

Teacher Evaluation of Learning Objects in Middle and Secondary School Classrooms

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Abstract

Over the past 8 to 10 years, learning objects, which are web-based tools used to enhance learning, have been evaluated and received positively by higher education students. However, little research has been done examining teachers' perceptions of learning objects, particularly in middle and secondary school environments. The purpose of the current study was to evaluate teachers' assessment of learning objects used in middle and secondary school classrooms. The Learning Object Evaluation Scale for Teachers (LOES-T) had moderate to good reliability, and demonstrated construct and convergent validity. Overall, most teachers rated learning objects as high quality tools that engaged students and promoted successful learning. Teachers also noted that significant time was spent on searching for learning objects and preparing lessons. Technological problems related to learning objects were not reported often and focussed mostly on the speed of the Internet. The main suggestion offered by teachers was to be prepared to spend time selecting, testing, and preparing the materials in order to ensure successful use of learning objects.

Keywords: evaluate, assess, quality, scale, secondary school, learning object

Teacher Evaluation of Learning Objects in Middle and Secondary School Classrooms

In the past 10 years, a concerted effort has been made by many westernized countries to increase the presence of technology in K-12 classrooms. According to the US Department of Education, National Center for Education Statistics (2002), the average student-to-computer ratio in 2001 was 5.4 to 1, a significant increase from the 12:1 ratio reported in 1998. Furthermore, 99% of all public schools now have access to the Internet with 94% having high-speed broadband connections (US Department of Education, National Center for Education Statistics, 2002). Other countries have reported similar efforts to promote technology use in the classroom (Compton & Harwood, 2003; McRobbie, Ginns, & Stein, 2000; Plante & Beattie, 2004). In spite of these efforts, a number of researchers have argued that the mass infusion of technology in the classroom has had a minor or negative impact on student learning (e.g., Cuban, 2001; Roberston, 2003; Russell, Bebell, O'Dwyer, & O'Connor, 2003; Waxman, Connell, & Gray, 2002). Part of the problem stems from a considerable list of barriers that teachers face, even when computers are available. These barriers include a lack of time (Eifler, Greene, & Carroll, 2001; Wepner, Ziomek, & Tao, 2003), limited technological skill (Eifler et al., 2001; Strudler, Archambault, Bendixen, Anderson & Weiss, 2003; Thompson, Schmidt, & Davis, 2003), fear of technology (Bullock, 2004; Doering, Hughes, & Huffman, 2003), and a clear lack of understanding about how to integrate technology into teaching (Cuban, 2001). In addition, it is unclear how student-to-computer ratios translate into actual classroom use, as there are still reports of limited access to technology (e.g., Bartlett, 2002; Brush et al., 2003; Russell et al., 2003).

The Role of Learning Objects

Learning objects, defined in this study as “interactive web-based tools that support learning by enhancing, amplifying, and guiding the cognitive processes of learners” (Agostinho,

Bennett, Lockyer & Harper, 2004; Butson, 2003; Friesen, 2001; Gibbons, Nelson & Richards, 2000; Littlejohn, 2003; Metros, 2005; McGreal, 2004; Muzio, Heins & Mundell, 2002; Parrish, 2004; Polsani, 2003; Wiley, 2000; Wiley, et al. 2004), offer a number of noteworthy features that can reduce the impact of potential obstacles still plaguing teachers.

A typical learning object is designed to focus on a specific concept therefore it is limited in size and scope. These restrictions mean that most learning objects are *easy to learn and use*, and more attractive to busy educators who have little time to learn more complex, advanced software packages (Gadanidis, Gadanidis, & Schindler, 2003). Ease of use also makes learning objects more attractive to teachers who are apprehensive about using technology.

A wide range of learning objects exist including drill-and-practice assessment tools (Adams, Lubega, Walmsley, & Williams, 2004) or tutorials (Nurmi & Jaakkola, 2006), video case studies or supports (Kenny et al., 1999; MacDonald et al., 2005), general web-based multimedia resources (Van Zele, Vandaele, Botteldooren, & Lenaerts, 2003), and self-contained interactive tools in a specific content area (Bradley & Boyle, 2004; Cochrane, 2005). Furthermore, in contrast to other learning technologies burdened with implementation challenges and costs, learning objects are readily *accessible* over the Internet and users need not worry about excessive costs or not having the latest version (Wiley, 2000). It is speculated that a broad selection of readily accessible learning objects would make it easier for teachers to integrate learning objects into a classroom environment.

