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The International Journal of Instructional Technology and Distance Learning is refereed, global in scope, and focused on research and innovation in teaching and learning.

The Journal was established to facilitate collaboration and communication among researchers, innovators, practitioners, and administrators of education and training programs involving instructional technologies and distance learning. The editors and peer reviewers are committed to publish significant writings of high academic stature.

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Executive Editor

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Editorial

InService Training

The half-life of useful knowledge and skills is diminishing rapidly in the face of innovation and paradigm shifts. Periodically I find myself imprisoned in an expensive hotel to have my mind reshaped to fit global changes around me. This week was about viruses, last week was network security, next week - intelligent cell-phones. The flow of new technology is endless, and each brings fresh opportunities for business, industry, military, government, education, and personal growth. The dark side is ever present and misuse must be factored into our planning.

A month ago I signed up for a videoconference on my office computer. I was glad not to have traveled for *this* performance – a panel of speakers with fixed assignments and time-frames, no visuals, and no significant interaction. . . .

I compared the presentation with the brilliant productions of Adobe, Microsoft, Tend Micro, and other technology companies who use hotel environments to reach their core customers. These roadshows are supported by handouts, manuals, CDs, and teams of technical experts to field questions, demonstrate products, and service customer needs. Other incentives include food, refreshments. and door prizes. These shows are well attended in large cities throughout the country. They attract executives, politicians, technicians, sales persons, trainers and VARs (Value Added Resellers). They build relationships and grow profits.

These same technology industries are leaders in developing online tutorials that range from Help Text to short courses and Certificate programs. Certification from companies like CISCO and MicroSoft set industry standards for quality and relevance. Because of rapidly changing technology, these certifications must be regularly updated. Programs are available through community colleges and technical institutes, short-courses at conventions, and textbook with CD-ROM. There is often a hands-on laboratory component and all testing is online.

Text, CD and online components enable fast and scaleable course rollout. Courses are standardized and high in quality. Because they are computer based, they can be quickly revised, updated and replicated. . . .

By this time the videoconference was relegated to a tiny window in the corner of my screen and became increasingly smaller as I answered and initiated emails, corrected student assignments, and conducted web searches. In high and low moments of the videoconference I was able to respond with cheers and expletives that would not be appropriate in a hotel setting. ***I*** was in control because ***I*** was ***NOT*** physically present. The speakers continued to mumble through my cheers, groans, and insults.

Talking *off the cuff,* even by experts, does not compare with the focused objectives, illustrations, examples, and storytelling in roadshow presentations, or the concise *Just-In-Time* tutorials online. Educators and trainers should reassess their mission and environment, and acquire the expertise, technology tools and techniques used by their *best of class* colleagues in industry. And if they fail to do this well, their best of class colleagues may replace them using these same technologies.

As outsourcing replaces local jobs, and automation eliminates repetitive procedures, technology can improve services and lower cost. These trends seem to be irreversible and are hostile to procrastination and mediocre performance. Those who read this Journal are capable entrepreneurs and innovators in research, design, development, programming, dissemination, implementation, and evaluation of these higher order technology, education and training products.

Marshall McLuhan reminds us that change is around the corner. We cannot see the future in our rear-vision mirror.

Editor's Note: Up till now, much of the literature on Reusable Learning Objects has focused on research, definition and instructional design. This paper takes a practical application to determine the effectiveness of objects used in different course contexts.

Reusing Learning Objects in Three Settings: Implications for Online Instruction

Simone Conceição, Christine Olgren, Patricia Ploetz

Abstract

This paper describes the implementation and evaluation of sharable content objects (SCO) used as prototypes to test overall design considerations and learning effectiveness. The prototypes were evaluated in three settings: (a) a blended online and classroom model, (b) an online collaborative model, and (c) an online self-paced model. The results of the evaluation demonstrated that SCOs can be effectively reused in multiple environments and that their pedagogical value reflects the context of use. Implications for online instruction related to reusability, design, and learner outcomes are presented.

Keywords: sharable content objects, prototype evaluation, learning objects

Introduction

To meet the growing demand for educational resources, colleges and universities around the world are turning to online technologies to replace and/or enhance the traditional classroom experience. An important component of this new e-learning environment is the use of learning objects (Hamel & Ryan-Jones, 2002).

A great deal has been written about the concept of learning objects, their definition, and their potential application. However, much less is known about their actual use and re-use in educational contexts. Few studies have been conducted to date to research the application of learning objects in actual instructional settings and their value in practice (Mason, Pegler, & Weller, 2005; Nurmi & Jaakkola, 2005).

As Mason, Pegler, and Weller (2005) point out, one benefit of learning objects is to create short learning events that can be adapted to different learning needs and contexts. This flexibility of learning objects contributes to their potential use and re-use in different instructional contexts. The re-use of course material should improve the cost-efficiency of course development because the content chunks or learning events can be used across several courses to reduce development time and expenses.

According to the Department of Defense (DOD), learning objects have the following characteristics or "ilities": reusability, accessibility, interoperability, and durability. These "ilities," explains Kaiser (2000), result in activity-sized learning objects, just large enough to be a lesson, that retain their utility over time, are easy to locate and use, can be used on a variety of platforms or course management systems, and are able to be reused in different learning contexts. These characteristics are in line with the literature on learning objects (Downes, 2003; Hamel & Ryan-Jones, 2002; Ploetz, 2003; South & Monson, 2000).

Of the four "ilities," the most misunderstood is interoperability. In order to be fully interoperable, a learning object (the content) and its associated metadata file must be packaged according to the Sharable Content Object Reference Model (SCORM). Packaging is the process that brings together the learning object and metadata files, then it creates a manifest file that tells the learning management system how the learning content is organized and how the content is presented to the

user. When a learning object and its metadata have been packaged according to the SCORM, the result is a SCORM conformant sharable content object, or SCO. Learning objects are packaged so that they can be easily uploaded and used in SCORM conformant Learning Management System (LMS).

The ability to easily upload and use learning objects developed by different proprietary systems into a SCORM conformant LMS promotes reusability across programs and systems (Murphy, 2004; Ploetz, 2003). Therefore, in order to be truly reusable a learning object must be interoperable. The learning objects for this project conform to the SCORM standards for interoperability and, therefore, they will be identified as sharable content objects (SCOs) throughout the remainder of this paper.

This paper describes the implementation and evaluation of the SCOs created for a project entitled, *An Investigation of the Pedagogical and Economic Effectiveness of Sharable Content Objects Using Standards in Online Instruction* (Meachen, Olgren, & Ploetz, 2004). The project activities included developing and evaluating a library of SCOs for faculty training in 14 instructional areas (or modules) that are central to effective practices in online course conversion, design, teaching, learner support, and assessment. The module *Online Facilitation and Communication Techniques* was used as a prototype to test overall design considerations in the use of SCOs and was piloted under several conditions to assess reusability, faculty satisfaction, and effectiveness. The conditions involved three settings, or instructional models, in which SCOs are likely to be used: (a) a blended online and classroom model, (b) an online collaborative model, and (c) an online self-paced model.

The Three Settings

The *Online Facilitation and Communication Techniques* module comprised 11 SCOs. Each SCO was designed to be a self-contained lesson, or instructional event, that included an overview, objectives, content, practice activities, and/or self-check quiz, and a summary taking an estimated average of 20-30 minutes to complete (see Table 1 for a listing of the SCOs). The 11 SCOs were packaged to be SCORM conformant in meeting interoperability standards. The SCOs were made available to three instructional settings: a blended online and classroom course, an online collaborative course, and an online self-paced course at three higher education institutions in the United States to evaluate reusability and effectiveness in different instructional contexts.

Blended Online and Classroom Course

The blended course was part of a curricular redesign program and its goal was to provide higher education faculty new to the online environment the rationale and methods for redesigning one of their face-to-face courses for the online environment. Faculty met one day a week for four weeks for presentations and instruction; the rest of their work week was spent in the LMS Desire2Learn (D2L) reading articles, viewing SCOs, participating in discussion forums, and working on redesigning their face-to-face course.

Online Collaborative Course

The online collaborative course was part of a master's degree program in adult and continuing education. The purpose of the online collaborative course was to allow students to analyze concepts, theories, and research on distance education; and develop and assess distance education programs. The course met face-to-face for an orientation in the beginning of the semester and on the last day of the class. The remainder of the course was totally online using D2L. The course was divided into five modules for which readings and team tasks were assigned. Students participated in online group discussions, creation of concept maps, and a team project. SCOs

were used as instructional aids in the online collaborative course. Students were encouraged to view SCOs as part of the online course orientation and throughout the semester at their own pace.

Table 1

Online Facilitation and Communication Techniques Module

Lesson Topic	Learning Objectives	Estimated Time
1. An Introduction to Asynchronous Discussion Forums	Distinguish between synchronous and asynchronous modes of communication by identifying the basic features of an asynchronous discussion	10 minutes
2. Types of Asynchronous Discussions	Identify various types of asynchronous discussions based on the characteristics of the discussion postings Appropriately facilitate, direct, and respond to learners' discussion postings based on the discussion type	22 minutes
3. Netiquette for Online Discussion Forums	Identify appropriate behavior for participants in online discussion forums based on general rules and guidelines for online communication	17 minutes
4. The Art of Civil Disagreement Online	Use five guidelines to determine how to compose a respectful response to an offensive discussion post or email	20 minutes
5. Strategies for Planning and Managing Groups	To help you support collaborative learning among learners when they are online	10 minutes
6. Promoting a Sense of Community	To provide the elements to establish a learning community that will be the medium through which collaboration occurs	35 minutes
7. Fostering Participation	Identify characteristics and factors that lead toward creation of an online environment which fosters student participation Plan attributes for increasing participation in an online course	30 minutes
8. The Lurker	How to identify “lurkers” and how to help a student overcome lurking	10 minutes
9. Dealing with Difficult Students	Identify a difficult student in an online course Plan appropriate responses based on the degree to which the student is causing problems	30 minutes
10. Time Management Tips for Facilitating Online Courses	Identify and determine strategies to efficiently manage time while facilitating online courses	30 minutes
11. A Rubric to Assess Participation in Online	To assess student participation based on a rubric that categorizes types and levels of activity	30 minutes

Discussion Forums	within an online discussion forum	

Online Self-Paced Course

The online self-paced course was part of a Distance Education Certificate Program that provides a curriculum of online collaborative and self-paced courses for professional development in online teaching, technology, instructional design, evaluation, and management. The prototype was set up as a self-paced course for online learning. The course consisted of 11 lessons, where each lesson was a SCO. The 11 SCOs were the sole source of content and activities. The only other instructional resource was an overview of the course procedures and content. Participants could complete the course at their own pace, at any time during a one-month period. They used D2L to access the lesson content, submit lesson evaluations, and post optional messages to a discussion board.

Methodology

Online survey research was used to collect data from participants. In order to capture participants' perceptions of the SCOs, the online survey was administered after interacting with individual SCOs. The survey questionnaire included questions related to the design layout, content presentation and relevancy, and features that were relevant to respondents' learning and future application (see Table 2 for Online Survey Questionnaire). The same online questionnaire was used for all three settings. The questionnaire was designed to be short in asking nine questions, but it provided responses to key elements related to the design and content of the SCOs. Survey respondents were all non-traditional adult learners.

Prototype Participants

Fourteen faculty participated in a month-long blended course: four were tenured professors, seven were in tenure track positions, and the remaining three were classified as teaching academic staff. There were six female (43%) and eight male (57%) participants. Five of the participants had previously used the Internet and public folders (early discussion forums) as instructional aids to existing face-to-face courses or had previously used an LMS such as WebCT or Blackboard. During the first week of the program, faculty were instructed to view three of the eleven SCOs of their choice and complete the online questionnaire for each SCO viewed. There were a total of 47 evaluations.

For the online collaborative course, participants evaluated the 11 prototype SCOs immediately after viewing them. A reminder about viewing and evaluating the SCOs was emailed to students at the beginning of each course module. The online collaborative course included 13 graduate students (15% male; 85% female) pursuing a certificate program in health professional education and non profit management (15%), a master's degree program in adult education (62%), and a PhD program in education (23%). A total of 120 SCO evaluations accounted for the graduate students who participated in the online collaborative course.

The online self-paced course involved 21 participants who volunteered to participate in the course to increase their knowledge of facilitation strategies. Each participant had to complete and evaluate all 11 lessons. All of the participants had prior experience in using an LMS for online learning. Of the 21 participants, 17 completed the course. The completers comprised 14 females and 3 males representing the following types of organizations and job functions: higher education (53%), business/industry (18%), government/military (18%), and other non-profit (12%). Participants of the self-paced online course were involved in the following types of job functions: design/development (35%), management (24%), faculty training (18%), and teaching (24%). The self-paced participants submitted 205 SCO evaluations.

Table 2

Online Survey Questionnaire

Evaluation of Prototype Learning Objects

Please take a few minutes to evaluate how you experienced the learning object. Your feedback will be very helpful in assessing its effectiveness and in making improvements.

