; mean rating for "Favourite" LO = 3.9.

The frequency distributions for the question concerning difficulty of the LO (Figure 2B) shows that a large number of students rated the difficulty as "Just Right" – the optimal point on the scale. The number of students at the optimal point is larger for "Favourite" LOs and smaller for "Least Favourite" LOs. There is also a large number of students rating the difficulty as

"Too Easy", and the numbers do not change much when the distributions are separated according to "Favourite" and "Least Favourite" LO. The two Figures suggest that the students are discriminating between "Favourite" and "Least Favourite", but for a large proportion of students, even their "Favourite" LOs were too easy.

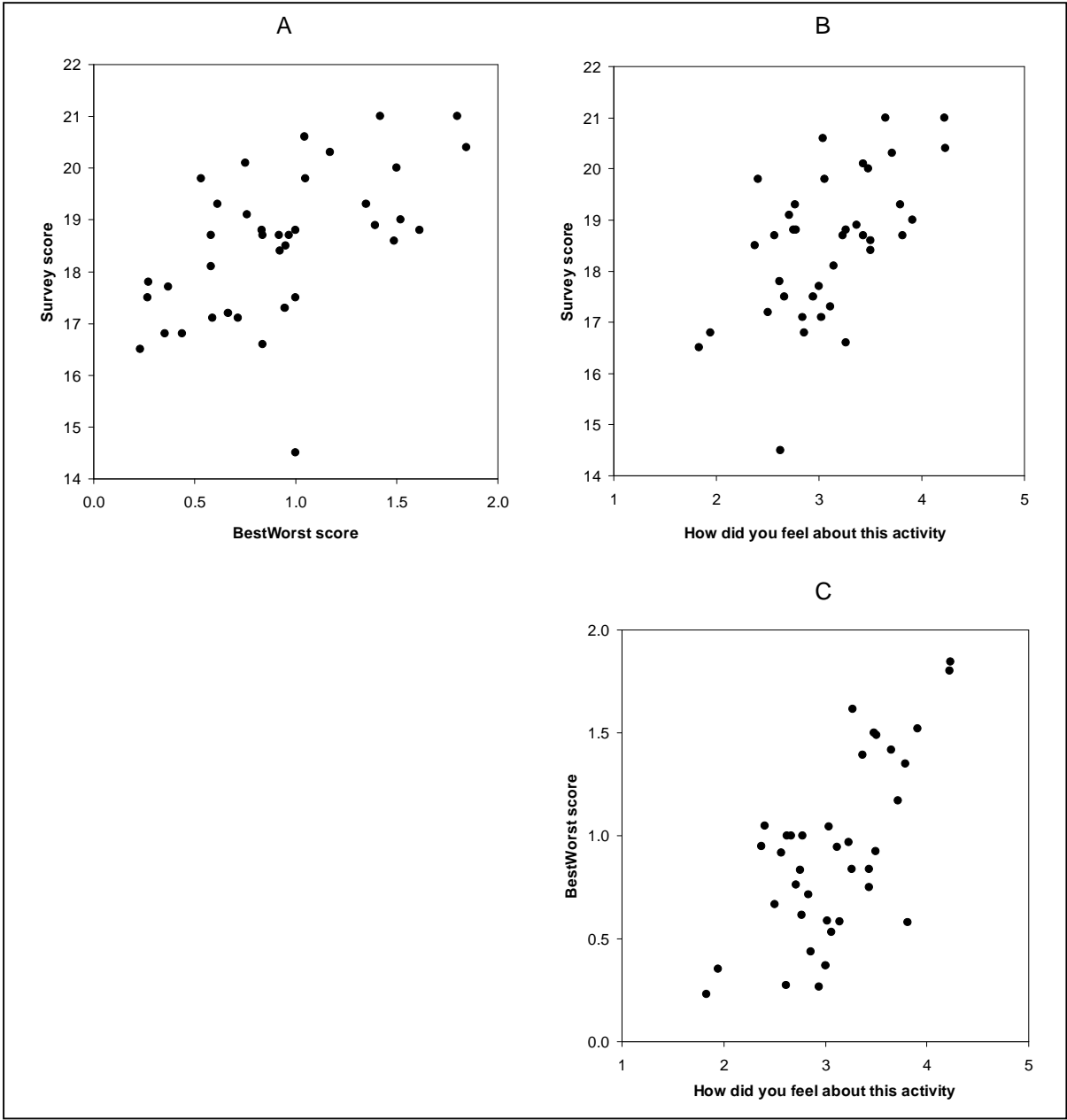
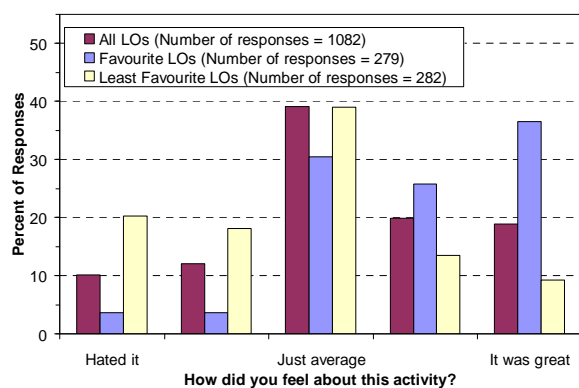


