

**Students' evaluations of Learning Objects:
Challenge, graduated difficulty, and interactivity**

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INTRODUCTION

This paper reports on one component of an on-going evaluation of an online curriculum initiative: The Le@rning Federation (TLF). TLF is charged with creating online curriculum content in priority curriculum areas and with making the content available to all education authorities in Australia and New Zealand. In specifying their approach to educational 'soundness' in the production of LOs, TLF has drawn attention to four key principles (drawn from Atkins & Jones, 2004: 2-7):

- i. **Learner focus** (addressing the needs of all students with particular attention to differences relating to gender, socioeconomic conditions, race, culture, geographic location, physical and mental wellbeing, stage of development, and preferred learning modes and styles);
- ii. **Content integrity** (design of learning materials with a view to domain-related accuracy, authenticity and purposefulness);
- iii. **Usability** (intuitive, consistent and meaningful interaction design and sequences); and
- iv. **Accessibility** (accessibility standards for students with languages other than English, with a variety of disabilities, and from rural and remote communities).

With regard to the learning framework guiding the development of materials, TLF has indicated the following 'soundness criteria':

- i. **Problem-based learning** (puzzles, algorithms, story problems, rule-using problems, decision making, trouble shooting, diagnosis-solution problems, and so on, following Jonassen, 2004);
- ii. **Inquiry-based and investigative learning** (framing and focusing questions, locating, organising and analysing information and evidence, evaluating, synthesising and reporting conclusions);
- iii. **Authentic, situated contexts for learning** (based on the users' own direct observations and interpretations of data, thereby enabling them to build on and construct their own new knowledge and understandings, as in Salter, 2003); and

- iv. **Constructive, scaffolded feedback** (the tailoring of graduated feedback in light of the anticipation of likely errors and partly correct responses).

One form TLF curriculum materials take is learning objects (LOs). These aim to capitalise on the potential of digital technologies to enhance learning, and are designed as 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 recruitable into classroom units of work.

TLF, now in its fifth year of operation, has made available more than 1,700 LOs for use in Australian and New Zealand schools. Prior to its formal release, each new LO is subjected to field trialling in classrooms, and evaluated by groups of teachers and researchers. In addition, TLF has undertaken cycles of evaluation designed to monitor and enhance the quality and efficacy of its educational products (see Freebody 2005, 2006; Freebody, Muspratt & McRae, 2007). These evaluations have reported on teacher and student surveys, site visits to observe classroom use of LOs, and, in the most recent report, field experimentation aimed at testing the effects of use of LOs on students' learning outcomes in Mathematics. In this paper, we report on interviews with 300 students concerning their interactions with TLF LOs, with particular attention to features they found attractive, motivating and effective, and those they found less so.

PROFESSIONAL AND RESEARCH BACKGROUND

This work is part of a growing body of research that attempts to evaluate the efficacy of the use of digital technologies in educational settings and to explore possible improvements in creative and effective uses. Many available evaluations have expressed a concern that expenditures in making ICTs available to school systems has not been warranted in terms of their uptake and creative use (e.g., Jamieson-Proctor, Burnett, Finger & Watson, 2006; Smeets, 2005; Nichol & Watson, 2003). It has been argued by some that one of the problems is a lack of digital content that is 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 potentially as a solution to many of the problems of ICT usage in classrooms. But there have been cautions issued. For instance, Butson (2003) claimed that advocates for the LO model were mere optimists:

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)

With the development of large repositories and portals to access and distribute LOs, however, many researchers claim that LOs offer possibilities for improving educational practice, but they point to the need for ongoing research to investigate the practical, strategic, and theoretical problems that accompany LO usage (Nurmi & Jaakkola, 2006a; Parrish, 2004; Polsani, 2003).