	Learning Object Name:	Please Select				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1.	The objectives are stated clearly.	☐	☐	☐	☐	☐
2.	The screen layout is easy to navigate.	☐	☐	☐	☐	☐
3.	The content is relevant to my needs.	☐	☐	☐	☐	☐
4.	The content presentation and activities are engaging.	☐	☐	☐	☐	☐
5.	The content added to my knowledge or skills.	☐	☐	☐	☐	☐
6.	I gained practical information that I can apply to my work in the course.	☐	☐	☐	☐	☐
		Too Little	**About Right**	**Too Much**		
7.	The amount of content is:	☐	☐	☐		
		Too Deep	**About Right**	**Too Shallow**		
8.	The degree to which the content was covered was:	☐	☐	☐		
.		**Very Good**	**Good**	**Fair**	**Poor**	
9.	What is your overall rating of the learning object?	☐	☐	☐	☐	
10.	How long did it take you to complete the learning?					
11.	What suggestions do you have for improvements?					

Prototype Evaluation Results

Quantitative and qualitative records were used to analyze data from participants' responses to the survey items. The survey items provided data about the following elements: overall rating of each SCO, the SCO design and content, and learning outcomes in relation to knowledge gains and applications.

Overall Rating

Participants in all three settings rated the SCOs favorably (see Table 3 for ANOVA Comparison of Mean Scores for the Three Settings). For the overall rating in Question 9, participants were asked to rate each SCO on a scale of 1 to 4. All three formats were rated at least "good," with average scores of 3.00 to 3.46. The Self-Paced group average rating of 3.46 was significantly higher than either the Blended or the Online (Blended and Online did not differ significantly). Interestingly, the Self-Paced mode was perceived as being of higher quality overall, where the SCOs stood alone as the sole source of content and activities.

Table 3

ANOVA Comparison of Mean Scores for the Three Settings

Survey Questions					
1. The objectives are stated clearly.	4.63		4.60		4.63
2. The screen layout is easy to navigate.	4.50		4.17		4.25
3. The content is relevant to my needs.	4.43		4.50		4.43
4. The content presentation and activities are engaging.	4.02	<	4.47	>	4.18
5. The content added to my knowledge or skills.	4.00		4.31		4.27
6. I gained practical information that I can apply to my work.	4.00		4.30		4.28
7. The amount of content is: (too little, about right, too much)	2.17	>	2.07	>	1.97
8. The degree to which the content was covered was: (too shallow, about right, too deep).	1.84		1.95		1.97
9. What is your overall rating of the learning object? (poor, fair, good, very good)	3.00	<	3.46	>	3.18

Notes:

Questions 1-6 used a five-point scale of strongly disagree=1, disagree=2, neutral=3, agree=4, and strongly agree=5.

The anchors used for questions 7-9 are shown in the table.

The < or > symbols denote significant differences between means in the indicated direction with significance level of $p<.01$

SCO Design and Content

Five questions on the survey asked participants to rate elements of the SCO design and content related to: (1) learning objectives, (2) layout and navigation, (3) motivational engagement of the content and activities, (4) amount of content, and (5) depth of content. Each element was rated on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

For the SCO design, the participants in all three settings agreed (minimum rating of 4.0) the objectives were clearly stated, the SCOs were easy to navigate, and the content and activities were engaging. The ratings for the three settings were quite similar. However, when asked to rate whether they agreed or disagreed with the statement, "The content presentation and activities are engaging," those in the Self-Paced group rated this statement significantly higher than those in the Blended or in the Online groups. Differences in ratings between the Blended and Online groups were not significant.

Questions 7 and 8 asked about perceptions of the content. All three groups responded, on average, that the amount of content and depth of content were “about right” for the prototype SCOs.

Knowledge Gains and Applications

Participants found the SCOs to be effective in learning outcomes. They agreed (minimum rating of 4.0) the content was relevant to their needs, added to their knowledge or skills, and provided practical information applicable to their own work. There was no significant difference among the three groups in their ratings of effectiveness (see Table 3).

The quantitative data about SCO effectiveness was supported by the qualitative comments made by participants. The qualitative comments also provided insights into how the SCOs were used. In the online collaborative course, respondents evaluated the content in the SCOs in relationship to their learning in the course and application of the material during online discussions. For example, two of the students stated how the SCOs were used as a learning tool: “I knew most of this material already, but was able to pick up a few tips and it was a nice refresher of things I already knew” and “This learning objective was applicable to what has been discussed in this [course] module and helped me apply what I have learned in a clearer manner.” Another student revealed how the content in the SCO could be applied during the online course discussions: “I was surprised by a few of the 'correct' answers, and hope to facilitate Module 2 discussion on those points.”

During an online program session on multimedia in the online environment, faculty were asked to compare the effectiveness of the SCOs to other media. Faculty overwhelmingly agreed that the SCOs were more effective in providing instruction than other types of media including online video/audio lectures and PowerPoint presentations. Comparing SCOs to other forms of multimedia allowed faculty to become aware of the potential use of SCOs for online instruction.

It was evident that students in the online course were looking at the SCO content as a tool that contained information they could apply in the future. One student said that the information in the SCO will assist in teaching online courses. Another student stated, “I thought that the case studies were very helpful and provided great insight as to what I could do when I become an instructor.”

Consistency in Layout and Variety in Design

The last item on the survey asked respondents to provide suggestions for improvement of the SCOs. Most of the qualitative responses involved participants’ perceptions of the SCO layout, content, and design features that affected their learning. A theme emerging from the qualitative responses brought up issues related to the consistency in layout and variety in design.

The SCOs were designed using the same instructional template to enhance consistency in content layout, but they varied in terms of instructional activities. Consistency in content layout is defined

in terms of font color and page layout. Design variety means using a variety of instructional activities in each SCO. When different instructional activities were used in the design of the SCOs users could interact with the content in a variety of ways. These activities included case studies, quizzes, matching activities, puzzles, game-like strategies, and analogies. It was evident that depending on the learning preference of the user, certain methods were favored. Responses that indicated learning preference for certain methods compared strategies used in one SCO. For example, a student in the online collaborative course said, “I thought that quizzes were sufficient in testing if information was learned; I didn't think that we needed to go through the scenarios.” Another student stated, “I thought the cake analogy was a bit overdone, but enjoyed constructing paragraph responses for the offensive scenarios.”

Depending on the type of analogy and topic introduced in the SCO, course participants had different reactions. One of the SCOs compared team building to a basketball team, which made the information transferable to people who were familiar with team sports. For some people the crossword puzzles were enjoyable; for others they were annoying. One respondent said that “asking to 'fill in the blanks' would eliminate the hassle of scrolling, clicking tabs, and tinkering with arrows to try to fill in letter boxes.” Other respondents stated that action examples were insightful. For some, the use of scenarios was real and thought provoking.

Several participants in the online self-paced course made comments about consistency and variety from an instructional design perspective. Because the self-paced participants were involved in a certificate program to gain knowledge and skills in online instruction, their evaluation of the SCOs included comments about design considerations.

One self-paced participant liked the variety of instructional activities, saying: “By nature I would prefer consistency, but I think variety adds a lot. It makes the learning process interesting, prevents monotony.” Another person saw benefits to both, where consistency made it easier to navigate the SCOs and to know what to expect, while variety added interest. As she said, “I'm not sure which side of this fence I want to fall on and am trying to think of some ideas to promote consistency while keeping the variety…At the very least, I think the colors and navigation where it is similar need to stay consistent.”

A third person wondered how a designer would approach the question of balance between the two: “I know that the idea with SCOs is that they be granular, standalone pieces that can be used on their own or reassembled into a course, but I'm not sure how that approach played into the creation of this course. For example, I really liked the graphics of the people—because they were done in a consistent style, they lent coherence to the modules. On the other hand, one module had a basketball theme, one module had a cake baking theme, etc. That made the modules feel somewhat disjointed. How did the project team approach this balance between coherence and independence among the SCOs?”

More research is needed on the instructional design of learning objects, including the balance of consistency and variety. Participants in the self-paced course indicated that an appropriate balance affected their level of satisfaction with the learning experience, ease of navigating the content, motivational interest, and level of understanding both within and between the SCOs.

Implications for Online Instruction

This study examined the implementation of prototype SCOs in three instructional settings to test overall design considerations and evaluate their learning effectiveness. The results of the evaluation demonstrated that SCOs can be effectively reused in multiple environments and that their pedagogical value reflects the context of use.

Reusability

A key benefit of learning objects, in theory, is their reusability in different instructional contexts. As Nurmi and Jaakkola (2005) state, a major reason for creating learning objects is to achieve a "learning object economy" that maximizes the reuse of learning resources to reduce the costs and time of course development. However, in practice, questions exist about the feasibility and effectiveness of reusing learning objects in different contexts (Christiansen & Anderson, 2004; Mason, Pegler, & Weller, 2005).

This study found that SCOs can be effectively reused in different learning environments that involved a blended online and face-to-face mode, a collaborative online mode, and a self-paced online mode. The learning environments had different audiences (faculty, graduate students, and trainers) and were offered by three different institutions. Although the settings were quite different, the SCOs were evaluated as being effective in achieving learning objectives. The study found that reusability was aided by packaging the SCOs to meet SCORM standards, which made them easily uploaded and unpacked in an LMS. Because all three settings used an LMS from the same vendor, the study did not examine interoperability across platforms.

The study also found that the SCOs could be reused in different ways to aggregate course content. In the blended and online collaborative modes, lesson-sized SCOs supported instructor flexibility in combining the SCOs with other resources. The instructors remained in control of the course design and used the SCOs as a supplement or a complement to other aspects of instruction (Collis & Strijker, 2003). The online self-paced mode capitalized on the value of the SCOs for just-in-time learning and as a sole source of content. The SCOs were organized into a logical sequence of lessons, but no other instructional element was used except for a narrative course overview. In all three contexts, the SCOs served as a source of content that met course goals and achieved learning objectives. In addition, because the SCOs were designed to be self-contained units of instruction, they demonstrated the value of having a higher level of granularity where each SCO contained all the necessary elements of a holistic learning experience (Mason, Pegler, & Weller, 2005). While South and Monson (2000) argue that a smaller or more granular object is more reusable, this study found that a higher level of granularity was effective.

Design

Consistency of presentation and variety of instructional activities proved to be two important elements in the design of the SCOs. In this study, a template approach to content presentation provided consistency in layout and look, which learners said clarified navigation and helped them to know what to expect. On the other hand, the SCOs incorporated a variety of instructional strategies to add variety and learner-to-content interactions, such as drag and drop activities, crossword puzzles, quizzes, animations, scenarios, analogies, and case studies. Learners had mixed feelings about the instructional variety. Some found it enhanced motivation and understanding, some expressed preferences for certain types of strategies but not others, and some students wondered if the variety interfered with coherence. The need to balance variety with consistency is identified as a major design challenge by Weller, Pegler, and Mason (2003). As they said, variety is important to student motivation, while consistency is important to a cohesive design approach. In this study, the balance between variety and consistency emerged as a major consideration that requires further research.

Learner Outcomes

Critics of learning objects claim that the learning object approach may break down the narrative flow that holds individual elements together in a course, leaving a series of disconnected pieces that affect the learning process (Mason, Pegler, & Weller, 2005; Nurmi & Jaakola, 2005). Our experience reveals that the SCO content, as experienced by our learners, can achieve a specific

learning outcome and provide a higher level of granularity where each object contains the necessary elements of a holistic learning experience that can be meaningful and relevant to the learner. The respondents in all three contexts evaluated the SCOs positively in terms of learning for understanding and application. The self-paced mode was particularly interesting because the SCOs were sequenced as a series of lessons with no other source of content or narrative transitions (except for a course overview). The self-paced mode found the SCOs worked together to provide instruction in a format that did not seem fragmented to the learners, but was experienced as integrated and effective in learning about the content.

Conclusions

Much has been written about the potential of learning objects to increase the efficiency of instruction through the reuse of learning resources for course development and delivery. However, research on the actual use of learning objects in instructional contexts is just beginning to address questions related to their pedagogical value and learning effectiveness.

This study found that SCOs can be reused effectively in multiple environments, and they can serve as flexible sources of content in achieving learning objectives. Within the context of use, the pedagogical value of SCOs is related to how they are employed to help accomplish particular learning goals. In addition, as this study found, SCOs can be used in at least two different ways for content presentation: (1) as a series of lessons arranged in a logical sequence in serving as a sole source of content; and (2) as aggregated with other learning elements in serving as part of the content. In either case, a SCO can be experienced as a holistic learning experience if the level of granularity contains all the elements needed to support the objectives.

However, issues of learner preferences need to be taken into consideration. Designers may want to consider the balance between consistency in SCO structure and variety in instructional methods. The prototype evaluation presented here describes the use of SCOs in an LMS; however, a knowledge repository, where SCOs can be stored and searched, would give more options for the type of methods that appeal to specific instructors or learners.

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Editor's Note: Dr. Liu regularly reports his latest research through this Journal. In this instance he is validating the results of online as compared to pencil and paper evaluations for classroom and online courses.

A Comparison Study of Online versus Traditional Student Evaluation of Instruction

Yuliang Liu

Abstract

This comparative study was designed to investigate whether there were significant differences in student evaluation of instruction in a graduate educational research course simultaneously taught by the same instructor between an online WebCT section and a traditional section. This study used a quasi-experimental design to collect two sets of data. First, one student evaluation of instruction survey was administered online for the online WebCT section and on paper for the traditional section in an identical course at a Midwestern public university in the USA during the summer semester of 2003. Second, a student evaluation of instruction survey was also administered online for the online WebCT section and on paper for the traditional section during an identical course in the fall semester of 2004. Results from these two sets of data revealed no significant differences in student evaluation of instruction between online and traditional sections in the identical course. Further implications result from this study.