Figure 1 A, B and C: Scatterplots showing associations among Survey scores, BestWorst scores, and the extent to which students "liked" the activity

A) Extent to which an LO was liked



B) Difficulty of LO

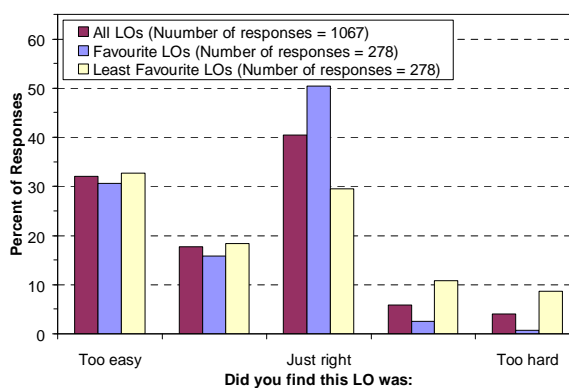


Figure 2: Frequency distributions – Students' views on: A) Whether or not they liked an LO; and B) Difficulty of an LO

Interviews and Open-Ended Survey Questions

At the end of the previous section, it was noted that a large number of students thought the LOs were too easy. This was confirmed in students' answers in the interviews and questionnaires. A recurring comment was that the LO was "too easy" or "too boring". The comment was more prevalent when students were speaking about their "least favourite" LO, but it was nevertheless made with respect to most LOs in the sample. Some students did not elaborate much beyond "too easy" but it is clear, as the following typical examples show, that these students were looking to be challenged:

It was really easy and wasn't really challenging;

It is very repetitive and very easy too, it gets boring after a while;

Too easy, make it harder and more difficult.

When students elaborated, a number of reasons for LOs being "too easy" or "too boring" became evident. First, some students felt they were not being confronted with new content. Although students were critical of such LOs, comments concerning an LO's failure to teach something new were usually accompanied by other disparaging comments:

I found it a bit boring. [It was] too easy and I did not learn anything new and I did not see much to the game. I knew most of it.

I just found it really boring and didn't learn much and was really repetitive. I can't remember anything new from doing it as I already knew [it].

Second, some students thought that it was "too easy to cheat". The majority of the LOs provide feedback of some form. In its most common form, students are presented with a number of questions, and, if students select incorrect responses, a brief explanation for why the response is incorrect is provided. Students' expectations of LOs, possibly derived from experiences with digital games, was that some penalty be incurred for incorrect responses,

but when LOs allowed them to progress without even having to read the feedback, students' expectations were not being met:

How you had to pick a word and if you got it wrong you could just keep clicking it until you got it right.

It was too easy and there were no penalties for getting it wrong. I read it but if you got it wrong you could just keep guessing until you got the right answer.

Any LO that eventually gave the correct answer, or the correct path to follow, or the correct equipment to select, and so forth, was criticised. In addition, there were LOs that, for instance, required students to produce text, but these LOs could not evaluate and thus could not provide feedback on the response. These LOs too were criticised:

All you had to do was listen to people's opinions on whether he was guilty or not and then write an article but it was really just copy and paste.

In general, LOs that could not detect short-cut strategies were criticised for being too easy.

The third reason why some LOs were "too easy" or "too boring" was because they had limited user control, or allowed little interaction with the LO, or limited the options available to students:

There was nothing to do. All you had to do was get the guys from our rocket.

There are LOs, for instance, Gold Rush, that initially are highly interactive but take control from the students as they progress through the LO. Students are engaged while they are making the decisions, and there are students who rated Gold Rush as their "Favourite" because of its interactive features:

The Gold Rush was interactive, more interactive compared to Design a School [which] was more 'follow the instructions', whereas Gold Rush, you could go to whatever mine shaft you wanted and you could buy your own sort of food, how much you wanted.