There is some documentation of how teachers search repositories and portals for relevant LOs. Recker, Dorward & Nelson (2004) report that teachers were more likely to use LOs that could be incorporated into existing teaching programs, and as a consequence, teachers preferred smaller LOs, those, as they put it, "whose granularity is smaller than a typical class lesson" (p. 102). McCormick and Li (2006) similarly concluded that teachers preferred modular LOs, which focus on one idea or topic, rather than integrated LOs, which electronically link a number of ideas. The argument here was that, if teachers used large, complex and integrated LOs, they would lose some control over both the pedagogy and students' pace and progress. Thus teachers have been found to prefer to search for LOs according to 'topic'. However, the functionality of search engines attached to LO repositories or portals are not as effective as commercial search engines such as Google (McCormick & Li, 2006), and so a teachers' 'Topic' search finds, 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). Despite teachers' preference for searching by 'Topic', it proves to be an unhelpful way to search. McCormick and Li (2006) 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). There are both technological and pedagogical issues associated with reusability. Of central interest here are the pedagogical issues as they may be evaluated by students. We can consider two pedagogical sites - the pedagogy embedded in the LO and the pedagogy operating in the surrounding learning environment. Nurmi and Jaakkola (2006a) argued that 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) encouraged developers and users of LOs to think in terms of possible 'pedagogy

surrounding an LO'. 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 & McCrae, 2007) of teachers using LOs in pedagogically different ways, and using them with various other digital and non-digital resources. It is fanciful to think that LOs can be independent of pedagogy. The question is: Whatever pedagogy is embedded in an LO and however explicitly or implicitly it is built into the LO, does it either constrain or over-depend on teachers' ingenuity and abilities to adapt LOs to suit their particular teaching environments?

There are a few studies that have investigated 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).

The evaluations of the TLF initiative also documented 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). 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 study reported here presents data based on interviews and open-ended survey questions in which the students nominated what was relevant and pertinent. In addition, so that students could directly compare LOs, each student worked with four LOs that were a mixture of LOs generally rated as "good" and "poor" in the survey findings.

METHODS

Selecting the LOs

The current study was conducted in Year 6 classrooms, so only those LOs designed for the upper primary years were used. Also, LOs developed for two of TLF's curriculum domains were not included because too few LOs had been developed in the case of Business and Enterprise, and Arts, Design and Technology, and because of the difficulty of locating classrooms that included the content in their teaching programs in the case of Languages. 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 systematically 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 students' 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. 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; and the converse for a low scoring LO. 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 scores between high and low scoring LOs were not large; indeed, all low scoring LOs had scores above the midpoint of the scale. Composite score for the LOs used in this study are depicted in Figure 1.

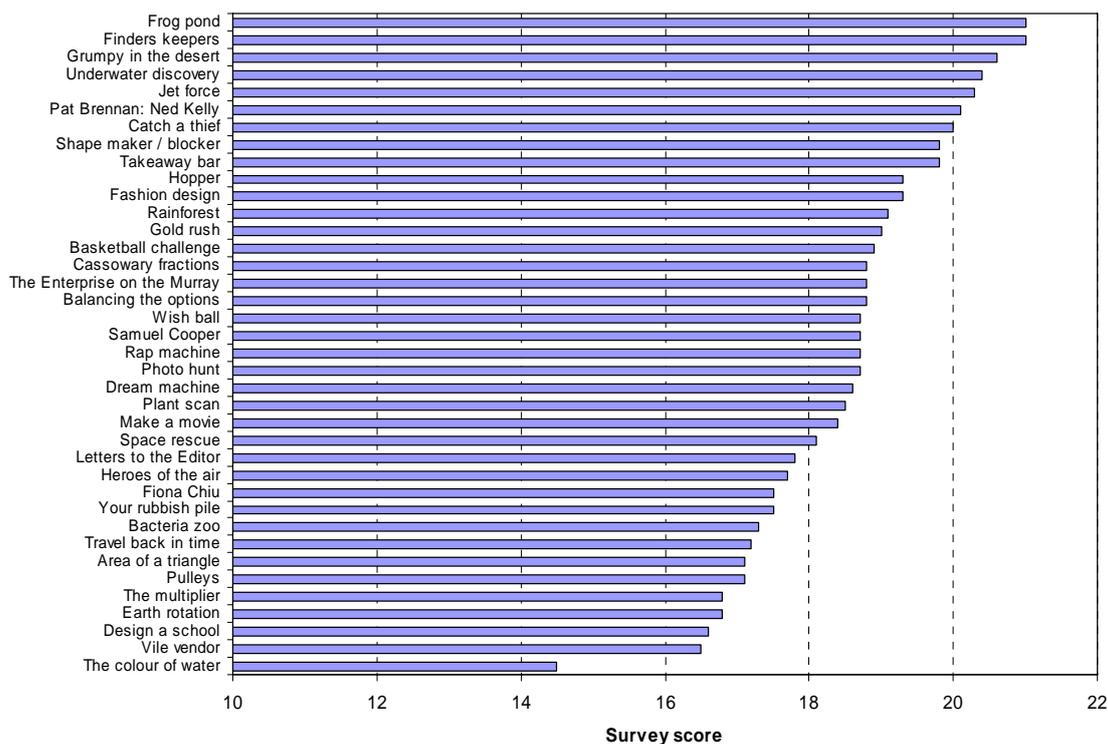


Figure 1: Mean composite scores for LOs selected for use in the comparison study.