Keywords: student evaluation, online instruction, traditional instruction, quasi-experimental design, no significant difference.

Introduction

Student evaluation of instruction is widely used in most colleges and universities in the USA. Student evaluation of instruction is used by two major groups for different purposes: (a) by administrators to evaluate faculty teaching effectiveness and to make personnel decisions (e. g, tenure and promotion) and (b) by faculty to improve teaching. Typically, students are requested to complete the evaluation of instruction on paper form by using No. 2 pencils in the final week of each semester. But the format has changed recently. Presently with the rapid development of computing and Web technologies, many institutions are offering online courses. According to Waits & Lewis (2003), distance education has grown quickly in recent years. In the 2000-2001 academic year, 56% of all 2-year and 4-year institutions offered various distance education courses. In addition, 12% of all institutions planned to offer distance education courses in the next 3 years. Recent studies (Cooper, 1999; Thurmond, Wambach, Connors, & Frey, 2002) have indicated that students are satisfied with online courses. This signifies that Web-based technology is an acceptable platform for learning and instruction.

Online student evaluation of instruction has received increasing attention in recent years. In 2000, Hmieleski surveyed the 200 mostly wired institutions in the USA and found that 98% of responding institutions still used the paper-based method as the major approach to student evaluation. This indicating that online student evaluation was extremely limited outside the distance education programs. However, since Hmieleski's study, some universities have explored other possible methods of collecting and reporting student evaluation data (Bullock, 2003; Hardy, 2003; Hoffman, 2003). Hardy reported that Northwestern University implemented a campus-wide system for online student evaluation in 1999 and found that the average numerical scores for the online evaluation were approximately the same as those for the paper-based evaluations.

However, some case studies indicated that students in the online courses had a higher overall level of satisfaction. For instance, Cooper (1999) found that all students in her online anatomy course were very satisfied with her online course and the class met their expectations.

Online student evaluation has been noted as a viable alternative to the traditional paper-based method and has numerous advantages such as time efficiency, flexibility, detailed written comments, and low expense (Ballantyne, 2003; Dommeyer, Baum, Hanna, & Chapman, 2004; Sorenson & Reiner, 2003). Thus in recent years, the number of studies on online student evaluation in the literature has grown (Cantera, 2002; Hoffman, 2003; Mayer & George, 2003; McGourty, Scoles, & Thorpe, 2002). According to Hoffman (2003), although paper-based evaluation remains the major method for student evaluation data collection in traditional face-to-face courses, the use of the Internet as a primary method for collecting student evaluation data has increased approximately 8% since 2000. In addition, some institutions use both paper-based and online methods for collecting student evaluation data. At these institutions, online courses are increasingly being evaluated online and the number of face-to-face courses evaluated online has also increased.

The question of there being significant differences in student evaluation of instruction between online and paper-based methods is important since previous research indicates that the response rate in online student evaluation for the online section is likely to be lower than that in the paper-based evaluation for the traditional section. Dommeyer et al. (2004) conducted a study involving 16 instructors and undergraduate business majors. They found that students' response rate to the online student evaluation was generally lower than that of the traditional paper-based survey. However, according to Dommeyer et al., the difference between the online evaluation and paper-based evaluation was minimal if a grade incentive was used for encouraging the online response rate. Other recent research has indicated that the response rate to the online survey can also be increased with other approaches such as the use of a sweepstakes approach (Bosnjak & Tuten, 2003; Cobanoglu & Cobanoglu, 2003).

Recent studies have indicated that the most important factor affecting student evaluation of instruction is the online learning environment. Thurmond et al. (2002) conducted a study to determine the impact of a Web-based class by controlling for student characteristics. They found that the virtual environment in the online course had a greater impact on student satisfaction than student characteristics. According to Thurmond et al., the online instructor has complete control of the virtual environment. In addition, principles of good practice (e. g, active learning and timely feedback) in traditional classrooms can also apply to the virtual classroom. This implies that if an instructor has experiences of good teaching practice in the traditional classroom, he/she will be able to transfer the good teaching practice to the virtual classroom as well. Thurmond et al.'s perspective has been supported by later studies. McGhee and Lowell (2003) compared online student evaluations in an online course with paper-based evaluations in a traditional course. McGhee and Lowell found that any possible differences in student evaluations were likely related to differences in the instructional environment.

Other comparison studies show students in online courses have similar results in their evaluation of instruction as compared to their counterparts in traditional courses. Hardy (2003) compared six courses evaluated online and on paper and found little or no overall differences in terms of the average numerical scores, the number of positive, negative, and mix comments in online and paper-based student evaluations. Hardy also found that the students who did respond wrote more detailed comments online in spite of the lower response rate. These comments provided a valuable resource for the instructor to improve teaching and learning in future course offerings. In accordance with previous studies, more recent studies have found no systematic differences between online and traditional paper-based student evaluations of instruction (e. g., Carini,

Hayek, Kuh, & Ouimet, 2003; Thorpe, 2002), even when different incentives were offered to the students for the completion of online evaluations (Dommeyer et al., 2004).

The above literature review indicates that (a) online student evaluation of instruction in online courses is generally similar to that in traditional courses if both courses are taught by the same instructor, (b) the response rate in the online student evaluation in the online section is likely to be lower than that in the traditional section, and (c) students in the online section will write more detailed comments related to the course than their counterparts in the traditional section. Thus, the purpose of this study is to investigate any possible significant differences related to the above three issues in the student evaluation of instruction in the educational research course at the master level based on the course delivery method: online for the online section and paper-based for the traditional section.

The specific research hypotheses in this study are stated as follows:

> **Hypothesis 1**: There was no statistically significant difference in student evaluation in a graduate educational research course between the online section and the traditional section if both sections were taught by the same instructor in the same semester.
>
> **Hypothesis 2**: The response rate in the online student evaluation in the online section was lower than that in the traditional section.
>
> **Hypothesis 3**: Students in the online section wrote more detailed comments related to the course than their counterparts in the traditional section.

Method

Participants

The participants in this study were recruited based on convenience sampling on two occasions. The first set of data collected for this study was in the summer semester of 2003. In that semester, the author was assigned to simultaneously teach one online section and one traditional section of the educational research course. All students who self-selected to enroll in this course for 10 weeks during the summer semester of 2003 were solicited in the first week of the semester for participation in this study. The educational research course is a required core course in education at the master's level at a Midwestern state university in the United States. Students in this course were from different graduate programs in education. Twenty-four students enrolled in the online section, but two of them withdrew within the first two weeks due to time commitment and unexpected family issues. Twenty-two students in the online section were included for final analysis and twenty-one students enrolled in the traditional section. Thus, a total of 43 participants in both sections were recruited to participate in the study. Participants in both sections were asked to complete consent forms and demographic surveys in the first week. A pretest of course content in both sections was administered. A preliminary analysis of the pretest revealed that although the traditional section scored a little higher than the online section, but no significant differences were detected between the two sections.

The second set of data collected for this study was in the fall semester of 2004. In that semester, the author was assigned again to simultaneously teach one online section and one traditional section of the same above course. Similarly, all students who self-selected to enroll in this course for 16 weeks during that semester were solicited in the first week for participation in this study. Students in this course were from different graduate programs in education. Nineteen students enrolled in the online section and twenty-one enrolled in the traditional section. Thus, a total of 40 participants in both sections were recruited to participate in the study. Participants in both sections were asked to complete consent forms and demographic surveys in the first week. A

pretest of course content in both sections was administered. A preliminary analysis of the pretest revealed that no significant differences were detected between the two sections.

Instruments

Although many researchers (e. g., Harrington & Reasons, 2005) have recently proposed developing useful online student evaluation of instruction for distance education courses, this study used the existing student evaluation forms of instruction from the author's department. The author's department decided to use the same student evaluation of instruction for both traditional and online courses. That is, online courses were evaluated online via WebCT and traditional courses were evaluated using the paper-based approach in the traditional classroom during the last two weeks of each semester. However, both traditional and online courses used the same student evaluation survey. Thus the student evaluation survey in both types of classes has the same validity and reliability. The administration of the student evaluation was anonymous and confidential. During administration, the instructor was required to leave the classroom for the traditional sections. A student volunteer was asked to seal the completed evaluation surveys in the envelope and to take the envelope back to the department's secretary. In the online section on WebCT, students evaluation results were not related to their identifications such as names.

The student evaluation survey used in the summer semester of 2003 had 16 five-point Likert scale items: 1-Poor, 2-Fair, 3-Average, 4-very Good, and 5-Superior. There was one additional item to evaluate the level of difficulty of the course, from Very Easy (1) to Very Difficult (5). Students circled the appropriate number for each item. In addition to these numeric items, students could also write comments.

Since the fall semester of 2003, the author's department revised the student evaluation of instruction survey and approved the new version. The new student evaluation survey used in the fall semester of 2004 had 18 five-point Likert scale items: from 1-Strongly Disagree to 5-Strongly Agree. Similarly, there was one additional item to evaluate the level of difficulty of the course, from Very Easy (1) to Very Difficult (5). Students circled the appropriate number for each item. In addition to these numeric items, students were provided with a space to write open comments.

After the administration of each student evaluation survey, the departmental secretary added each student's evaluation result, calculated the average score for each item, and the average score for all 16 (in 2003) and 18 (in 2004) items for each section. Students' qualitative comments were typed and added to the report as well. The results were then released to the administrators and the faculty.

Research Design

This study used a non-equivalent control group design. In both the experimental group (online via WebCT) and control group (traditional classroom), the dependent variables of learning performance were pretested and posttested. The dependent variable of student evaluation of instruction was completed in the final two weeks of the semester, online for the online section and paper-based in the traditional section. The independent variable was online vs. traditional instruction in a graduate course. Based on recommendations from the Institute for Higher Education Policy (2000) and Kearsley (2000), a hybrid of instructional techniques were employed in the online section. Specifically, several major features of WebCT were used throughout the semester such as weekly online writing, peer critiquing, bulletin board discussion, online testing, and e-mail. Constructivist learning theory was the major theoretical foundation for online instruction in this course. Instructional design was based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) proposed by Dick, Carey, and Carey (2001). For

additional information on design, development and instructional strategies used in this course, see other recent publications by the author (Liu, 2003a; 2003b).

To reduce learner anxiety and maximize learning, one Face-to-Face (FtF) orientation was conducted during the first week for the online section. The traditional section met once a week for 3 hours, and was primarily taught FtF throughout the semester. Both sections were taught simultaneously by the lead investigator in the summer semester of 2003. In order to make the sections as equivalent as possible, the instructional objectives, content, requirements, assignments, and assessments in both sections were the same.

Procedure

The pretest was administered in paper-and-pencil format to both sections during the first week of the semester to determine initial learning and performance. The participants in the online section were introduced to the online WebCT environment from the second week through the final week. Ongoing posttests, including chapter quizzes, a final test, and student evaluation of instruction were administered online for the online section and administered in paper-and-pencil format for the traditional section.

Results and Discussion

Pretests and posttests of learning performance, as well as student evaluation data in both sections in the summer semester of 2003 and in the fall semester of 2004 were coded and analyzed using SPSS 12.0. Regarding students' learning outcomes in the summer semester of 2003, there was a significant difference in most chapter quizzes and the final test between online and traditional sections. Specifically, online learners outperformed their counterparts in the traditional section (Liu, 2005a). In addition, regarding students' learning outcomes in fall 2004, there was not a significant difference between online and traditional sections. That is, online learners performed as well as their counterparts in the traditional section (Liu, 2005b).

Research Hypothesis 1

Regarding students' perceptions and satisfactions with the course, the student evaluation survey used in the summer semester of 2003 found that the average scores and standard deviations (SD) for all 16 items combined for online and traditional sections were, respectively, 4.5 with a SD = .23 and 4.3, with a SD of .34. The descriptive statistics for all the items in this survey are presented in Table 1. Results from the paired t test in Table 2 revealed that a significant difference in student evaluation of instruction between online and traditional sections was only detected in item 15 ($t = 2.08$, $p = .044$), but no significant differences were found in the other 15 items ($p > .05$). Item 15 asked students to give an overall rating of this instructor's general teaching effectiveness (related to the course objectives and new understanding). The results of item 15 showed that the online section gave a higher rating (mean = 4.77, SD = .43) while the traditional section gave a lower rating (mean = 4.29, SD = 1.01).

The student evaluation survey used in the fall semester of 2004 found that the average scores and standard deviations (SD) for all 18 items for online and traditional sections were, respectively, 4.4 with a SD = 1.1 and 4.4, with a SD of 1.0. The descriptive statistics for all the items in this second survey are presented in Table 3. Results from the paired t test in Table 4 revealed that no significant differences were found in all 18 items ($p > .05$). In addition, the major reason for the large SD in both sections in the fall semester of 2004 is that there was one student (outlier) who misunderstood the survey instructions and completely chose "1" for all 18 items in each section. This can be verified from that student's very positive qualitative comments.