Learning objects, then, offer a number of potential solutions to the barriers preventing teachers from using technology.

Learning Object Research in Middle and Secondary School Classrooms

Most research on learning objects has been done in higher education. Out of the 39 empirical studies reviewed for this paper, 29 (74%) focussed on higher education, whereas only six (15%) looked at middle or secondary school classrooms (Brush & Saye, 2001; Kong & Kwok, 2005; Liu & Bera, 2005; Nurmi & Jaakkola, 2006; Kay & Knaack, 2007a; Lopez-Morteo & Lopez, 2007).

Three studies examined middle school students' use of learning objects. Kong & Kwok (2005) looked at nine year old students' independent use of learning objects for 15-20 hours while attempting to learn about fractions. Students who used leaning objects significantly outperformed students who did not use learning objects. Liu & Bera (2005) examined middle school students use patterns with respect to a range of learning object tools. Eighty-two percent of the students generated successful solutions using learning objects. Finally, Nurmi & Jaakkola (2006) reported that interactive, simulation-based learning objects produced significantly better results than drill-and practice learning objects.

Three other studies looked at the use of learning objects in the secondary school classroom. Brush & Saye (2001) reported that students tended to look at superficial content in a learning object when left to their own devices and that more active guidance and structure was needed when using information-based learning objects. Kay & Knaack (2007b) used a comprehensive assessment tool to evaluate the use of learning objects and found that overall usefulness, clear instructions, organized layout, and good theme/motivation were particularly important to students. Finally, Lopez-Morteo & Lopez (2007) reported that students perceived interactive, recreation-based, collaborative learning objects positively.

Overall, research on the use of learning objects is positive, albeit somewhat ad hoc and inconsistent with respect to evaluation tools used. Two studies used performance data (Kong & Kwok, 2005; Nurmi & Jaakkola, 2006), two studies use descriptive data (Brush & Saye, 2001; Liu & Bera, 2005), one study used a formal survey (Kay & Knaack, 2007a, 2007b) and one study used anecdotal reports (Lopez-Morteo & Lopez, 2007). All six studies looked at student's perceptions exclusively – teacher impressions of how well the learning objects worked were left unexamined.

Methodological Issues

At least five key observations are worth noting with respect to methods used to evaluate learning objects. First, the majority of evaluation papers focus on a single learning object (Adams et al., 2004; Bradley & Boyle, 2004; Kenny et al., 1999; Krauss & Ally, 2005; MacDonald et al., 2003). It is difficult to determine whether the evaluation tools used in one study generalize to the full range of learning objects that are available.

Second, sample populations tested in many studies have been noticeably small and poorly described (e.g., Adams et al., 2004; Cochrane, 2005; Krauss & Ally, 2005; MacDonald et al., 2005; Van Zele et al., 2003) making it challenging to extend any conclusions to a larger population.

Third, while many evaluation studies reported that students benefited from using learning objects, the evidence is based on loosely designed assessment tools with no validity or reliability (Bradley & Boyle, 2004; Howard-Rose & Harrigan, 2003; Krauss & Ally, 2005; Kenny et al., 1999; Lopez-Morteo & Lopez, 2007; Schoner, Buzza, Harrigan, & Strampel, 2005; Vacik, Wolfslehner, Spork, & Kortschak, 2006; Van Zele et al., 2003; Vargo, Nesbit, Belfer, & Archambault, 2002). As well, very few evaluation studies (e.g., Kenny et al., 1999; Kay &

Knaack, 2007a, 2007b; Van Zele et al., 2003) use formal statistics. The lack of reliability and validity of evaluation tools combined with an absence of statistical rigour reduce confidence in the results presented to date.

Fourth, only one study (Kay & Knaack, 2007a) out of the 39 reviewed for this paper evaluated the use of learning objects with a sample consisting of multiple teachers. In other words, very little has been written about the actual use of learning objects from a classroom teacher's perspective.

Finally, a promising trend in learning object evaluation research is the inclusion of performance measures (e.g., Adams et al., 2004; Bradley & Boyle, 2004; Docherty, Hoy, Topp, & Trinder, 2005; MacDonald et al., 2005; Nurmi & Jaakola, 2006). Until recently, there has been little evidence to support the usefulness or pedagogical impact of learning objects. The next step is to refine current evaluation tools to determine which specific qualities of learning objects influence performance.