Participants

Students from 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 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 had access to their own laptops. In some schools, the classroom teachers had made extensive use LOs in the past, but for some, their participation in the current study was their first time to use 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 highly rated LOs and two poorly rated LOs from any or all of the 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 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 LOs were selected varied: most LOs (24) were selected once, but only a few LOs were selected a large number of times (two LOs were selected five times, two selected four times and two selected three times). Table 1 shows the breakdown of LOs used in the study by curriculum area. The full design matrix showing how students received selected subsamples of LOs is shown in the Appendix.

Table 1: Number of LOs selected for inclusion in the study

Curriculum Domain	Number of LOs: 'Good'	Number of LOs: 'Poor'
Literacy	6	5
Mathematics	6	4
Science	4	4
Studies of Australia	3	6
TOTAL	19	19

Procedures

During a one-hour block of time students worked with one LO and completed either a questionnaire or an interview about the LO. Students worked with four LOs in total, and their work with the LOs could have been spread over a number of days. Students were provided with a summary of each LO before they began and were reminded to read instructions on the screen so that they knew what they were 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 needed.

The questionnaire included requests to rate whether or not they liked the activity (on a five-point scale), if the activity was too easy or too hard (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. Students discussed the LO with an interviewer who encouraged the students to give as much detail as possible about the LO. 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 as to answer 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 completed the questionnaires using an on-line facility or in hardcopy format.

RESULTS

Survey data

The purpose of these analyses is to provide information on students' evaluations of LOs over three occasions and in three different ways, and to assess the levels of consistency evident in these three data sets. The three measures were: the composite survey score from the earlier evaluations; the ranking of LOs as "Favourite" and "Least Favourite"; and the degree to which students liked the LO.

Students rank-ordered the four LOs from "Favourite" to "Least Favourite". The proportion of students who rated an LO as favourite was combined with the proportion who rated it as least favourite to calculate a BestWorst score for each LO. The proportions used in the calculation are of the number of students who used the LO; not of the number in the sample. The expression for BestWorst score is:

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

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 are more likely to be selected as "Favourite" and less likely to be selected as "Least Favourite", and so in these cases the BestWorst score is closer to two. LO with small scores display the opposite trend. LOs with mid-range scores have small to mid-range proportions of students selecting them as "Favourite" and as "Least Favourite", and their BestWorst scores are close to 1. Figure 2 shows the overall BestWorst scores for all LOs used in this study.