But once the LO took control from the students, they became less engaged, and there are more comments such as the following criticising this lack of user control:

The computer was mainly controlling it. All I really did was buy stuff and I did not dig. More the computer playing the game for you than me playing it.

Fourth, repetitiveness made some LOs "too easy" or "too boring". Some of these LOs might have initially engaged the students, but once students had mastered the content or the navigation, the LO does not then go on to challenge the students, and the students could see no point to having to repeatedly display their mastery. Again, it appears as though students' experiences with digital games led them to expect the LOs to progress to more difficult options or levels, but students' expectations were not met:

It was really boring because it was just easy and once you had done it once you knew what you had to do and you did it over and over again.

There are two other major reasons why students found fault with LOs. The first concerns LOs' instructions. TLF provides advice to developers regarding instructions: Instructions are

not necessarily limited to text and could comprise combinations of other modes (graphic, animation, audio); but when text is used, it "should be minimal [and] ... limited to single sentences, dot points or short paragraphs" (Atkins & Jones, 2004, pp. 17, 18). Students nevertheless found instructions for some LOs difficult to understand, and expressed their frustration with inadequate, complex, or lengthy instructions:

The instructions I thought they were really bad because they were hard to understand and not really clear at all. The text was hard to understand.

It was a bit confusing in some points. At the start we did not understand it. The instructions, they weren't, we found them hard to understand.

Atkins & Jones (2004) argue that students focus less on an LO's content if they need to expend effort thinking about how to interact with the LO.

Second, students were critical of LOs that resembled conventional classroom work, or at least some components of the LOs had the appearances of conventional work. For instance, some mathematics LOs, as far as these students were concerned, too closely resembled the practice of giving students sets of similar exercises to work through, and thus the LO did not appear to be making the most of the benefits that the technology could deliver:

Because it was like normal maths. You were just learning about the shapes and you kind of knew it.

It didn't have a good story line and it was the same as doing it on a sheet of paper because it was just working things out.

Similarly, students were critical of LOs that required a large amount of reading and writing:

Fiona Chiu, it was boring because all you have to do is writing and reading and writing, and it kept repeating the activity.

Sammie Copper was dreary and annoying and there was heaps and heaps of writing and it was not all necessary to read.

We would like to think that it was not the amount of reading and writing of itself that the students were criticising, rather that students were commenting that their expectations of the interactive nature of the LOs were not met. Interaction had been overshadowed or displaced by the requirement for large amounts of reading and writing.

Earlier, we mentioned the possibility of students' expectations of LOs being derived from their experiences with digital games. When students were offering advice on how to make the LOs better, some indeed saw a resemblance to commercial games:

Like make a better game, like make something else not just put fractions on the screen, like you can change it to be like Sim City.

LOs cannot compete with commercial games, but TLF encourages developers to employ game-like characteristics in their LOs (Atkins & Jones, 2004) because, as Olbinger (2004) and Gee (2003) argue, games have many of the attributes of effective learning environments. However, for many of the students, the LOs were not sufficiently game-like, as is conveyed in their suggestions for improving LOs:

- More control: *Make it more like a game - like you could walk around in the rainforest and you could pick up a pebble and identify where it came from or something, and you could climb. I would like to have a free roaming jungle [where you're] moving around [and] more control. This is just click and drag it. You don't get to use the arrow keys and stuff on these objects.*
- Harder as it progresses: *Add more triangles to work out other areas. Like more shapes - make it harder.*
- Penalties for wrong answers: *When you choose the equipment and you pick the wrong one, they just tell you that it is wrong. The player should get to make mistakes and then find out for themselves.*
- Rewards for correct answers: *It would be fun if you got to choose your character. You could get points which would make your character go faster.*
- More options and harder options: *Instead of going back to get the food all the time, add some other options, like challenges and things. There was only two ways you could do the gold mining and you were not controlling it, it was just doing it itself. Maybe if you could control the gold mining it would be more fun.*
- Graded levels: *Different levels and make each level harder, harder questions. You could do the school first and then a shopping centre and make bigger and bigger stuff.*

This is not to argue that these students simply want to play games all the time. Rather these suggestions are about allowing more interaction with the LO by giving the students more control over how to progress through the LO, and allowing students to learn from their mistakes.