In summary, previous methods used to evaluate learning objects are limited with respect to sample size, representative populations, reliability and validity of data collection tools, and the use of formal statistics. Recent evaluation efforts to incorporate learning performance should be encouraged in order to advance knowledge of learning object features that may influence learning.

Purpose

The purpose of this study was to evaluate learning objects from the perspective of the classroom teacher. Based on a detailed review of studies that have assessed learning objects, the following steps were taken:

1. a large, diverse, sample was used;

2. reliability and validity estimates were calculated ;
3. formal statistics were used where applicable;
4. both qualitative and quantitative data were collected;
5. specific learning objects features based on instructional design research were examined;
6. a range of learning objects was tested.

Method

Sample

Teachers. The teacher sample consisted of 33 teachers (12 males, 21 females) and 64 classrooms (a number of teachers used learning objects more than once). These teachers had 0.5 to 33 years of teaching experience ($M = 9.0$, $SD = 8.2$) and came from both middle ($n=6$) and secondary schools ($n=27$). Most teachers taught math ($n=16$) or science ($n=15$). A majority of the teachers rated their ability to use computers as strong or very strong ($n=25$) and their attitude toward using computers as positive or very positive ($n=29$)., although, only six teachers used computers in their classrooms more than once a month.

Students. The student sample consisted of 1113 students (588 males, 525 females), 10 to 22 years of age ($M = 15.5$, $SD = 2.1$), from both middle ($n=263$) and secondary schools ($n= 850$). The population base spanned three separate boards of education, six middle schools, 15 secondary schools, and 33 different classrooms. The students were selected through convenience sampling and had to obtain written permission from their parents to participate.

Learning Objects. A majority of teachers selected learning objects from a repository located at the LORDEC website (<http://www.education.uoit.ca/lordec/collections.html>), although several reported that they also used Google. A total of 44 unique learning objects were selected

covering concepts in biology, Canadian history, chemistry, general science, geography, mathematics, and physics.

Procedure

Teachers from three boards of education were asked if they wanted to volunteer to use learning objects in their classrooms. Each teacher received a half day of training in November on how to choose, use, and assess learning objects (see http://www.education.uoit.ca/lordec/lo_use.html for more details on the training provided). They were then asked to use at least one learning object in their classroom by April of the following year. Email support was available throughout the duration of the study. All students in a given teacher's class used the learning object that the teacher selected, however, only those students with signed parental permission forms were permitted to fill in an anonymous, online survey about their use of the learning object. In addition, students completed a pre and post test based on the content of the learning object.

Data Sources

Teacher survey. After using a learning object, each teacher completed the Learning Object Evaluation Scale for Teachers (LOES-T) in Appendix A. The quantitative items of this scale looked at perceptions of student learning (learning construct), the quality of the learning object (quality construct), and student engagement with the learning object (engagement construct). These constructs were selected based on a detailed review of the learning object literature over the past 10 years (Kay, submitted for publication). In addition, teachers were asked to estimate the amount of time it took to (a) find a learning object and (b) prepare a learning object lesson plan. The qualitative items examined overall impact on learning, technical

problems, and suggestions for future use. Descriptive statistics for the quantitative component of the LOES-T are presented in Table 1.

Insert Table 1 about here.

The internal reliability estimates for the LOES-T constructs were 0.63 (Learning), 0.69 (Quality), and 0.84 (Engagement) – see Table 1. The engagement construct showed good reliability, but the learning and quality constructs demonstrated relatively low reliability (Kline, 1999; Nunally, 1978).

A principal components analysis was done to explore whether the three learning object constructs (learning, quality, and engagement) in the LOES-T formed three distinct factors. Since all communalities were above 0.4 (Stevens, 1992), the principal component analysis was deemed an appropriate exploratory method (Guadagnoli & Velicer, 1988). Orthogonal (varimax) and oblique (direct oblimin) rotations were used, given that the correlation among potential strategy combinations was unknown. These rotational methods produced identical factor combinations, so the results from the varimax rotation (using Kaiser normalization) are presented because they simplify the interpretation of the data (Field, 2005). The Kaiser-Meyer-Olkin measure of sampling adequacy (0.750) and Bartlett's test of sphericity ($p < .001$) indicated that the sample size was acceptable.