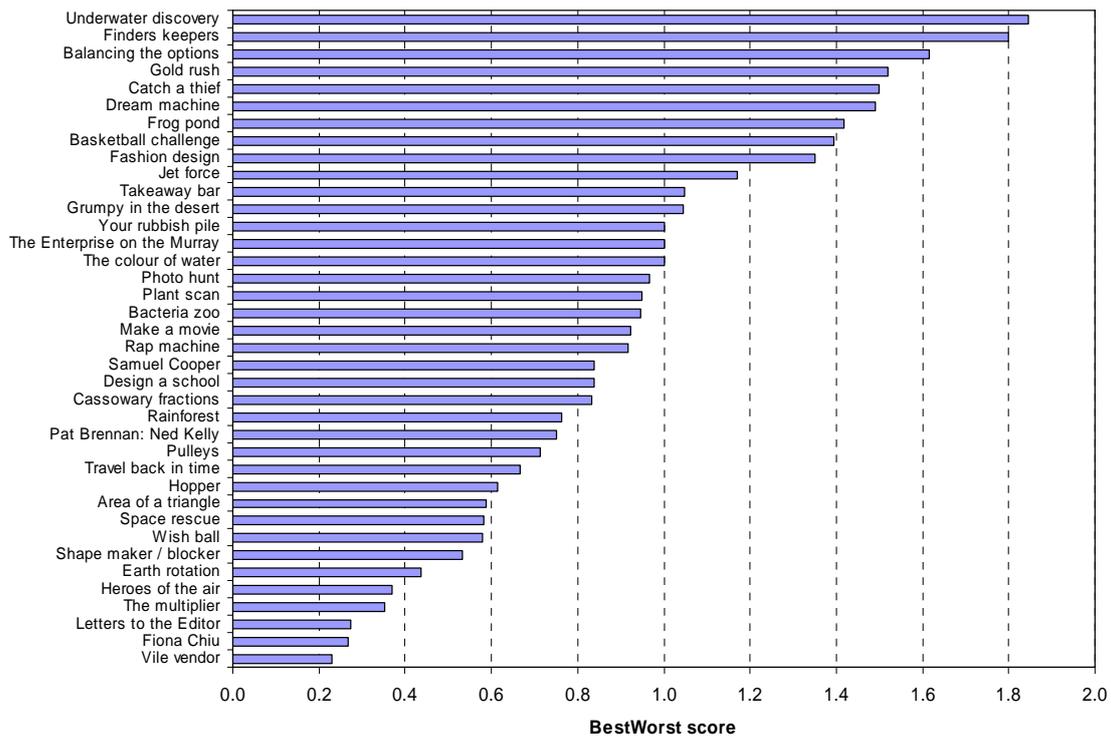


Figure 2: Overall BestWorst scores for LOs

Figures 3 and 4 show means for two specific general questions: One concerning overall levels of students' "liking" or "not liking" the LO (Figure 3); the other showing scores on students' perceptions of the difficulty levels of the LOs they had used.