Table 1

Descriptive Statistics for Summer 2003 Student Evaluation Items

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Item 1	experimental	22	4.50	.598	.127
	control	21	4.33	.577	.126
Item 2	experimental	22	4.50	.598	.127
	control	21	4.33	1.017	.222
Item 3	experimental	22	4.32	.568	.121
	control	21	4.10	1.179	.257
Item 4	experimental	22	4.23	.869	.185
	control	21	3.71	1.146	.250
Item 5	experimental	22	4.91	.294	.063
	control	21	4.95	.218	.048
Item 6	experimental	22	4.73	.456	.097
	control	21	4.81	.402	.088
Item 7	experimental	22	4.55	.596	.127
	control	21	4.38	1.024	.223
Item 8	experimental	22	4.73	.456	.097
	control	21	4.48	.814	.178
Item 9	experimental	22	4.50	.598	.127
	control	21	3.90	1.261	.275
Item 10	experimental	22	4.64	.581	.124
	control	21	4.33	1.065	.232
Item 11	experimental	22	4.59	.503	.107
	control	21	4.67	.483	.105
Item 12	experimental	22	4.05	.844	.180
	control	21	3.90	.700	.153
Item 13	experimental	22	4.55	.596	.127
	control	21	4.05	1.071	.234
Item 14	experimental	22	4.14	.774	.165
	control	21	4.38	1.024	.223
Item 15	experimental	22	4.77	.429	.091
	control	21	4.29	1.007	.220
Item 16	experimental	22	4.55	.596	.127
	control	21	4.14	1.153	.252
Item 17	experimental	22	4.55	.510	.109
	control	21	4.33	.658	.144

Table 2

Independent Samples t Test Results for Summer 2003 Student Evaluation Items

		Levene's Test for Equality of Variances						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Item 1	Equal variances assumed	.281	.599	.929	41	.358	.167	.179
	Equal variances not assumed			.930	40.993	.358	.167	.179
Item 2	Equal variances assumed	2.188	.147	.659	41	.514	.167	.253
	Equal variances not assumed			.652	32.051	.519	.167	.256
Item 3	Equal variances assumed	4.341	.043	.796	41	.431	.223	.280
	Equal variances not assumed			.784	28.506	.440	.223	.284
Item 4	Equal variances assumed	1.640	.207	1.658	41	.105	.513	.309
	Equal variances not assumed			1.648	37.279	.108	.513	.311
Item 5	Equal variances assumed	1.227	.274	-.546	41	.588	-.043	.079
	Equal variances not assumed			-.550	38.686	.586	-.043	.079
Item 6	Equal variances assumed	1.603	.213	-.626	41	.535	-.082	.131
	Equal variances not assumed			-.628	40.760	.534	-.082	.131
Item 7	Equal variances assumed	2.381	.130	.648	41	.521	.165	.254
	Equal variances not assumed			.640	31.856	.527	.165	.257
Item 8	Equal variances assumed	5.264	.027	1.256	41	.216	.251	.200
	Equal variances not assumed			1.241	31.121	.224	.251	.202
Item 9	Equal variances assumed	6.822	.013	1.993	41	.053	.595	.299
	Equal variances not assumed			1.963	28.256	.060	.595	.303
Item 10	Equal variances assumed	4.764	.035	1.166	41	.250	.303	.260
	Equal variances not assumed			1.151	30.634	.259	.303	.263

Item 11	Equal variances assumed	.966	.331	-.503	41	.618	-.076	.151
	Equal variances not assumed			-.504	40.998	.617	-.076	.150
Item 12	Equal variances assumed	2.821	.101	.593	41	.556	.141	.237
	Equal variances not assumed			.596	40.240	.555	.141	.236
Item 13	Equal variances assumed	1.203	.279	1.895	41	.065	.498	.263
	Equal variances not assumed			1.871	30.982	.071	.498	.266
Item 14	Equal variances assumed	.673	.417	-.886	41	.381	-.245	.276
	Equal variances not assumed			-.881	37.237	.384	-.245	.278
Item 15	Equal variances assumed	12.805	.001	2.080	41	.044	.487	.234
	Equal variances not assumed			2.046	26.761	.051	.487	.238
Item 16	Equal variances assumed	5.336	.026	1.449	41	.155	.403	.278
	Equal variances not assumed			1.429	29.665	.164	.403	.282
Item 17	Equal variances assumed	1.356	.251	1.185	41	.243	.212	.179
	Equal variances not assumed			1.178	37.684	.246	.212	.180

In addition, the last additional item from both sets of data described previously found that a majority of students in both online and traditional sections indicated this course as either "Moderately Difficult" or "Very Difficult" among the five options. The numeric averages in two online sections and two traditional sections were all between 4 (Moderately Difficult) and 5 (Very Difficult) (see the last item in Tables 1 and 3). This result was not surprising for the author of this study since this is a graduate course that requires rigorous instruction. In addition, this seems to be one of the most difficult and challenging course in all educational graduate programs. Results in this study showed that the research hypothesis 1 was supported. This is consistent with findings in other studies. Recent studies have consistently found no systematic differences between online and traditional paper-based student evaluations of instruction (e. g., Carini, et al., 2003; Hardy, 2003; Thorpe, 2002), even when different incentives such as grade were offered to the students for the completion of online evaluations (Dommeyer et al., 2004).

Table 3

Descriptive Statistics for the Fall 2004 Student Evaluation Items

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Item 1	experimental	19	4.16	1.302	.299
	control	21	4.48	.873	.190
Item 2	experimental	19	4.58	1.261	.289
	control	21	4.67	.796	.174
Item 3	experimental	19	4.53	1.264	.290
	control	21	4.67	.966	.211
Item 4	experimental	19	4.42	.961	.221
	control	21	4.19	1.030	.225
Item 5	experimental	19	4.00	1.247	.286
	control	21	4.19	1.078	.235
Item 6	experimental	19	4.42	1.017	.233
	control	21	4.19	1.123	.245
Item 7	experimental	19	4.42	1.170	.268
	control	21	4.57	.926	.202
Item 8	experimental	19	4.74	.933	.214
	control	21	4.67	.966	.211
Item 9	experimental	19	4.58	.961	.221
	control	21	4.57	.978	.213
Item 10	experimental	19	4.58	.961	.221
	control	21	4.62	.921	.201
Item 11	experimental	19	4.26	.991	.227
	control	21	4.52	.981	.214
Item 12	experimental	19	4.47	.964	.221
	control	21	4.43	1.028	.224
Item 13	experimental	19	4.47	1.264	.290
	control	21	4.48	1.030	.225
Item 14	experimental	19	4.37	.955	.219
	control	21	4.29	1.102	.240
Item 15	experimental	19	4.37	1.012	.232
	control	21	4.33	.966	.211
Item 16	experimental	19	4.42	.961	.221
	control	21	3.95	1.203	.263
Item 17	experimental	19	4.68	.946	.217
	control	21	4.43	.978	.213
Item 18	experimental	19	4.37	1.012	.232
	control	21	4.57	.870	.190
Item 19	experimental	19	4.2632	.93346	.21415
	control	21	4.1429	.65465	.14286

Table 4

Independent Samples t Test Results for Fall 2004 Student Evaluation Items

		Levene's Test for Equality of Variances						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Item 1	Equal variances assumed	1.662	.205	-.916	38	.365	-.318	.347
	Equal variances not assumed			-.898	30.998	.376	-.318	.354
Item 2	Equal variances assumed	.710	.405	-.266	38	.792	-.088	.330
	Equal variances not assumed			-.260	29.822	.797	-.088	.337
Item 3	Equal variances assumed	.683	.414	-.397	38	.694	-.140	.354
	Equal variances not assumed			-.392	33.614	.698	-.140	.358
Item 4	Equal variances assumed	.228	.636	.729	38	.470	.231	.316
	Equal variances not assumed			.732	37.958	.469	.231	.315
Item 5	Equal variances assumed	.076	.784	-.518	38	.607	-.190	.368
	Equal variances not assumed			-.514	35.824	.610	-.190	.370
Item 6	Equal variances assumed	.278	.601	.678	38	.502	.231	.340
	Equal variances not assumed			.681	37.999	.500	.231	.338
Item 7	Equal variances assumed	.800	.377	-.453	38	.653	-.150	.332
	Equal variances not assumed			-.448	34.276	.657	-.150	.336
Item 8	Equal variances assumed	.164	.687	.233	38	.817	.070	.301
	Equal variances not assumed			.234	37.823	.817	.070	.301
Item 9	Equal variances assumed	.021	.887	.024	38	.981	.008	.307
	Equal variances not assumed			.024	37.726	.981	.008	.307
Item 10	Equal variances assumed	.032	.860	-.135	38	.894	-.040	.298
	Equal variances not assumed			-.134	37.210	.894	-.040	.298

Item 11	Equal variances assumed	.007	.935	-.835	38	.409	-.261	.312
	Equal variances not assumed			-.835	37.518	.409	-.261	.312
Item 12	Equal variances assumed	.207	.652	.143	38	.887	.045	.316
	Equal variances not assumed			.143	37.944	.887	.045	.315
Item 13	Equal variances assumed	.103	.750	-.007	38	.995	-.003	.363
	Equal variances not assumed			-.007	34.831	.995	-.003	.367
Item 14	Equal variances assumed	.475	.495	.252	38	.802	.083	.328
	Equal variances not assumed			.254	37.939	.801	.083	.325
Item 15	Equal variances assumed	.024	.877	.112	38	.911	.035	.313
	Equal variances not assumed			.112	37.179	.911	.035	.314
Item 16	Equal variances assumed	2.943	.094	1.351	38	.185	.469	.347
	Equal variances not assumed			1.367	37.458	.180	.469	.343
Item 17	Equal variances assumed	1.134	.294	.838	38	.407	.256	.305
	Equal variances not assumed			.840	37.820	.406	.256	.304
Item 18	Equal variances assumed	.161	.691	-.682	38	.499	-.203	.298
	Equal variances not assumed			-.677	35.747	.503	-.203	.300
Item 19	Equal variances assumed	.544	.465	.476	38	.637	.12030	.25296
	Equal variances not assumed			.467	31.899	.643	.12030	.25743

In addition, the high means in the author's student evaluation for both the online and traditional sections may be related to various reasons. First, the author of this study used the constructivist learning theory as the major foundation for instructional strategy in both the online and traditional sections (see Liu, 2003a, 2003b). Second, the author took students' learning styles and needs into account during the instructional process. He conducted a student background survey during the first week and a midterm course feedback survey in the midterm week. The results of those surveys were very helpful for the instructor to adapt to students' learning needs. This finding is consistent with the findings reported by other researchers. Spencer and Schmelkin (2002) found that responding to students about instructional adaptations as a result of midterm feedback has positive effects.

Research Hypothesis 2

Results also indicated that no statistically significant differences existed between the online section and the traditional section in the summer semester of 2003 or in the fall semester of 2004. All students in both online and traditional sections participated in the study. Thus, research hypothesis 2 was not supported. This result was surprising to the author since no incentives were used for completing the online and traditional student evaluation of instruction in either section. Students in both online and traditional sections were only requested to complete the student evaluations during the last two weeks. This finding is not consistent with findings in other recent studies. According to Dommeyer et al. (2004), students' response rate to the online student evaluation was generally lower than that of the traditional paper-based survey. In order to increase the student response rate in the online evaluation, various approaches have been used in recent research. These include the use of the grade incentive (e.g, Dommeyer et al., 2004) and the sweepstakes approach (e. g., Bosnjak & Tuten, 2003; Cobanoglu & Cobanoglu, 2003).

Research Hypothesis 3

The numeric results in Table 5 indicate that there was a significant difference in terms of both the number and the details of students' qualitative comments. In terms of the number, in the summer semester of 2003, there was a significant difference in the number of qualitative comments ($\underline{X}^2$ = 4.17, $\underline{p}$ = .04) and words in those comments (($\underline{X}^2$ = 433.95, $\underline{p}$ = .00) between the online and traditional sections. In the online section 20 students (91%) wrote qualitative comments which had a total of 1233 words while in the traditional section only 9 students wrote qualitative comments which had a total of 393 words. Meanwhile, during the fall semester of 2004, there was a significant difference in the number of qualitative comments ($\underline{X}^2$ = 6.00, $\underline{p}$ = .01) and words in those comments (($\underline{X}^2$ = 835.28, $\underline{p}$ = .00) between the online and traditional sections. In the online section, 18 students (95%) wrote qualitative comments which had a total of 1192 words while in the traditional section only 6 students wrote qualitative comments which had a total of 138 words.

Table 5

Chi-Square, Numbers, and Words Results for Students' Qualitative Comments between Online and Traditional Sections in Summer 2003 and Fall 2004

		Number of students	Number of qualitative comments	Number of words in all qualitative comments	Percentages of students who wrote comments
Summer 2003	**Online section**	22	20	1233	91%
	Traditional section	21	9	393	43%
	X^2		4.17	433.95	
	p		.04	.00	
Fall 2004	**Online section**	19	18	1192	95%
	Traditional section	21	6	138	29%
	X^2		6.00	835.28	
	p		.01	.00	

In addition, students' qualitative comments in the summer semester of 2003 and fall semester of 2004 indicated that students in the online section were more motivated than those in the traditional section. For instance, a few students in the traditional section complained about the content and the frequency of chapter quizzes while those in the online section did not. In addition, students in the online section wrote more detailed comments and expressed greater satisfaction with the effectiveness of their learning in this course. Majority of students in the online section thought they had learned more in this course than from a traditional section. It was clear that such students' qualitative comments were consistent with the research findings described previously.

These results support the previous findings that online students wrote more detailed qualitative comments than their counterparts in the traditional section. Thus research hypothesis 3 in this study was supported. Hardy (2003) found that the students who do respond write more detailed comments online in spite of the lower response rate using the online evaluation approach. These comments provide a valuable resource for the instructor to improve teaching and learning in future online course offerings. In addition, two of the six courses he studied had a higher percentage of positive comments than the class evaluated on paper. McGhee and Lowell (2003) found that online students reported more efforts in online courses and gave overall evaluations similar to their counterparts in traditional courses.