The principal components analysis was set to extract three factors (Table 2). The resulting rotation corresponded well with the proposed learning object evaluation constructs with one exception. Scale item 6, referring to students' liking to interact with the learning object showed a high value for both learning and engagement constructs. Overall, the structure was

consistent with previous research (Kay & Knaack, 2005, 2007, 2007b) and the proposed grouping of scale items listed in Appendix A.

Insert Table 2 about here.

Correlations among the three LOES-T constructs (learning, quality, and engagement) were significant, but also small enough to support the assumption that each construct measured was distinct (Table 3).

Insert Table 3 about here.

Student survey. After using a learning object, students completed the Learning Object Evaluation Scale for Students (LOES-S) to determine their perception of (a) how much they learned (learning construct), (b) the quality of the learning object (quality construct), and (c) how much they were engaged with the learning object (engagement construct). LOES-S showed good reliability, construct validity, convergent validity, and predictive validity (see Kay & Knaack, submitted for publication)

Student performance. Students completed a pre and post test created by each teacher based on the content of the learning object used in class. The measure was used to determine student performance as a result of using the learning object.

Data Analysis

The following analyses were run to examine teacher perceptions of the use of learning objects in the classroom.

- 1) descriptive overview of students learning, quality, and engagement as perceived by the teachers;
- 2) quantitative data on search and preparation time;
- 3) correlation between teachers and student analysis of learning objects; and
- 4) correlation between LOES-T constructs and student performance.

In addition, teacher comments were summarized for overall learning (Question 9 – Appendix A), technological issues (Question 10 – Appendix A), and suggestions for future use (Question 11 to 12 – Appendix A).

Results

Descriptive Overview of Learning, Quality and Engagement

Teachers. Perceived student learning, learning object quality, and student engagement were given high ratings by teachers. Average item ratings (out of 7) ranged from 5.8 to 5.9 (see table 1 for construct means). Over 78% of all teachers agreed or strongly agreed that students learned effectively with learning objects. Sixty-four percent agreed or strongly agreed that the learning objects selected were of high quality, and sixty-five percent agreed or strongly agreed that students were engaged while using the learning objects.

Students. Average ratings for students were lower than those given by teachers, ranging from 3.4 to 3.8 out of five (4.8 to 5.3 on a 7 point scale). Student ratings were closer to neutral (3 on a 5 point Likert scale) with respect to learning ($M=3.4$; $S.D. = 0.9$) and engagement ($M=3.4$; $S.D. = 0.8$) and to agree (4 on a 5 point Likert scale) with respect to quality of the learning object ($M=3.8$; $S.D. = 0.9$). Compared to teachers, students selected agree or strongly agree far less for the learning (32% vs. 78%), quality (49% vs. 64%), and engagement constructs (36% vs. 65%).

Searching and Preparation Time

Just over 40% (n=26) of the teachers reported that finding a suitable learning object took them less than 30 minutes. Thirty-eight percent (n=24) took 30 to 60 minutes to find an appropriate learning object. The remaining 22% (n=14) took over an hour to finding the learning object they wanted to use in their class.

With respect to preparation for using the learning object in class, 8 % of the teachers (n=5) spent little or no time, 41% (n=26) spent less than 30 minutes, 30% (n=19) spent 30 to 60 minutes, and the remaining 22% (n=15) spent over an hour.

Correlation Among Teacher and Student Perceptions of Learning Objects

All three constructs on the teacher scale (LOES-T) were significantly correlated with all three constructs on the student scale (LOES-S). Correlations were modest (0.25 to 0.47) indicating a certain degree of consistency between student and teacher evaluations of learning objects.

Insert Table 4 about here.

Correlation Between Teacher Evaluations and Student Performance

Learning performance (percent change from pre to post tests) for classes where a learning object was not used for review purposes (n=19) was significantly and positively correlated with teacher's perceptions of student engagement ($r = .49$; $p < .05$, n=19), but not with perceptions of student learning ($r = .22$; *n.s.*, n=19) or learning object quality ($r = .36$; *n.s.*, n=19) constructs. In

other words, students performance was better when teachers perceived learning objects as engaging.