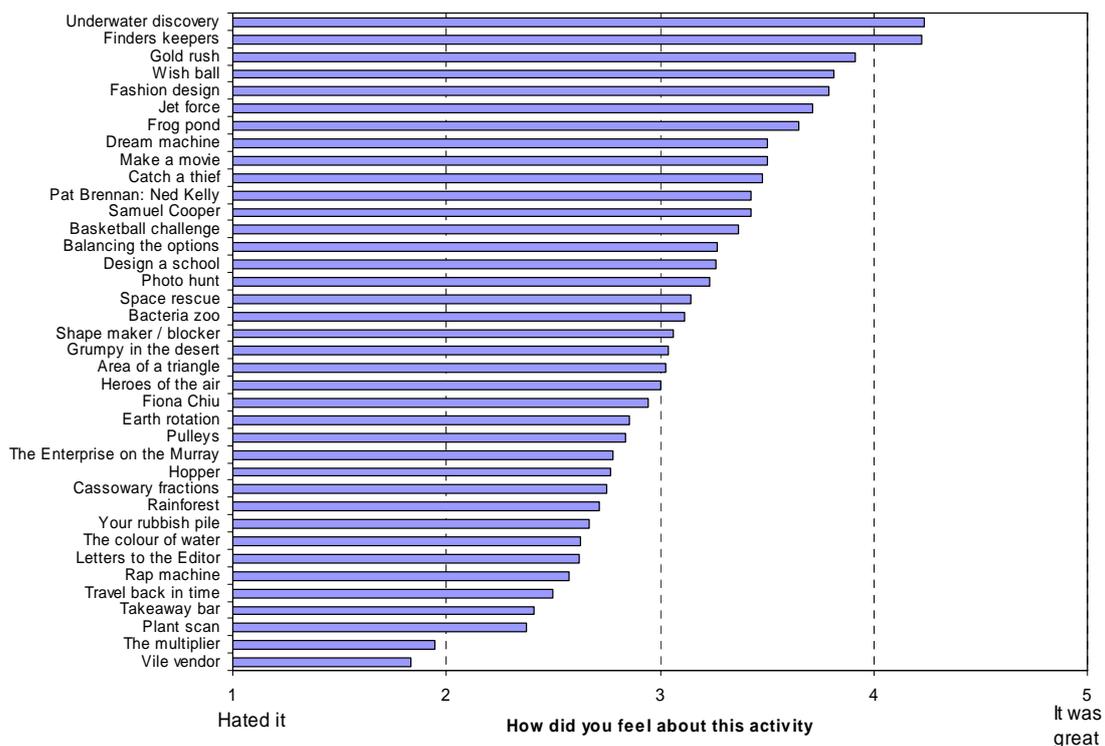


Figure 3: Mean "liking" scores for LOs used in this study

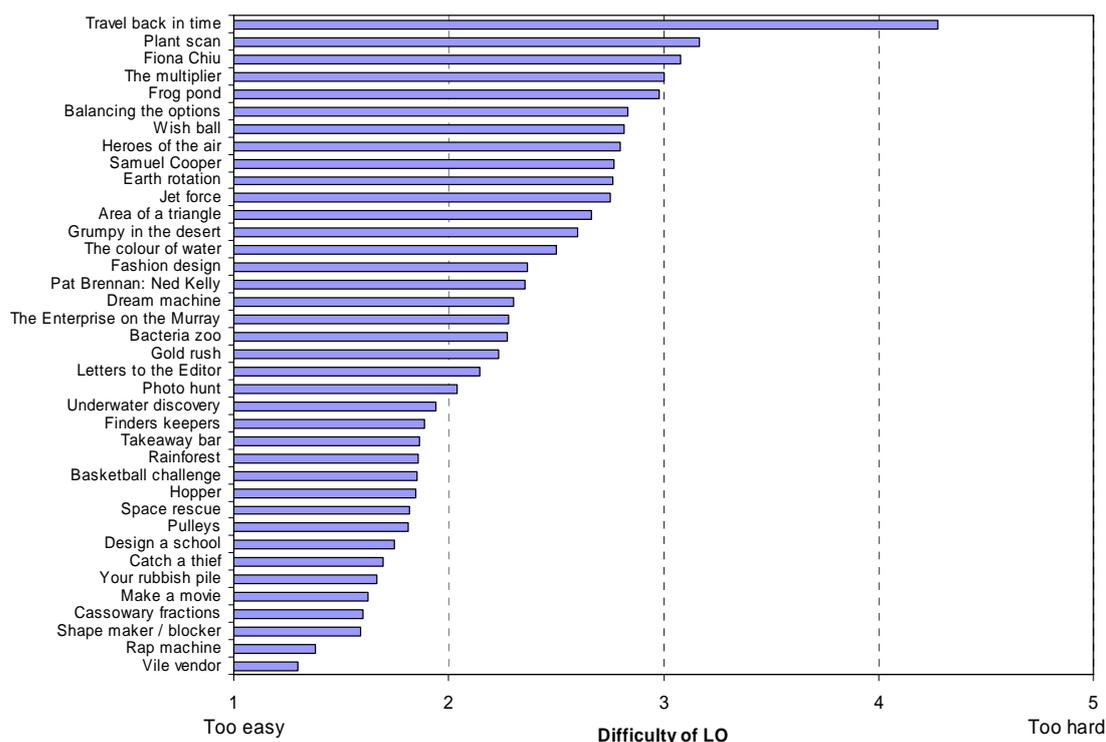


Figure 4: Mean “difficulty” scores for LOs used in this study

Three comparisons are informative in these analyses of students’ views: relationships between survey-based responses and BestWorst scores and levels of overall “liking”. These are depicted in Figures 5 A through C.

Figure 5A compares BestWorst scores and survey scores. There is a statistically significant and moderately strong relationship between the two sets of ratings (Pearson $r = 0.56$, $p < 0.001$). The two measures assessed different aspects of the LOs, and the methods used to calculate the two scores did not take account of the clustering of students within classrooms (many LOs, whether completed for the earlier evaluations or for the current study, were used in just one classroom). Also the BestWorst score for an LO was doubtless influenced by the other LOs selected to accompany it in a particular classroom setting. Nevertheless, these calculations show that there is an association between the two measures; that students’ opinions concerning interest, fun, level of help needed, and whether or not the LO helped them to learn, aligned with students’ selections of LOs as “Favourite” and “Least Favourite”.

Figures 5B and C show two additional associations. In the questionnaires that students completed after working through each LO, students 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 and moderately strong

(Figure 5B: $r = 0.57$, $p < 0.001$; Figure 5C: $r = 0.67$, $p < 0.001$). Thus, the three scatterplots demonstrate some degree of consistency in the ways different students rated the LOs on measures that assess different aspects of the LOs.