Conclusion

This study supports some previous research that (a) there is not a significant difference in student evaluation of instruction between online and traditional learners and (b) online students wrote more detailed qualitative comments than their counterparts in the traditional section. However, this study found that no statistically significant differences existed in terms of the response rate between the online section and the traditional section. Based on results form this study, it can be concluded that online instruction can be a viable alternative for higher education. This study has significant practical international implications for higher education. It also contributes to the current literature in the area of online instruction and e-learning. However, the results of the present study are limited to only one course and one instructor in an educational research course in two different semesters. Thus, care should be taken in generalizing the results to other environments such as other courses in different subjects.

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Editor's Note: Learning architects continue to ask the question; "What is significant?" In research we also ask the question; What is NOT significant?" From the results we can design more effective lessons for traditional and distance learning. This comparative study provides useful data that, when compared and combined with findings of previous studies, advances our knowledge of design and learning.

A Comparative Study Between Traditional and Distance Education Instructional Environments Involving Two Graduate Level Learning Disabilities Classes

Larry S. Tinnerman

Abstract

As education enters the 21st Century, teachers are challenged daily to keep up with the rapid changes that are evolving at an even increasing rate. Learning theory and age old principles of education are being made to accommodate to new and faster means of information delivery, often utilizing technology. This, unfortunately, comes sometimes without full regard to the learner of the resulting qualitative impacts on teaching. This study focused on comparing various dynamics between two graduate-level courses in Learning Disabilities, taught by the same professor to both a distance education and a traditional class. The total class sizes were 25 traditional students and 22 distance education students. While the researcher attempted to have all class members participate in the study, seven distance students and three traditional students declined to do so. There were twenty-three traditional students involved in the pre and post testing sessions. The additional participant failed to respond to the other instruments used in this study.

Some of the findings have their support in the literature, including "no significant difference" (Shearer, 2000) (Phipps & Merisotis 1999). This was true when comparing both pre and post test outcomes using t-test analysis at the $p<.05$. Other items of significance using chi square at $p<.05$ centered on the following:

- Student-to-student communication
- Student-to-teacher communication
- Student-to-content understanding of communicational issues
- Impromptu and exploratory communication
- Time spent in defining and understanding course content and expectations
- Continuity of curriculum for instructor to instructor
- Technology issues, including experience and expertise of both the students and the instructor
- Perceptions of distance educational effectiveness

During the course of the research, there were other factors that were observed for distance education students including:

- The awkwardness of the communication effectively using a nonverbal typed method such as chat or discussion forum
- The compatibility of various software packages
- The difficulty of teacher modeling for the students
- The demand for the instructor to be both a content expert and a technical expert

KeyWords: distance learning, distance education, no significant difference, DL, DI, online learning, virtual classroom, asynchronous learning, synchronous learning, graduate study, computer learning, education in the 21st century.

The Problem

The problem under investigation in this study was a comparison of a Masters level class being offered in both traditional and online delivery modalities. Factors being examined included student composition, methods of content delivery, instructional effectiveness, student achievement on both a pre and post test, student attitudes and perceptions in regards to the opposite educational model (traditional attitudes on distance and distance attitudes on traditional) and comparative advantages and drawbacks to each instructional model (distance education and traditional education). Please note that distance education and online are terms that are used interchangeably.

Importance and Relevance of this Study

For the past thirty years, there has been a growing interest in distance education. At first the idea was embraced in the business world as a way to train employees with a minimum disruption to employment productivity. It was considered cost prohibitive and ineffective to send individual employees across the country to training seminars and conferences. With the advent of the World Wide Web (WWW), it became more productive and effective to have workers receive training as part of a distance learning approach.

In recent years, academic institutions have begun to explore the possibility of not only offering training on line, but entire degree programs as well. This has spurred a grad deal of discussion and controversy among educators, administrators, and potential employers as to the relative effectiveness of distance education programs when applied to the academic arena. (Twigg, 2003) There have been many studies and articles published in the past few years which debate the issue of “no significant difference: in education (Brown, 2000). However, the debate over effectiveness is particularly critical when considering the preparation of future educators, particularly for educators dealing with students with special needs in the field of Special Education. It is important to know the limitations and strengths of such an endeavor, since the consequences of inadequately trained individuals in special education could have a profound impact on many children in our society.

The General Problem under Investigation

Is there a significant difference between students choosing to receive their degrees using a distance educational model as compared to a more traditional classroom approach? Further, are there differences in content delivery leading to variations in the quality and effectiveness of learning for students choosing to receive their degrees via distance education as compared to the traditional classroom approach? Particular attention will be paid to obstacles encountered by faculty, students or both.

Research Questions

1. What educational similarities and differences exist for individuals enrolled in distance education classes versus the traditional classroom setting, in particular, educational background, professional status in the field of education and professional status in the area of special education in particular?
2. How does the educational background in regards to parents and spouses compare between each of the two groups under study?

3. What demographic similarities and differences exist for the individuals enrolled in each educational setting? In particular: gender, age, marital status.
4. What are the perceived and specific time management differences that exist for the individuals enrolled in each educational setting? Particularity in regards to academic tasks performed and time spent in communication with instructors and classmates.
5. How do students compare on standard evaluations of content material when looking at students enrolled in each educational setting?
6. What are the perceptions and opinions of students in each educational setting of those students enrolled in the opposite educational setting (online, traditional course format) of the same course? Include in this section, perceptions of advantages in terms of quality and depth of instruction, relevance and educational obstacles.

Assumptions

1. Students in the on-line program were adhering to the specified conditions of both the pre and post tests, i.e. that both tests were to be taken without books or notes.
2. Students in both classroom answered questions honestly and openly under the condition of anonymity.
3. The on-line students' activity logs reflected the actual time spent in each section of the course.
4. On-line students were actually who they say they were and did not have outside individuals complete their assignments for them.
5. The pre and post test instruments validly and reliably measure similar content.
6. The instructor delivered course content in a consistent manner despite the knowledge that this study was taking place.
7. The student participants in this study had no vested interest in the outcome of the study.

Limitations

1. The inability to observe distance learners as they complete their tasks.
2. Due to the anonymous nature of the sample, the inability to reconnect a student with their participant number if that student 'forgets' their participant number.
3. The inability to mandate that a student completes the project.
4. The inability of the researcher to observe all classroom interactions in both settings.
5. The duration of time available to complete the study due to the length of the semester in which the course was offered.
6. Consistent contact with distance learners is dependent on electronic communications such as on-line surveys or emails which had the potential to constituting significant delays.

Design

The Characteristics of the Defined Population

- The populations consisted of graduate level university students at a state university enrolled in a Learning Disabilities course during the 2003 spring academic semester.
- Students in the population received instruction either by the traditional classroom approach offered in a campus classroom or a distance educational model offered via computer.
- Students in the population ranged between 18 and 55 years of age, of mixed gender, marital status, socio-economic backgrounds, professional educational experience and employment status.

Participant Selection Process

Students were selected for this study using a census approach as constituted by their enrollment in the course by either traditional or distance instruction. It was this researcher's intent to get as close to total participation from all the students in both settings as possible.

Participant Target Number

Traditional face-to-face class – 25 students

Distance Education class – 21 students

Total anticipated population – 46 students

Research Methodology

The study incorporated two integrated approaches

- Experimental – The independent variable was the method of instructional delivery, i.e. the traditional classroom instructional approach or the distance method of instruction. Enrollment in the class, the instructor and course content were the dependant variables. Since the class was offered by the same instructor to both groups at the same time, this provided an excellent opportunity to examine the similarities and differences between the groups in the areas of content delivery, student performance and student satisfaction.
- Descriptive – Attitudes and opinions of students in both groups were investigated through both open ended and Likert-like scale questions.

Procedure

1. Students in both groups were randomly assigned participant ID numbers to assure their anonymity during the study.
2. Week One – A Pretest of content materials projected to be covered during the first 9 week of class. This instrument was use to measure prior knowledge and to establish a baseline for both groups. The pretest was comprised of 20 multiple choice questions covering content materials taken from the course test bank for Chapters one thru six. The identical instrument was used by both groups of students.
3. Week Three – A Demographic Survey was distributed to each group. Students again only used their participant ID numbers to assure anonymity.
4. Week Seven – A Student Perception Survey was distributed to each group. Participants in both groups were provided the entire spring break period to complete their surveys (March 5th – March 16th, 2003)

5. Week Nine – A Post test of content materials covered in the first nine weeks of the semester was given to both groups. The post test was comprised of 20 multiple choice questions covering content materials taken from the course test bank for Chapters one thru six. The identical instrument was used by both groups of students.
6. Post week nine – It was planned to distribute a Faculty Feedback Questionnaire to all university professors in the Department of Special Education and School Psychology who were currently teaching distance education courses for the department to collect perceptions of the experience from the instructors point of view, but time limitations made this exercise impossible.

Data Instruments

1. Pretest - comprised of 20 multiple choice questions covering content materials taken from the course test bank for Chapters one thru six. The identical instrument was used by both groups of students.
2. Demographic Questionnaire – This tool was constructed by the researcher based on the questions on which this study was based. There was an attempt at developing construct validity based on the issues being investigated. This instrument has no formal measure for validity or reliability.
3. Student Perception Survey – This tool was constructed by the researcher based on the questions on which this study was based. There was an attempt at developing construct validity based on the issues being investigated. This instrument has no formal measure for validity or reliability.
4. Post test – comprised of 20 multiple choice questions covering content materials taken from the course test bank for Chapters one thru six. This instrument has no formal measure for validity or reliability.

Potential Threats to Internal Validity

1. Instrumentation – There were no formal measures of validity or reliability, although there has been an attempt at developing construct validity based on the fact the questions were designed to directly study the major questions being investigated.
2. Attrition - As all the students were assigned anonymously, the researcher had no method to guarantee that all participants would finish the entire process.
3. Testing – The instruments used have no formal measure for validity or reliability; however, they did possess content validity base on the fact that they were derived for the course content in both the pre and post tests and were identical for both groups.
4. Experimenter Effect –
    a. Observer bias – as the researcher also works closely with the department offering this course, there was the potential threat of bias in interpreting the data. For this reason, data collection was largely objective using Likert scales. The subjective sections of the study only included opinions of students and faculty.
    b. Hawthorne Effect – It was anticipated that the researcher was to attempt to observe the traditional classroom directly to document instructional procedures, however, it was noted that the presence of the observer in the classroom was potentially having an effect on the instructional methodologies utilized by the faculty member. Therefore, this entire planned component of the study was eliminated.

Generalizability of This Study to Other Sites/Subjects

While this study is particularly restricted to one course by one professor teaching in the two investigated instructional methodologies, it is believed that certain aspects of this study will generalize to other sites and similar subjects. To be sure, individual instructor approaches to the tools and instructional methods available will have a wide impact on the effectiveness of instruction, regardless of the mode of delivery. This can be said of even comparisons of traditional classroom environments across varied teaching methodologies. However, certain pervasive points should emerge, especially in the areas of perceived effectiveness.

Basic advantages, obstacles and/or barriers to the distance educational modality of instruction can be kept in mind by instructors when designing future criteria to either maximize or minimize their impact through creative use of instructional methodologies. This study can be used as a tool in conjunction with other like investigations through other instructional venues in order to provide a cross comparison of similarities and differences. In particular, this research should help in the planning and construction of future courses offered by universities at the graduate level to make the course offering the most effective experience for the student that is possible in both the traditional and distance educational environment. This comparative study can supply hints as to what is instructionally effective regardless of the method of delivery.

Findings

Overviews of Procedures

The methods of analysis included chi-square analysis of the questionnaire data and t-test analysis of the pre and post test data. Both analysis methods were performed at the $p<.05$ level of significance.

Sample size: N=37 students (15 from the distance education class and 22 from the traditional class settings). The total class sizes were 25 traditional students and 22 distance education students. While the researcher attempted to have all class members participate in the study, 7 distance students and 3 traditional students declined to do so.

Departure for the original planned procedure included the following decisions:

1. Not to pursue the time study option due to an inability to accurately assess the time spent by on-line participants. In addition, the tools necessary to monitor the time spent in the traditional classroom were not accessible.
2. Not to administer the faculty questionnaire due to both faculty and personal time constraints and faculty availability due to the ‘crush’ at the end of the term.

Presentation of Data

The Demographic Questionnaire

A base demographic analysis of both groups was conducted. In regard to gender, females constituted the majority for both groups. However, the genders were somewhat more balanced in the traditional classroom setting. The differences between the groups were, however, not significant. The racial composition for both groups was 100% Caucasian. The marital status of participants between groups varied a bit, but again, was not significant. In the traditional class, the majority of the students were single, while in the on-line class, the majority of the students were married. There was no significant difference between the two classes in regards to the number of children in the household, with the majority of both groups reporting “no children.”

The educational background of parents and spouses of both groups was examined. When looking at the highest level of education completed the participant's mothers, the majority of the respondents in the traditional class indicated high school while college was the highest reported statistic for mother's education of the on-line learners. However, the differences were not statistically different between the two groups. While the similarities between the two groups in regards to their fathers' educational background was more similar, the on-line group seemed to indicate a higher percentage of fathers completing advanced degrees at both the Masters and Doctorate levels when compared to the traditional group. As far as the educational levels of spouses, both groups were similar without any significant differences or trends. One observed factor, however, was that in the traditional classroom, the majority of students were single.