Teacher Comments

Overall impact. Four themes emerged from the 89 comments that teachers made about the overall impact of the learning object: learning (n=54, 61%), engagement (n=23, 26%), time (n=9, 10%), and individual differences (n=3, 3%).

With respect to learning, 17% of the teachers made direct comments about how much students learned. Most teachers (n=10) made positive comments about how much was learned or how students were on task:

“The students gained good insight into a new concept”

“Students had a much better background in the subject when it was introduced [using learning objects]”

“All students were on task during the 90 minute lesson – Note it is usually only a 60 minute class!”

Some teachers (n=4) observed that the learning object was not as successful as they had hoped:

“Although the learning object did not improve as many students' initial understanding of equation solving as I had hoped, it was useful.”

“They still had great difficulty distinguishing between vertical and horizontal stretches and compressions.”

“The method of explanation and some of the wording was different than our ... textbook”

Many teachers (n=19, 21%) commented on the effectiveness of learning objects to provide visual supports:

“[the] learning object helped them gain a solid visual of what happens to a parabola as you change the numbers of the

vertex form of a parabola.”

“Students were able to see a visual of a concept new to them.”

“I think it really helped the students to visualize ... the meaning of balancing equations.”

A good number of teachers (n=15, 17%) felt that the learning objects worked as good review tools for their students:

“It helped review a topic that I had taught them last year in grade 11”

“This learning object was a great interactive review of concepts learned in grade 6. It not only helped review concepts, but it also motivated students about probability (the topic of our new unit)”

“I am always reviewing balancing equations, and this learning object provided [the] students with an interactive and immediate means to assess what they remembered.”

Finally, with respect to learning, a few teachers (n=4, 5%) commented that the learning objects provided good interactivity for the students.

“This learning object was a great interactive review of concepts learned in grade 6.”

Over one quarter of the teachers (n=23, 26%) noted that one of the key impacts of the learning object was engagement. Students were more interested or motivated when using this tool:

“Students were more motivated.”

“I think students seemed to enjoy using it”

“The learning object helped to motivate students and get them excited about learning math”

Some teachers (n=9, 10%) mentioned that time was an issue, either in creating a good lesson plan with a learning object, saving time, booking the right time to use a learning objects, or not having enough time:

“The learning object allowed me to take a much shorter time to teach to teach the concept”

“I had only had one class prior to using the learning object to introduce the concept to the class because of problems at the school in terms of booking computer time.”

“I think the learning object was helpful. However, due to the time constraints of using this lesson, the usefulness was limited as well.”

Finally, three teachers noted individual differences with respect to the impact of learning objects.

“Some students seemed to work well, however, one student was finished in 5 minutes, whilst another was finished in 35 minutes”

“The learning object was a good one, but only my strongest students were able to learn the concept using the learning object and accompanying worksheets.”

Technological issues. Forty-three percent of the teachers (n=31) reported having no technical problems whatsoever. Four key issues emerged from those teachers who did report problems: access (n=14, 19%), speed of Internet connections (n=10, 14%), software (n=9, 13%), and hardware (n=7, 10%). The main access problems teachers experienced were booking time for students from the school computer lab and having enough computers in the lab to service the full class.

“It was very difficult to get the class into a computer room during this time period.”

“There were not enough working computers so that each student could have his/her own.”

“I love using learning objects but will continue to avoid the use of computers in the classroom until we have more access to better computers.”

A number of teachers found speed, specifically loading time, to be an issue with using the learning objects.

“The loading of the [learning object] was slow”

“The students had to be very patient waiting for the program to upload.”

Software problems experienced included not having the correct version of Java or Flash to load a learning object or the link to the learning object being too complicated and long to type for students to type in quickly and accurately.

Finally, a few teachers experienced hardware problems in the form of old, slow computers, computers that froze or did not work, and equipment such as a headphone not working.

“One of the four computers in my classroom broke down in the middle of when the students were using learning object.”

“The computers ... in the room I booked [did] not all work. The ones that [did] work [were] very slow.

Suggestions for future use. Four areas were emphasized by teachers when offering suggestions for the future use of learning objects: searching (n=35, 42%), preparation (n=22, 27%), testing (n=15, 19%), and support materials (n=15, 19%). With respect to searching for learning objects, many teachers said it took a long time and requested a single, searchable database organized by subject area, concepts, and/or curriculum expectations:

“I would prefer a central place where I can find learning objects indexed by topic of instruction.”