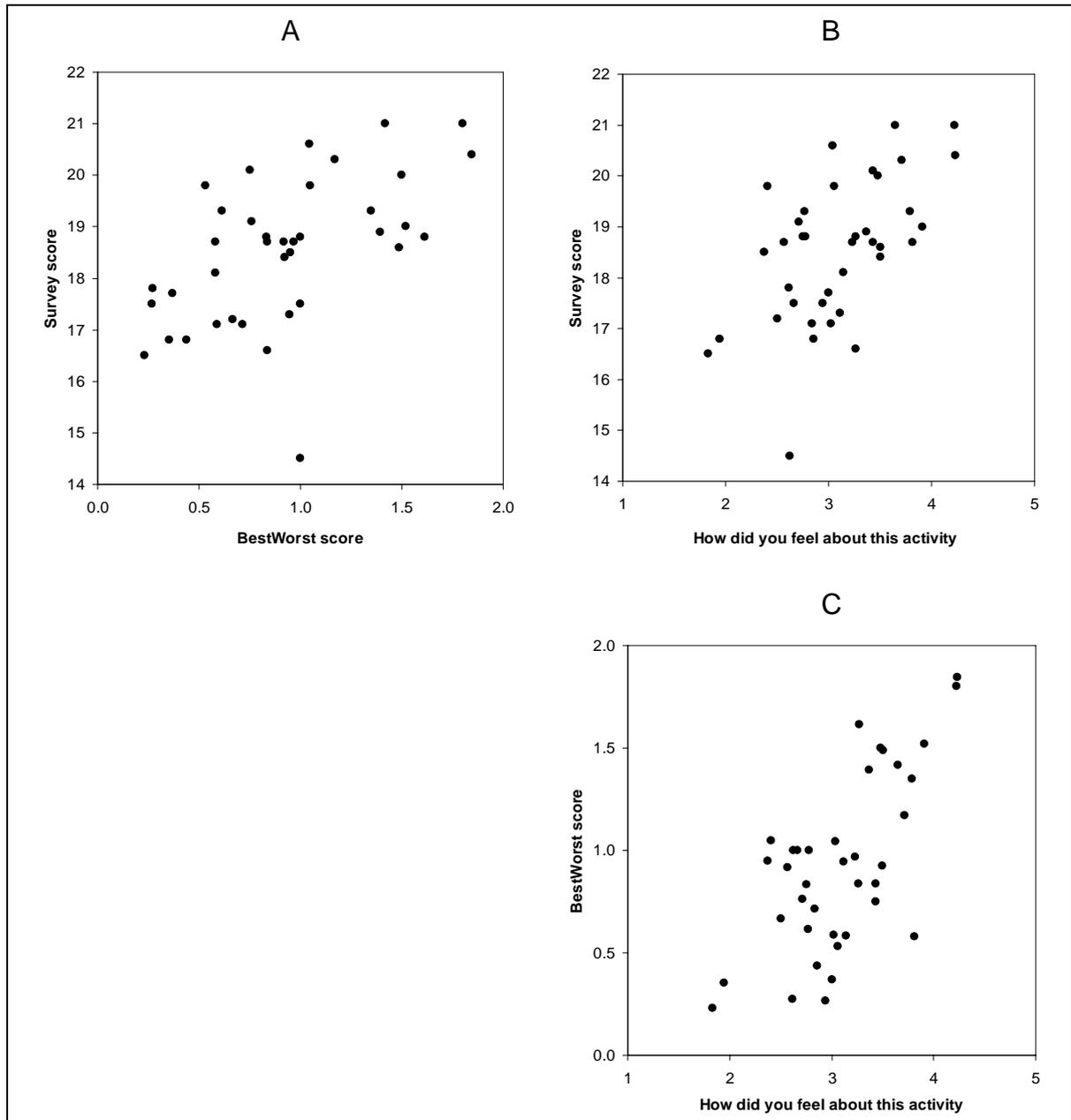


Figure 5 A, B and C: Scatterplots showing associations among survey scores, BestWorst scores, and students' means for "liking" the activity

Figure 6A shows frequency distributions for the question concerning the extent to which an LO was liked. Across all responses for all LOs, the mean rating was 3.2 – close to the midpoint of the scale – but the distributions for "Favourite" LOs is shifted toward the right and the distribution for "Least Favourite" LOs toward 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.