Looking at the years since undergraduate school offered no significant difference between the two groups with the majority of the traditional participants indicating a rage of 1-3 years and a majority of on-line participants divided between 4-5 years and 10 or more years. Examining further educational background of students for both traditional and on-line classes, several factors offered significant differences. Credits taken towards the masters degrees between the two croups varied significantly. The data indicates that traditional students have taken significantly more graduate course work in preparation of their graduate degree with 11 members (50%) of the participants having taken more than 28 credit hours. This contrasts with the 14 members (93%) of the on-line students taking between 10 and 27 credit hours.

Years teaching also varied significantly between the two groups in this study. In the traditional group, only 4 (18%) of the participants had ever taught, while 14 (93%) of the on-line participants had formal teaching experience.

When considering certification in the field of Special Education, only 1 of the traditional students had special education certification while 4 students in the online class had special Education Certification. However, this difference did not rise to the level of significance.

When certification is generalized to fields other than Special Education, the differences between the two groups was found to be significant with 5 (23%) of the traditional group and 12 (80%) of the on-line group claiming such certification. When asked if the participant functioned in the role as a special education teacher, there were no traditional students functioning in this role as compared the distance education group in which 9 (60%) of the 15 participants functioned in some role as a special educator. This variance was determined to be significant.

When asked if there is or has been a special needs child in the family, both groups appeared to have between 36% and 40% representation. While the differences between the groups were insignificant, it is interesting to note that the presence of such a trend existed in both groups.

Opinion Survey

The opinion survey was divided into the following subdivisions:

<u>The students' perception of time management (8 questions)</u>

The following items indicated no significant difference between the two groups:

- Perceived time spent reading class text
- Perceived time spent reading supplemental assigned materials
- Perceived time spent writing assignments for class
- Perceived time spent in communication with instructor
- Perceived time spent in class research activities

The following items indicated a significant difference between the two groups:

- When looking at participants' perceived time spent in dealing with technology issues, 100% of the traditional participants indicated time spent to less than 1 hour per week. However, 60% of the on-line participants reported to spend from 1 to 2 hours per week dealing with technology concerns.
- When looking at participants' perceived time spent in communication with other class members, 100% of traditional participants indicated less than 2 hours per week. However, 40% of the on-line participants reported spending time in excess of 2 hours a week. This variance between the two groups was determined to be significant.
- When looking at participants' perceived time spent each week in total class activities (Including time spent in class in chats, discussions, and other time related to class activities) 59% of the traditional participants' reported less than 2 hours which when contrasted to the on-line participants responses where 40% reported 2-5 hours, 20% reported 6-10 hours and another 40% reported more than 10 hours.

The students' perception of student to student communication (5 questions)

The following items indicated no significant difference between the two groups:

- Accessibility of other students in your class
- Effectiveness of student to student discussions to progress or interest in class
- Frequency of contacting other classmates in completion of assignments

The following items indicated a significant difference between the two groups:

- When participants' perceptions of other classmates having a broad scope of knowledge that helps make the course topics relevant, only 27% of the traditional participants strongly agreed while 60% of the on-line participants strongly agreed.
- Further inquiry was made as to participants' contacting other classmates during the week in a social or causal context, 67% of the on-line participants claimed that they somewhat agree or strongly agree as compared to 32% of the traditional participants.

The students' perception of student to instructor communication (5 questions)

The following items indicated no significant difference between the two groups:

- Instructor accessibility
- Prompt and helpful feedback from the instructor in a timely manner
- Instructional methods learn and understandable
- Instructor sympathetic to needs and situations of a graduate student
- Instructor provides ample opportunity for questions and the voicing of concerns and opinions.

There were no items indicating a significant variance in this category of questions.

The students' perception of course effectiveness and relevance (7 questions)

The following items indicated no significant difference between the two groups:

- Factors beyond the control of the student, instructor or university that contribute to frustration and confusion
- Relevance of material presented in regards to personal career goals

- Generalizability of material to other professional and or personal life endeavors
- Material found to be thought provoking and intellectually stimulating
- Satisfaction as to how class is progressing
- Perception of the difficulty of participation in the on-line version of this class

The following items indicated a significant difference between the two groups:

- Ninety-five percent of the traditional participants found that they strongly agreed that they found the course content to be clear and understandable. This strongly contrasted with only 53% of the on-line participants. While the majority of the respondents in both groups strongly agreed, the variance between the two groups was found to be significant.

The students' perception of the varied delivery method and overall satisfaction (2 questions)

The following items indicated no significant difference between the two groups:

- Overall satisfaction level with the class (100% of both groups indicated that they were either Somewhat Satisfied or Very Satisfied.

The following items indicated a significant difference between the two groups:

- When asked for their perception as to which model would offer the greatest depth of information for the student, 100% of the traditional participants indicated that the traditional classroom would be best as compared to 73% of the on-line participants. It should be noted that 27% of the on-line participants' believed that the distance learning approach offered greater depth.

In a descriptive section of the questionnaire, students were asked to comment on the perceived advantages and disadvantages found between the two different modalities. The following items help summarize comments made by both groups.

Traditional –

- More face to face interaction in traditional setting
- No need to travel to class
- Ability to work at times convenient to student for on-line setting
- Ability to ask questions and seek clarification in traditional setting

On-line –

- Time, flexibility, lessened inhibitions online
- No child care expenses for on-line format
- More face to face interaction in traditional setting
- Working at one pace for LD students online
- On-line class more time consuming
- Stronger foundation in learning having to find information in varied locations
- Note taking difficult in traditional class, can't keep up
- Clarity of instructors directions more difficult on-line sometimes
- Immediate feedback available in traditional setting
- No classes to attend, therefore no penalty of missing class online
- Immediate dialog in traditional setting

When asked to make suggestions as to how to make this class more effective, the following summarizes comments from both groups.

Traditional –

- Instructor needs to be more specific when giving research instructions
- More discussion of interest to each field
- I am happy with the class
- Less time reviewing previous material
- Clearer syllabus (research assignments required)

On-line –

- Less work for on-line class
- Better explanation on research project expectations
- Open office hours on-line / instructor availability
- No mandatory chats for online
- Get graduation requirements out of the way sooner
- Greater coordination between different professors
- Other on-line classes need to be as structured as and as well organized as this one
- More chat and discussion sessions to share concerns and advice among students
- The course if fine as it is.

Pre and Post test analysis

Table 1

Descriptive Statistics of Pre and Post-test Performance
(N=37, Online Class = 15, Traditional Class = 22)

	Distance		Traditional	
	Pre	Post	Pre	Post
Mean	76.67	88.00	73.26	83.70
Median	80.00	85.00	80.00	85.00
Mode	80.00	85.00	80.00	95.00
Standard Deviation	12.34	9.02	13.62	13.25

Table 2.

t-test Analysis of Pre and Post-test Performance
(N=37, Online Class = 15, Traditional Class = 22, P<.05)

Two Sample t-test

	t	p	df
distance pretest to traditional pretest	0.80	0.431	32
distance post-test to traditional post-test	1.19	0.242	35
distance pretest to distance pretest	4.01	0.001	NA
traditional post-test to traditional post-test	4.90	0.000	NA

Two Sample t-test

Distance Education Pretest to Traditional Education Pretest: t=.80, p=0.431. df=32

There was no significant difference between the performance on the pretest for the distance education group and the pretest for the traditional education group at least p=.05

Two Sample t-test

Distance Education Post-test to Traditional Education Post-test: t=1.19, p=0.242, df=35

There was no significant difference between the performance on the post-test for the distance education group and the post test for the traditional education group at least p=.05

Two Sample t-test

Distance Education Pretest to Distance Education Post-test: t=4.01, p=.001

There was a significant increase in performance from the pretest to the post-test for the distance education group at least p=.05

Two Sample t-test

Traditional Education Pretest to Traditional Education Post-test: t=4.90, p=.000

There was a significant increase in performance from the pretest to the post-test for the traditional education group at least p=.05

Implications and Concluding Comments

Suggestions for future study include:

1. The study of the relationship between instruction velocity and rigor in the traditional classroom and the impact of the ability to regulate that in the distance education environment. Educational research has shown that the truly effective teacher establishes a pace of instruction with their students that "ebbs and flows" as needed. This concept is difficult to monitor in the on-line environment.
2. The study of the impact of learning styles with distance education students. Currently, the technology is a bit limited in addressing or considering this issue. What happens to the student who happens to be an auditor learner? What is the impact of distance learning that is largely tactile and visual?
3. The continued study of the on-line student group from this study as it comes to the end of their educational pursuit. A follow-up investigation would determine on how students in the online program performed on their competency exam as compared to their traditional counterparts?
4. A study to examine the effectiveness of new technologies and ways to deliver these technologies despite the limitations that the internet now imposes on the methods of delivery.
5. A study to investigate the optimal situation of using distance learning as merely a supplemental tool for the traditional classroom or hybrid.

"The marketing strategy in the on-line community must become… "Focus attention on what kinds of education people need, want, and for which they are willing to pay." The pitfall is the notion of technology for technologies sake and forgetting the learners". (Wilson, 2003, p.3)

While students were able to perform equitably on pre and post test analysis, it is important to point out that the reproduction of fact on a test do not necessarily represent the fullness of the learning experience. This is a particular concern when examining the learning experience for the on-line students as compared to that of the face-to-face traditional class. As technology continues to surge forward, there are broad implications to today's education administrator, educator and student (Twigg, 2003). The driving force behind education must continue to be research supported educational methods and strategies. Technology must never become the controlling force alone. It must be remembered that there is a difference between the teacher and the tools that the teacher uses.

While many implications can be derived from this study, the key points must focus on quality instruction, regardless of modality. In the past, education has made assumptions based on the convenience. While the endless practice and drill sheets were convenient, today we know they were not a best practice in education. Just because distance education is convenient, it must be effective as well to survive. Issues surrounding communication have a centerpiece in the discussion. A technological limitation such as uniform bandwidth which hinders video transfer tends to challenge today's distance educator. Distance educators must continue to tackle these impacting issues with as much fervor as their mainstream educational colleagues to assure that both the student and the instructor are relating in as optimal am manner as can be designed.

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Biography

Mr. Tinnerman graduated from Edinboro State College in 1976 with a BA in Psychology and a teaching certification in Secondary Social Studies. In 1998, Mr. Tinnerman taught computer science at a Junior College in Erie, PA. In 2003 Mr. Tinnerman earned his M.Ed. in Special Education and helped develop the departments distance learning program. Mr. Tinnerman has also taught 6th and 7th grade learning support classes in the public schools. Mr. Tinnerman is currently a doctoral student at Indiana University of Pennsylvania in Curriculum and Instruction where he currently teaches courses in elementary education as a teaching associate.

Editor's Note: The tools of online learning have attracted the attention of instructors to enhance learning in traditional classrooms. This is not surprising since internet tools have become global, ubiquitous and easy to use.

On-Line Learning: A Creative Environment for Quality Education

Nitin Upadhyay

Abstract

Learning is not limited to geographical area and time domain. Electronic media and supporting resources, along with well planned structured learning material, enhance learning. In this paper the author highlights issues related to online learning such as learning goals, technology, challenges, evaluation schemes and discusses the future potential of online learning.

KeyWords: Online learning, CBT, CAI, WBT, m-learning, e-learning.

Introduction:

Online learning is considered as the extension to distance and distributed learning. An important aspect is to customize learning for students and to make it available anytime, anywhere.

Table 1

Learning Environments.

Technology word	Joining word	Education word	Purpose
CD-ROM		Training	A large storage capacity interactive medium for distribution of learning programs for training.
Computer	Based	Instruction	Virtually any kind of computer use in educational system, including drill and practice, tutorials, simulations, instructional management, writing using word processors, and other applications.
Computer	Assisted	Instruction	Drill-and-practice, tutorial, or simulation activities governed either by themselves or as supplements to traditional, teacher directed instruction.
Computer	Managed	Instruction	Use of computers by institute staff to gather student data and make instructional decisions or activities where the computer evaluates students' performance, and store and manage the outcome after analysis.
Computer	Based	Training	An education system where student's learn by executing a special training program on a computer.
Interactive Media	----------	Training	Two way communication with a program that incorporates video, audio, text and graphics.
On-line	----------	Training	Generic term for any type of training on-line.
Web	Based	Training	Learning experiences presented on computers that are connected to intranet, extranet, and internet.

It has been identified that online learning enables the level of interaction of learners with each other and also with tutorial staff which in no way possible with traditional correspondence course [1]. Table 1 shows different learning environment for online training and education.

Key factors for the online learning are:

Learning material: These must be effective and suitable as per need of the learner. It can be as simple as traditional lectures and quizzes that are transcribed into a computer program; or depending upon the learner input it guides learner to the actual content; or the material can be based on work session compiled by chat session. The material that learner interacts with can be presented as text, graphics, animated graphics, audio, video, or a combination of these.

Supportive resources: To support learner's learning request effectively proper resource must be used that are available through computers. These resources come under two categories- first for preparing learning program or material and secondly for delivering the outcome to learners.

Paradigm Shift

The acceptance of online learning is due to growing availability of commercially available Learning Management Systems (LMSs) such as WebCT, BlackBoard, Learning Space, IntraLearn , Top Class, eCollege, Click2learn, Authorware, LearnLinc ,Virtual-U, Web Course in a Box, UniLearn and WebBoard [2].