“A more streamlined method of finding learning object would help in greatly reducing the amount of time spent finding suitable learning objects.”

“Surfing the various websites is an area that requires a lot of time.”

Regarding preparation, suggestions did not follow any consistent pattern. Key advice included the following:

1. Make sure you are well prepared – you need to think about supporting worksheets, key questions, and sequencing (5 comments);
2. Allow extra time for using the computers – it takes longer than you think (5 comments);
3. Give students a sheet with the web address of the learning object to save time (2 comments);
4. If you cannot get a computer lab, learning objects can work well for homework (2 comments);
5. Plan well ahead because it can be very hard to book computer time (2 comments);
6. Make sure not to leave the students on their own – teacher support and discussion after the using the learning object is important (2 comments);

A sizeable number of teachers (n=15) warned that it was critical to test the computers, peripherals (e.g., headphones and mice), Internet speed, and learning object thoroughly before giving to a class. Finally, some teachers noted that the support materials can take a lot of time to develop, so they thought that learning objects be offered with pre-designed lessons plans and worksheets.

Discussion

The purpose of this study was to examine learning objects from the perspective of the middle and secondary school classroom teacher. Based on the design of the learning object survey (LOES-T) and the qualitative results collected, six key observations will be discussed:

1. The quality of the evaluation tool (LOES-T) used in the study;
2. Student learning;
3. Quality of learning objects;
4. Engagement of learning objects;
5. Use of learning objects; and
6. Teachers suggestions for future use

Evaluation Tools for Learning Objects

One of the main premises of this paper was that, to date, there were no valid and reliable measures of learning objects, as assessed by teachers. It is important, then, to establish the quality of the LOES-T. The measure showed good construct (principal component analysis) and convergent validity (correlations with student comments) and moderate to low reliability. The qualitative component of the measure provided rich supplementary data and was consistent with the quantitative data reported. The learning construct, which showed relatively low reliability, may require modification for future research. Overall, the evaluation tool used provided a reasonable foundation with which to assess the impact of learning objects.

Student learning and learning objects

The majority of teachers in this study felt that learning objects resulted in successful student learning. This data was corroborated by qualitative feedback where teachers indicated that learning objects led to increased student learning, provided effective visual aids, or offered a helpful review of concepts. Finally, teacher assessment of learning was significantly correlated to student assessment of learning. These positive results are consistent with previous data supporting the use of learning objects in elementary and secondary schools (Brush & Saye, 2001;

Kong & Kwok, 2005; Liu & Bera, 2005; Nurmi & Jaakkola, 2006; Kay & Knaack, 2007a; Lopez-Morteo & Lopez, 2007).

It is worth noting that teachers' assessments of student learning did not correlate significantly with actual student performance in the pre-post tests. This may indicate that the learning construct does not have predictive validity, however, it could also show how challenging it may be for a teacher to estimate student learning while a lesson is in progress. In addition, the sample size was small, so no firm conclusions can be made.

Quality of learning objects

Almost two thirds of the teachers agreed that the learning objects selected were of good quality. This result is not surprising given that the teachers selected the learning objects to be used in their own classrooms. However, teachers did have an opportunity to observe the quality of the learning object objectively during the classroom lesson before they actually rated it. Furthermore, teacher ratings of learning object quality were significantly correlated with student ratings. Finally, the fact that almost half of the teachers reported no technical problems and very few reported software difficulties provides indirect support that the learning object functioned well.

The results suggest that teachers are able to select good quality learning objects that are received positively by their students. However, learning quality was not significantly related to learning performance. The quality of a learning object, then, may not have a direct impact on student learning. Again, the sample is small, so it would be premature to openly accept this conclusion.

Engagement of learning objects

There was considerable evidence to suggest that engagement of a learning object was an important component. According to the survey data, close to two thirds of the teachers felt that students were engaged by the learning object. This result is supported by teacher comments where over 25% of the teachers spontaneously wrote that students were very interested and motivated by the learning object. Furthermore, teachers' assessments of engagement were consistent with student assessments. Finally, engagement was significantly correlated with student performance. Clearly, engagement is a characteristic strongly associated with successful use of learning objects.