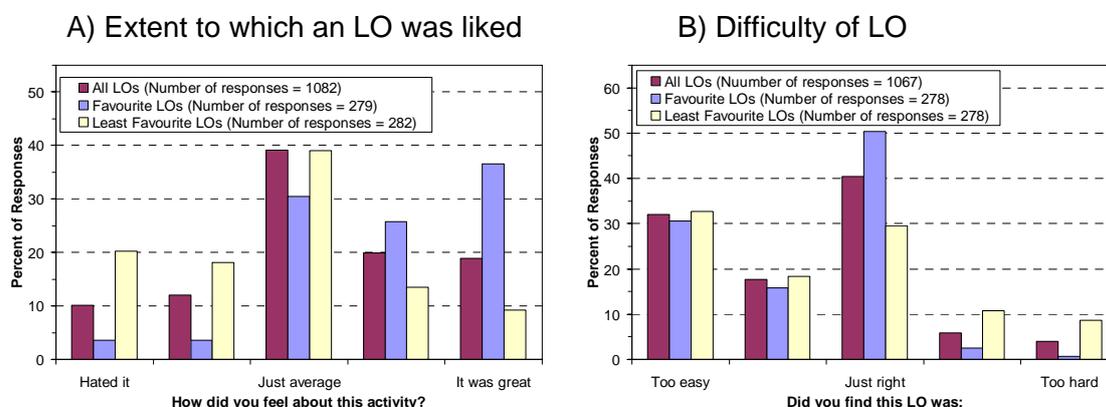


Figure 6: Frequency distributions – Students' views on: A) Whether or not they liked an LO; B) Difficulty of an LO

The frequency distribution for the question concerning the difficulty levels of the LO (Figure 5B) shows that a large number of students rated the difficulty as "Just Right", the optimal point on the scale. The percent of responses at the optimal point increases for "Favourite" and decreases for "Least Favourite" LO. There were also a large number of students rating the difficulty as "Too Easy", and the percentages do not change much when the distributions are separated according to "Favourite" and "Least Favourite" LO. The two Figures suggest that the students discriminated between "Favourite" and "Least Favourite", but for a large proportion of students, even their "Favourite" LOs were too easy.

Interview and comment data

A comment recurring throughout the interviews and open-ended survey questions 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 representative 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. Comments concerning an LO's failure to teach something new were also usually accompanied by other disparaging comments:

It 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 a brief explanation is provided if students select incorrect responses. Students' expectations of LOs, possibly derived from experience 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 simply provided 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 because these LOs cannot store and evaluate textual material the students enter, they cannot provide feedback on their responses. These LOs were also 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 described as "too easy" or "too boring" was because they have limited user control, or allow little interaction with the LO, or limit 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 that are initially highly interactive but take control as students progress through the LO (for example, *Gold Rush*). Students were engaged while they were 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 takes control from the students, they become 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 students, but once students had mastered the content or the navigation, the LO does not then go on to challenge the students. Students reported that they 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.

Second, students were critical of LOs that resembled conventional classroom work, or at least of those components of LOs that had the appearance of conventional work. For instance, some mathematics LOs, as far as these students were concerned, too closely resemble the practice of giving students pages of similar exercises to work through, and thus the LO does not make 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.

It seems that interactional possibilities had been displaced by the requirement for extensive amounts of reading and writing.

Above 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.

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.*

These suggestions focus on 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 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, students took it that the LOs are also supposed to teach them something, and, in order to teach, the LOs must first motivate and engage them 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 developers and for teachers using LOs in their classrooms. Earlier we made the case that LOs have value when they can be 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 give the students the opportunity to base their comments on systematic contrasts among LOs. Nevertheless, their comments draw our attention to delivery and design issues of which teachers should be aware.

Many TLF LOs form a series with each element 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. We drew on McCormick and Li's (2006) work earlier 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. *Sequence and cumulative mastery are critical.*

Students' comments also direct us to design issues. One design issue is a consequence of constructivist pedagogy embedded in the 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. Feedback can take various forms, but at its simplest, students are presented with a multiple choice quiz, and the program provides feedback for correct and incorrect responses. The problem is that students can proceed without necessarily understanding or even reading the feedback. As the

students claim, "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 this is difficult to achieve. But, moreover, even for those LOs with simple feedback mechanisms, it is the teacher who needs 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. *Cheating becomes irrelevant to the ongoing learning program.*

Finally, there are 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 LOs are effective when applied to areas that are difficult to teach well (Nurmi & Jaakkola, 2006b, Freebody, Muspratt & McRae, 2007). 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 well. That is, it is not the LOs themselves that are good or poor; rather the value of an LO is determined by its relationship to the educational environment of which it is experientially a part.

CONCLUSIONS

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 such and such characteristics; poor LOs lack these characteristics, and so on. 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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APPENDIX

Design of the study