> *"Behaviorist, cognitivist, and constructivist theories have contributed in different ways to the design of online materials, and they will continue to be used to develop learning materials for online learning. Behaviorist strategies can be used to teach the facts (what); cognitivist strategies to teach the principles and processes (how); and constructivist strategies to teach the real-life and personal applications and contextual learning. There is a shift toward constructive learning, in which learners are given the opportunity to construct their own meaning from the information presented during the online sessions. The use of learning objects to promote flexibility and reuse of online materials to meet the needs of individual learners will become more common in the future. Online learning materials will be designed in small coherent segments, so that they can be redesigned for different learners and different contexts. Finally, online learning will be increasingly diverse to respond to different learning cultures, styles, and motivations" [3].*

Emerging technologies are leading to the development of many new opportunities to guide and enhance learning that were unimaginable even a few years ago. There are already about one million courses on the internet, 30,000 of them compiling with a scientific definition of online, 22,000 of these are listed on the telecampus portal, with many of them making didactic use of the World Wide Web [4].

A significant and remarkable shift in paradigm has been identified. Table 2 describes the paradigm shift:

Medium of Learning

Learning can be identified as of the perspective view – intentional or coincidental. Acquiring this perspective, the designers and programmers tend to conceptualize their views and programs in order to achieve learner goal effectively and efficiently [5]. It has been identified that an online course could require two or more hours a day to read student mail and discussions and make appropriate responses [6].

Table 2

Paradigm shift from traditional to online learning

Traditional Learning (From)	Online Learning (To)
teacher-centered	learner-centered
comprehension of content	acquisition of content
content	Process
subject-oriented	task-oriented
class	Session
theoretical	Practical
Individual effort	Team effort
Print (document) media	mixture of media
fact-centered	problem-centered

Table 3 describes different major contexts and medium in which learning can be achieved.

Table 3
Medium of learning

Medium	Purpose	Working	Technology
Collaboration	Situations where people learn side-by-side while working	People work in different locations so learning involves use of— E-mail, chat, discussion, file & report sharing, announcement. Conferencing. Synchronous and asynchronous.	**Minimum:** Connectivity to computer network. E-mail account. Software necessary to perform sharing of resources. **Maximum:** High-speed network connectivity to transmit audio-video files. Camera and related software to capture and transmit images. Microphone and related software to capture and transmit sounds. Software which enable to view and transmit all files.
Knowledge Management	Deals with capturing, storing and organizing lessons learned and experiences of individuals and groups within an organization.	Information retrieving through knowledge database. Information retrieval: Formal corporate information. Informal information. Expertise information	A network. Database program to manage data. Groupware. Graphical User Interface. Interactive media for handling queries.

Medium	Purpose	Working	Technology
On-line training and Education	Training and education involves structure events that are intended to enhance knowledge and skills. Event has— Learners Instructors	In a classroom, events are instructor (person) and earners (persons). But for online learning events are instructor (computer) and learners (persons)	For developing learning material: Computer and supportive resources to prepare rich interactive material. Word processors, authoring tools, presentation software, graphic software, audio and video management software. For delivering learning material: Computer, sound cards, speakers. Software for playing course material (including sound bytes and video sequences), and reading course material from internet.

The Three Dialogues and Interaction modes

Interactive online learning deals with the two aspects of communication and dialogue which are the key processes of learning, wherever, and whenever it occurs. Interactive online learning that is designed gives focus and is centered to these three types of dialogue and interactions. The dialogues are:

1. between instructors and learners,
2. among learners, and,
3. between the learner and a rich interactive media and supporting learning resources.

In extension to 'document delivery' for learning, teaching staff must concentrate to interaction mode available to them and even explore and identify more in order to make teaching effective. Fig 1 describes the interpersonal level of interaction available in the online course.

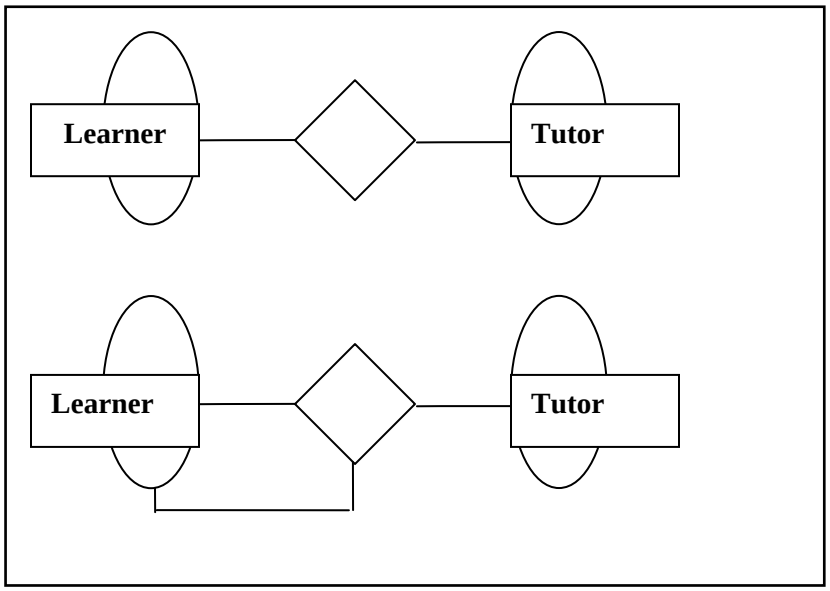

Figure 1 Interpersonal level of interaction available in the online course.

Electronic mail, chat, bulletin boards, discussion forum and online help are excellent and effective means for integrating the interactive dialogue with instructor to learner learning models. Acquiring these new strategies learners also tend to become more active learners and quickly group into communities of collaborative learners.

Online Courses- Perspective View

Faculty perspective view to develop online courses:

- Reuse, rethink and modify the course.
- Enhance and strengthen instructor to learner and learner to learner dialogue.
- Provide valuable information and access to extra resources.
- Complex figures and animations can be used in course structure.
- Easy to distribute assignments and exercises.
- Encourage student collaboration approach.
- Courses can be provided to students anytime, from anywhere.
- Students perspective view to enroll in online course:
- Work schedules and time constraints.
- Family obligations and responsibilities.
- Accessibility and distance.
- Convenience of learning at home or at work.
- Time flexibility in enrolling and taking the course.

Advantages

Flexible scheduling of course activities.

- Individualize learning.
- Free instructors for more meaningful contact with students
- Virtual office hours for interaction with instructor.
- Participation in an online learning community.
- Interaction with other learners through electronic discussion lists.

Give a sense of control over learning.

- Learning can be done anytime anywhere.
- The hypertext format makes the learning easy as it allows the learner to choose the sequence of the inquiry and to navigate through the material in a simple way.
- Course structure comprise of full multimedia resources which enhance the learning approach of learners.
- Providing learning materials, regardless of the format, is clearly one piece of the equation in the design of meaningful instruction.

Computer mediated communication provides a rich resource for discussion, interaction, sharing, reflection, and active participation in articulating personal understanding.

- The social learning environment available by means of written discussion forums invites careful reflection by providing the learner time to think and make proper responses.
- Learners can communicate and interact at times that best suit their schedules.
- The absence of face-to-face interaction or physical proximity may reduce learners' shyness and hesitant behaviour.

Build proficiency in computer use, which will be valuable later in life

Challenges

- reconceptualizing courses from student learning perspectives view;
- enhancing teaching strategies and modes in order to design online learning activities;
- writing sophisticated hypertext and structuring navigation for effective learning purposes;
- easy delivery using course management tools;
- guiding to do research as a professional development approach;
- engaging students in appropriate interactivity and sustaining it;
- assessing and evaluating learning at a distance; and
- negotiating intellectual property rights.

There are many benefits of online learning for both the learner and the instructor. The following are just a few of the potential benefits:

Scheduling Flexibility

It has been identified that adult students generally work full-time, many have family responsibilities and obligations, and many live far away from campus. If possible to complete selected courses from home or work without attending weekly classes is the greatest convenience.

Time Saving Learning

Time saved in traveling to and from campus in order to go for a selected course can be utilized and redirected to learning.

Growth in Adult Learners

Adult learning increases due to the fact that learner no way has to sit and attend the lecture meant for a large group rather can go for specific and specialized course of their interest.

Increased Interaction with Classmates

Web-based communication tools can actually increase interaction among students by permitting group work that would be difficult to arrange if students have to meet in the same place at the same time.

Virtual Office Hours

Electronic communication between students and instructor can actually increase the degree of interaction, since students can e-mail instructors at their convenience, rather than find time to get to office hours or reach instructors by telephone. Students and instructor can communicate at their convenience.

Unlimited Learning

The World Wide Web has a wealth of resources from which students can learn a great deal more than instructors can teach. Everywhere, the role of the faculty is being reconceptualized in the form of "coach" rather than "instructor". Students are perfectly suited to take benefit of coaching to get out of the course what will be of most value to them.

Accessibility and availability

Course material is accessible and available to students anytime, anywhere.

Collaboration

Online Learning increases the collaboration capability between learners and instructors for effective learning.

Features of Successful Online Learners

Before going to enroll for online courses one has to give self assessment test as not all students are successful in online courses. Some students have difficulty with time management, need the environment of a classroom, or miss the face-to-face interaction with other students and the instructor. The following are some of the features that the students should have to be successful learner online.

- Possess work management skills.
- Posses time management skills.
- Motivation to read, writes, and participates fully in class activities.
- Time to give approximately 12 hours a week to a 3-credit course for effective learning.
- Flexibility in dealing with technology problems.
- Self-initiator should not procrastinate.
- Capability of learning from the printed word.
- Ability to work independently and in teams.
- Do not hesitate in asking the questions when they do not understand.
- Knowledge about working computer, internet and accessories.
- Good at basic computer skills.

Table 4 shows the self-assessment test which must be taken by students going for the online courses. If self-assessment results in several "beginner" selections, then one want to build skills before enrolling an online course.

Evaluation

Evaluation includes getting ongoing feedback, from the learner, instructor and learner’s organization, in order to identify performance gaps and capture learned lessons for continuous growth and improvement [7]. Online courses include interactive session as well in comparison to distance learning. This can be done via synchronous and asynchronous mode. Evaluation process of online learning is an extension to distance learning. This follows the same principle as evaluation of distance learning course. Here interactive session and mode has to be considered. It has been identified that interviews and focus groups can provide a medium to assess individual response about the social aspect of the course and how they affected learning [8-10].

Table 4
Self-assessment questionnaire

Skills	Beginner	Intermediate	Advanced
e-mail working (sending and receiving messages and attachments)			
e-mail working (replying and forwarding messages and attachments)			
Managing sent and received messages and attachments in folders.			
File Management skills (creating, sharing, copying, deleting, moving files)			
Managing applications and files in a Linux, Mac or Windows environment.			
Able to use word processing software, (accessing and manipulating documents -Opening and Saving Files, etc.)			
Know basic working using internet (connectivity, modem etc.)			
Able to open web site if given its URL			
Able to use hyperlinks			
Able to save current web page, download things from site.			
Able to go back and forward to pages, and search items using search engines such as Google, AltaVista.			
Able to work with CD-ROM, Floppy etc.			

Future Potential

The wireless technologies of the mobile revolution have noticed the worldwide production of wireless communication devices [11].

It is experienced that in the e-learning market growth, mobile learning is evolving into a dynamic, interactive and personalized experience for employees. “Framingham, Mass.-based research firm IDC predicts the e-learning market will grow from $6.6 billion in 2002 to nearly $25 billion by 2006. The Economist Intelligence Unit, the UK-based business information arm of the company that publishes "The Economist," expects e-learning and traditional learning to become indistinguishable in the near future. More than 150 million Americans carry a mobile phone. According to IDC, that number will grow to more than 180 million by 2007” [12].

It has been identified that technology access makes technology an integral part of daily learning [13]. It has often been suggested that access on its own will not fulfill the promise which many have meant lies in the use of ICT in school [14], but where several criteria for the successful integration of ICT play a role[15].

It has been identified that learning in school is done by memorization and reproduction of school texts and where instructor presents teaching session which dominates and students' activity is centered to answering questions formulated by the instructor [16]. Expecting mobile telephony in such a learning culture, make their role as of an "intruder", a disturbance [17], and as such a *troublesome technology*. It has been pointed out that mobile technology actually offers the suitable educational environment to assist learning actions both inside and outside the classroom [18].

As Paul Harris in Goin' mobile states mobile learning is the ability to enjoy an educational moment from a cell phone or a personal digital assistant [19].

Today's ICT has significantly extended the scope for learning anywhere, anytime and the term mlearning has gained serious strength and influence in describing the future of education [20]. From a pedagogical perspective, mobile learning supports a new dimension in the educational process. Features of mobile learning include [21]:

- Urgency of learning need;
- Initiative of knowledge acquisition;
- Mobility of learning setting;
- Interactivity of the learning process;
- 'situatedness' of instructional activities; and
- Integration of instructional content.

Conclusion:

Online learning enhances the mode of learning as learning become easy anytime anywhere. In online learning the role of instructors has changed. Learning course material should be created after analyzing the target audience and resources available. Students are also advised to give a self-assessment test before going for any online course. It has been identified that analyzing of resource material and self assessment increases the growth of learning. The future potential of on-Line learning has been discussed. "In order to the proper functioning of the mobile Internet for learning, the e-learning community must focus on the performance and productivity issues rather than traditional lecture style training or courseware. To enhance the mobile learning environment, course content and learning methodology should encompass use of quizzes to test knowledge, summary of main learning points, and interaction with other students and the tutor" [22].