Use of Learning Objects

While this study did not provide detailed analysis of how learning objects were used, at least three key themes emerged from over 150 comments made by the teachers who used learning objects in their classrooms. First, time was a critical element that surfaced in many forms: time taken to search for good learning objects, time taken to develop good lesson plans and support materials, and time taken to test learning objects before they are used in class. Needing time to develop good handouts and guidance for students using learning objects is consistent with the results observed by Brush & Saye (2001). Not one teacher mentioned time being a problem with respect to learning how to use learning objects, a finding that supports the notion that learning objects are relatively easy to learn and use. Nonetheless, using learning objects effectively takes time – typical estimates were from one to two hours for both selecting objects and lesson plan preparation.

A second theme, related to time, was the effort required to search for learning objects. Over 40% of the teachers noted that this process was not only time consuming, but frustrating at times. Typical search times ranged from less than 30 minutes to an hour. Most noted that a

single database, searchable by various fields including subject, concept/topic and curriculum expectations would be helpful. Unfortunately, this type of database does not exist. One of the main benefits of learning objects is that they are readily available from numerous sources. At least 10 different databases were used for the current study. This availability, though, comes at the cost of losing precision and references to local curricula and subject organization.

The final theme gleaned from teacher's comments on use involved the influence of technology. Forty percent of the teachers reported no problems whatsoever, a good sign given the range of problems that can occur in any one lesson. However, almost 60% of the teachers did experience challenges. Two of the key problems reported, insufficient access and hardware problems, were unrelated to learning objects. Even though computer access ratios have increased to 1:5 in many Westernized countries, this influx of computers has not translated into reasonable access for some classroom teachers. One teacher articulated the situation quite well:

“I love using learning objects but will continue to avoid the use of computers in the classroom until we have more access to better computers. I am very computer literate-taught it for 5 years-but using computers in regular classes where we have to book out inferior labs is just a huge frustration. While the board insists our student to computer ratio is above average, in reality it is not. They count single computers in classrooms and computers I can never access because they are designated to computer and business classes. So I am stuck with just two labs-one in a very distracting library where I cannot teach. The other is a good location. As you can imagine booking the good room is an issue. There is a third room but the computers don't work. That is the room I had to use.”

Two problems noted that were related to learning object use included speed of Internet connection and not having the software needed to run the learning objects. Learning objects are web-based and often include animation. If the speed of the Internet is slow, this can cause considerable frustration and interrupt the flow of the class. Only 10 teachers experienced this problem, but it is still a key issue. A few teachers noted that the free software needed to run certain learning objects, either Java or Flash was not loaded on the computers. This was a

relatively small administrative problem, but one that needs to be checked before a learning object is used. Most boards can readily update software if given sufficient notice.

In summary, the literature suggests that many schools are technologically prepared to support the use of computers in the curriculum (Compton & Harwood, 2003; McRobbie, Ginns, & Stein, 2000; Plante & Beattie, 2004; US Department of Education, National Center for Education Statistics, 2002), but even with easy to use, readily available, free learning objects, significant access and hardware issues remain.

Suggestions for future use

The suggestions that teachers made for future use of computers focused squarely on time. Teachers advised new users of learning objects to give themselves enough time to search for learning objects, test the learning objects, and prepare lessons plans and support materials. All three factors are critical for the successful use of learning objects. While learning objects were valued by both teachers and students, using them effectively takes time. In fact, many teachers asked that the searching process be streamlined either in the form of a one stop, searchable data base or a “top ten” list. In addition, a significant number of teachers would have liked support materials.

Suggestions for Educators

The results from this study offer a number of practical suggestions for teachers who plan to use learning objects in the K-12 classroom.

First, according to both teachers and students, learning objects are effective, high quality learning tools that were engaging. However, finding good learning objects and preparing effective support materials takes time.

Second learning objects that are engaging lead to significantly higher learning performance in pre-post tests. Engagement, then, is an important feature to note when selecting a learning object.

Third, technological barriers in the form of insufficient access and hardware problems are a reality that needs to be addressed by booking labs well ahead of time and thorough testing. Software problems are relatively uncommon, but can also be avoided if the learning object is tested on student computers ahead of time.