When the students were asked to nominate the qualities of good LOs, most of their comments indicated that good LOs had what was lacking in the poor LOs. That is, good LOs were interactive, challenging, and game-like; had multiple pathways, options, levels of challenge, different starting points, and allowed the students to make decisions and to maintain control. Good LOs had concise but clear instructions, and more generally did not require students to read or write large amounts of text. Finally, as the following three-part comment makes clear, the LOs are also supposed to teach them something, but in order to teach, the LOs must first motivate and engage the students with challenging learning tasks:

Wishball was fun because even though it was maths, it was challenging to put the right number in the right place. It was cool because you had to try and beat your previous score, it was educational too because you got to learn about place value.

Implications

Students' comments have significance for teachers using LOs in their classrooms. Earlier, we made the case that LOs, independent of teaching and learning contexts, do not somehow of themselves constitute meaningful learning activities. LOs have value when they are embedded in teachers' constructed teaching and learning sequences. In many respects,

what the students were asked to do in this study can be viewed as the antithesis of good educational practice. The students were attempting to use the LOs as self-contained units, unrelated to any larger learning environment. Had the LOs been embedded in a sequence of learning activities, students may well have responded differently; but then we would not have been able to carry out the study in the available time nor give the students the opportunity to base their comments on contrasting LOs. Nevertheless, their comments draw our attention to delivery and design issues of which teachers should be aware.

Concerning delivery, many TLF LOs are packaged as a series of LOs with each member presenting either more challenging content or content that is different but related to a common theme. TLF distributes a series as separate LOs partly because of concerns to do with bandwidth. In a more realistic teaching environment than the one experienced by the students in this study, teachers are likely to download the complete series, and as a consequence students would experience more challenging content in different LOs. Nevertheless, there are consequences for teachers. Earlier, we drew on McCormick and Li's (2006) work to argue that teachers prefer LOs with modular rather than integrated granularity. Students' comments concerning the need to progress to more difficult levels suggest that if LOs are to motivate students to engage with the content, they cannot be too modular.

Students' comments also direct us to design issues. One design issue is a consequence of the constructivist pedagogy embedded in the TLF LOs. Developers of TLF LOs are encouraged to adopt a constructivist pedagogy (Atkins & Jones, 2004), and one aspect of constructivism is the provision of feedback. The feedback can take various forms, but at its simplest, students are presented with a multiple choice quiz, with the program providing feedback for correct and incorrect responses. The problem is that students can proceed without necessarily understanding or even reading the feedback. As one student claims, "It's too easy to cheat"; or as McCormick (2003) argues, "This simply encourages trial and error behaviour in students" (p. 10). There are LOs that have more sophisticated feedback mechanisms built into them, but it is difficult to achieve. Nevertheless, even for those LOs with simple feedback mechanisms, it is partly the teacher's responsibility to construct a classroom environment in a way that makes it difficult for students to adopt a trial and error strategy. The implication for teachers is concerned with one of the pedagogical issues discussed earlier. If it is assumed that pedagogy somehow resides in the LO, then students can cheat. It is better for the teacher to embed the LO into the teaching and learning environment and to assume that pedagogy resides in the classroom environment.

Finally, there are also design issues concerned with students' perceptions that some LOs too closely resemble conventional classroom activities. Included here are those LOs that

students criticised for their repetitiveness, and probably those LOs that require large amounts of teaching and writing. It could be argued that these LOs do not take advantage of what the technology has to offer, and as far as the students were concerned, they end up looking like conventional 'skill-and-drill' exercises that could just as easily be completed without using the technology. Earlier it was argued that traditional classroom teaching is at least as effective as LOs that attempt to replicate traditional teaching activities, but LOs are effective when applied to areas that are difficult to teach well (Nurmi & Jaakkola, 2006b; Freebody, Muspratt & McRae, 2007, in press). The implication for teachers is that they need to select LOs that will fit easily into the pedagogy of the classroom environment. But it could be that the very types of LOs that the students complain about actually can be made to fit quite well. That is, it is not necessarily the LOs of themselves that are good or poor; rather the value of an LO is determined also by the surrounding educational environment.

CONCLUSION

Many of these students are growing up with digital media, and see them not as tools, as the older generation might, but as spaces for facilitating interaction and engagement. It is not surprising then that these students, in their suggestions for making LOs better, call for LOs that allow interaction with the LO, that allow more control over how to progress through the LO, that do not look like conventional classroom activities, and that are more game-like. These students see a clear distinction between good and poor LOs. Good LOs have these characteristics; poor LOs lack these characteristics. But it is not up to the developers only to meet students' expectations for interaction and engagement; teachers too have a role to play. They need to incorporate LOs into classroom practices in a way that disperses the spaces for interaction and engagement into the surrounding environment. In this way, the participation structures of that surrounding environment itself can be reshaped by an understanding of the potential affordances of ICT-based learning.

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