Finally, the issue of time is important when using learning objects. It appears one to two hours is typical for the time needed to find a good learning object and prepare an effective lesson. Incorporating learning objects into a lesson takes extra time in the form of searching, testing, and preparation. It should be noted, though, that not one teacher said the time spent was a significant problem or that they would not use learning objects because it took too long to search and plan lessons. In fact, many teachers used learning objects more than once in this study. As one educator noted, there are always trade-offs with respect to time:

“The time spent looking for an effective learning object, and modifying it slightly, proves worthwhile with a lesson that pretty-much runs itself as the student interacts with engaging media.”

Summary

The purpose of this study was to evaluate teachers' perceptions of learning objects used in middle and secondary school classrooms. A moderately reliable, valid assessment tool was used that gleaned information about student learning, quality of learning object, engagement, technological issues, and suggestions for future use. Overall, most teachers rated learning objects as high quality tools that engaged students and promoted successful learning. Teachers also noted that significant time was spent on searching for learning objects and preparing

lessons. Technological problems related to learning objects were not reported often and focussed mostly on the speed of the Internet. The main suggestion offered by teachers was to be prepared to spend time selecting, testing, and preparing the materials in order to ensure successful use of learning objects.

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Table 1

Description of Learning Object Evaluation Scale for Teachers (LOES-T)

Scale	No. Items	Possible Range	Actual Range Observed	Mean (S.D)	Internal Reliability
LOES-T					
Learn	2	2 to 14	6 to 14	11.6 (1.7)	$r = 0.63$
Quality	3	3 to 21	11 to 21	17.7 (2.8)	$r = 0.69$
Engage	3	2 to 21	9 to 21	17.3 (2.4)	$r = 0.84$

Table 2

Varimax Rotated Factor Loadings on Teacher Learning Object Evaluation Scale (LOES-T)

Scale Item	Factor 1	Factor 2	Factor 3
T-Learn 1 - Graphics	.875		
T-Learn 2 – Students Learn	.694		
T-Quality 3 – Easy to Use		.795	
T-Quality 4 – Easy to Learn		.794	
T-Quality 5 - Instructions		.570	
T-Engagement 6 - Interact	.629		.558
T-Engagement 7 – On Task			.932
T-Engagement 8 – Motivated			.741

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	3.79	47.4	47.4
2	1.38	17.3	64.6
3	0.73	9.2	73.8

Table 3

Correlations Among Teacher Learning Object Evaluation Scale (LOES-T) Constructs

	T-Learn	T-Quality	T-Engagement
T-Learn	1.00	0.59 **	0.52 **
T-Quality		1.00	0.39 *
T-Engagement			1.00

* $p < .005$ (2-tailed)** $p < .001$ (2-tailed)

Table 4

Correlations among LOES-S and LOES-T Constructs

	S-Learn	S-Quality	S-Engagement
T-Learn	0.47 ***	0.47 ***	0.44 ***
T-Quality	0.45 ***	0.45 ***	0.43 ***
T-Engagement	0.25 *	0.33 **	0.39 *

* $p < .05$ (2-tailed)** $p < .01$ (2-tailed)*** $p < .001$ (2-tailed)

Appendix B – Learning Object Evaluation Scale for Teachers

	Strongly Disagree 1	Disagree 2	Slightly Disagree 3	Neutral 4	Slightly Agree 5	Agree 6	Strongly Agree 7
<i>Learning</i>							
1. The graphics and animations from the learning object helped students learn.	1	2	3	4	5	6	7
2. The students were able to learn from the learning object.	1	2	3	4	5	6	7
<i>Quality</i>							
3. The learning object was easy for students to use.	1	2	3	4	5	6	7
4. The learning object was easy to learn.	1	2	3	4	5	6	7
5. The students found the learning object instructions clear	1	2	3	4	5	6	7
<i>Engagement</i>							
6. The students liked interacting with the learning object.	1	2	3	4	5	6	7
7. The students were on task while using the learning object.	1	2	3	4	5	6	7
8. Students were motivated while using the learning object.	1	2	3	4	5	6	7
<i>Overall Impact on Learning</i>							
9. What was the overall impact of the learning object on your lesson?							
<i>Technological Problems</i>							
10. Were there any technology-based problems that you encountered while using your learning object. Please explain.							
<i>Suggestions for Future Use</i>							
11. What information would you like to have in order to use learning objects more effectively in the future? Please explain.							
12. What advice would you give to future teachers about using learning objects in their lessons?							