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Editor's Note: This article shows how choice of instructional design elements can positively or negatively affect cognitive learning.

A Learner's Cognitive Levels of Thought

Eshaa M. Alkhalifa

introduction

Learning has been regarded as a cognitive activity by a large number of world renown researchers including Piaget (1970) and Vygotsky(1962). As research advanced and human knowledge in this field amplified exponentially, new fields of research emerged one of which is dedicated for Cognitive Science. However, due to the novelty of the field, only sporadic attempts were made to benefit from the findings in evaluating existing teaching approaches from the cognitive perspective of a learner. This article presents a taxonomy of the major cognitive levels of thought that is based on Bloom's taxonomy of learning objectives (1971) that can be elicited by existing computer based educational system approaches.

Background

The process of learning as currently regarded is accomplished through exposing students to novel material, or a novel approach to solve a problem and then expecting learners to "recall" the essential parts of what has been presented. For example, if what is presented in a definition of a new concept such as "computers" then students are expected to be able to describe what computers are in their own words based on what they "understand" and "remember". Learning a process differs in that it may involve the sequence followed to solve a problem as in mathematics, or the sequence plus physical motor activities such as learning how to drive a car, how to operate on a patient, or how to repair a car engine.

Both major types of learning; require learners to "recall" some of what was presented, so the cognitive activity of "memory" is necessary. Both require learners to reason, because once they see several mathematical examples presented to them, they should be able to extract the main rules they should follow in solving a novel question. To sum up, it is extremely difficult to regard the learning process as distinct from cognitive processing which is a view shared by well known researchers including; Jonassen (1991), van Jooligan (1999), Albacete and VanLehn(2000a, 2000b) and Alkhalifa (2005, in press a).

The persistent goal is to achieve a clearer understanding of how cognition influences learning and how to utilize the findings in making the learning process more efficient.

Jonassen (1991), for example, is one advocate of the constructivist approach to learning where students play an active role in the learning process. In this approach students are given several tools to relieve them from repetitive computation or to externally display text they are required to recall (as when writing paper), in order to allow them to focus on the learning task at hand. He adopts the assumption originally proposed by Lajoie and Derry (1993, Lajoie, 1990) that computers fill the role of cognitive extensions, by performing tasks to support basic thinking requirements like calculating or holding text in memory which caused them to label computers as "Cognitive Tools". Jonassen's (1991) central claim is that these tools are offered to students to lower the cognitive load imposed during the learning process to facilitate learning by experimentation and discovery. However, no experimental evidence was presented to support these claims that students learn more or learn differently with these designs than in a classical classroom setting.

Wouter van Jooligan (1999) takes this concept a step further by proposing an environment that allows students to hypothesize and pursue the consequences of their hypotheses. They presented two systems; the first supports the hypothesis formation step by providing several windows that help students form their hypotheses, the second provides a formatted presentation of experiments already tested and their results in a structured manner. They added intelligent support to the system by providing feedback to students to guide their hypothesis formation approach. Yet again the work was lacking a proper comparative evaluation.

Albacete and VanLehn (2000a, 2000b) by contrast recognized the cognitive anomaly that exists between the naïve students' ill-structured knowledge of conceptual physics and the highly structured knowledge of experts in the field. Consequently their presented system concentrates on teaching students how the various concepts relate to each other. Evaluation of results exhibited no significant differences between the learning outcomes of the control group when compared to the experimental group. Albacete and VanLehn (2000b) then utilized alternative means of analysis to highlight various differences in learning between groups. The first was through measuring the effect size as done by Bloom (1984) while the second was to compare results to the nationwide score on a standardized test. The third was to consider how much students who have different pretest scores learned when compared to each other.

The lack of structure in this work led Alkhalifa (in press a, 2005) to offer several different formalization possibilities depending on the system designer's goals. One example (in press a) is an alignment or guide to all multimedia system designers who wish to take the effects cognitive processing characteristics into account. This formalization is supported by the positive effects on learning while utilizing a cognitively informed design of a multimedia educational system. Another example is a framework is also offered for the evaluation of multimedia systems (2005) where cognitive factors and individual differences are taken into account. Results here indicate that neglecting these factors may result in false negative evaluation outcomes.

Although prior research findings highlight how to take advantage of system design and how educational systems can be better evaluated, they do not give any clear indication of how different designs may be compared to each from the perspective of the cognitive system.

This necessitates introduction of a clear taxonomy that has well defined practical boundaries of the relative load imposed on the cognitive system during learning. Bloom's taxonomy of learning objectives, therefore offers a perfect starting point to introduce a new taxonomy of cognitive levels of thought that can be elicited through the characteristics of any learning approach.

The taxonomy presents the levels by using terms that are well defined in the field of cognitive science with the goal of making it possible to elicit any particular level through the various possible approaches to learning that exist. A case study that compared teaching students by eliciting two different cognitive levels was performed to show that eliciting different cognitive levels does interact significantly with the complexity of the taught material to the degree that it may retard learning. (Alkhalifa, in press b).

Table 1

Taxonomy of Cognitive Levels of Thought as Elicited by the Teaching Medium

Taxonomy of elicited cognitive levels of though	*Bloom's taxonomy*
1. **Simple recall:** Cognitive processing involves what was presented in memory without necessarily comprehending it.	*1.* ***Knowledge:*** *Students can remember what was presented to them word for word as in recalling prices of goods.*
2. **Language comprehension (descriptive knowledge):** Students are presented with the materials linguistically or through animation which results in a mental representation of learned concepts. This representation can then be evaluated by requesting a descriptive representation of the concept.	*2.* ***Comprehension:*** *Students can explain what they learned in their own words as in interpreting instructions.*
3. **Reasoning & Deduction (procedural knowledge):** Learning processes or steps followed in a sequence that requires a form of simple reasoning to take learners from what is given to deductions that they can make.	*3.* ***Application:*** *Students can apply what they learned in a new situation as in calculating an employee's remaining vacation time.*
4. Analogical Reasoning: **a.** Learn from analogies: Students presented with analogies from completely different domains have the ability to compare the structure of one domain as it maps onto the second to make comparisons and analyses.	*4.* ***Analysis:*** *Students can break materials presented to them into their components as in troubleshooting a piece of equipment using logical reasoning.*
b. Create new analogies: This is a higher level of analogical reasoning where one searches in memory for a domain that is comparable and selects an analogical situation similar to the situation being presented. Students have the components in their prior knowledge and create the structure by giving a description of the system they composed.	*5.* ***Synthesis:*** *Build a structure or pattern from diverse elements as in designing a machine to perform a task.*
5. **Meta reasoning:** A student regards work from an evaluator's point of view and considers reasoning followed by others to arrive at his/her conclusions.	*6.* ***Evaluation:*** *Make judgments about the value of ideas or materials as in selecting the most effective solution or hire the most qualified candidate.*

The first experiment involved a number of mathematical series problems to be given to students in order to identify the different types of errors they may make while solving them and this resulted in isolated 6 main types of errors.

Additionally, questions can be divided with respect to the complexity of the materials into two distinct levels of complexity as shown below:

series 1: Students are expected to produce the form $\sum_{i=1}^{5} 3i$

When given 3 + 6 + 9 + 12 + 15

series 2: Students are expected to produce the form $\sum_{m=1}^{5} 3^m$

When given 3 + 9 + 27 + 81 + 243

These levels of processing suffer from the burden of interaction between the elements as defined by John Sweller (1994). Students are expected to dissect each number into its components such that they would comprehend the relationship that is preserved between them. One possibility is as follows:

series 1: 3 x 1 + 3 x 2 + 3 x 3 + 3 x 4 + 3 x 5

series 2: 3 x 1 + 3 x 3 + 3 x 3 x 3 + 3 x 3 x 3 x 3 + 3 x 3 x 3 x 3 x 3

The result of applying similar transformations to the first and second is just a step towards identifying what the summation notation is. For the first, it is immediately clear that the terms are multiples of 3 and the index that alters goes from 1 to 5. In the case of the second, we find that the index of the series has to be counted as it is represented as the number of times the number 3 is multiplied by itself. This places it at a higher level of complexity than that of series 1.

The system compares these two levels through two modules used for teaching students how to solve this type of problem. The first module is interactive because it allow students to insert different values and calculates the resulting series live so it elicits the "Analogical Reasoning" level of cognitive processing. It displays different outcomes that emerge from conditions set by the learner and the learner is expected to generalize from the specific cases tested.

The second module cannot exist in isolation of the first because it studies student responses to a test, in order to infer the common errors made by that particular student and then reproduces through new examples the behavior of that student in front of them. A part of the screen will display the ideal solution produced to allow students to regard their behavior from an instructor's point of view. Consequently, this level elicits the "Meta Reasoning" level of cognitive thought, where a student analyses his solution procedure in comparison to an ideal procedure.

For the first part of the evaluation, 21 students took a pretest, then utilized the interactive module and then they took a post test. For the second part of the evaluation, 12 students took the pre test and then exposed them to the interactive module followed by the mirror modeler which showed them how they would solve sample problems as compared to the ideal approach and they then took the post test. All the tests were composed of three question types for comparative purposes, division, multiplication and power operations.

Analysis of Results

There are six error types isolated by the initial experiment for each question type possible for each student. The results of the first part of the evaluation when students are exposed to the interactive system alone are shown in Table 2.

If the number of errors in each column and the number of correct question parts are compared for the pre-test, then no significant differences emerge. This implies that the three types of questions do not differ in their difficulty. Running the same test on the post-test data gives a Chi Value of 5.914 with $\underline{p} < 0.05$ so student learn each operation differently from the others.

Table 2

The Number of Errors in the three operations in the pre and post tests in addition to the percentage improvement made by students

	Division	Multiplication	Power
Pre-test	56	70	54
Post-test	14	25	28
Percentage Improvement from total	33.3%	35.7%	20.6%
Chi Test Significance p <	*0.0000*	*0.0000*	*0.0007*

A Chi Yates value of 7.299 with p < 0.007 emerges upon more detailed testing between the division operation and the power operation. A large difference also exists between the multiplication operation and the power operation but it is not a significant one.

Results obtained in table 2 show that no significant differences in difficulty exist as students start the learning process but differences do exist when we compare the amount of learning they achieve for each operation while using the same interactive instructional system. So although learning occurs for all three operations while using the interactive module, the total gain and nature of this learning differs from one operation to the next, in a way that consistent with the implications of the cognitive load theory, because the differ in the level of complexity of the learned materials.

Additionally, the results of the second part of the evaluation when students are exposed to the interactive system in addition to the mirror modeler is shown in Table 3.

Table 3

Number of errors in the three operations in the pre and post tests

	Division	Multiplication	Power
Pre-test	6	21	10
Post-test	0	1	17
Percentage Improvement from total	8.3%	27.8%	-9.7%
Chi Test Significance p <	*0.037*	*0.000*	*0.200*

Analysis of student responses showed in general that the number of errors made in the Pretest were 37 and the number of errors made in the Post-test were 17 with a probability of **p** <.001 of this happening by chance. Table 7 shows the number of errors according to question type.

The results of using the interactive tutoring module followed by the mirror modeler shows a clear difference between the division, multiplication and power operations. The division and multiplication operations both recorded significant improvements in student levels while the power operation was not significantly affected by the modules that are presented. This is further evidence to support the assumption that the difference between the cognitive load requirements of the multiplication and division operations when compared to the power operation caused a

serious difference in the amount of learning achieved as students utilized these two modes of learning.

If both evaluations are compared to each other, then we find that students learned from the interactive hypermedia system in all operations, but learning was to a higher degree in the division and multiplication operations which require a lower cognitive load than in the power operation. This implies that the results obtained in experiment three for the power operation can only be obtained if the mirror modeler hindered learning for the power operation.

Elicited Cognitive Levels of Thought

A taxonomy of the learner's cognitive levels of thought is presented here to guide educational system designers in determining their cognitive objectives and achieving them. These levels describe how the different existing approaches to learning can result in different levels of cognitive load. A case study is presented to show that eliciting a higher level of thought during learning is not always desired when students are exposed to more complex materials, while it does encourage learning for simpler materials. This highlights a need to determine the most appropriate cognitive level elicited by the teaching medium that would maximize the amount of learning that occurs. The taxonomy therefore offers itself as a meter against which a comparative measurement can take place.

Future Trends

Since learning is a cognitive activity then it is logical for learning to be affected by the characteristics of the cognitive system. The presented taxonomy offers a series of benchmarks as classified by distinct areas of research in Cognitive Science. The levels are therefore practical in that they can be elicited by existing approaches which implies that they are measurable and subject to evaluation. Further work in this direction is also likely to inform cognitive scientists on the application side of their theoretical work.

Conclusion

A taxonomy of the learner's cognitive levels of thought is presented as a meter of comparison for educational system design. No similar meter exists to estimate the cognitive load imposed onto the learner with different educational system settings. None of the levels can be described as better as or worse than the others as they each have a purpose and each interacts differently with the learner's cognitive state. Yet, they are extremely important because ignoring the effects of cognitive load may result in situations where learning is retarded simply by the mismatch between the learned materials and method of presentation.

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Terms and Definitions

Cognition: The psychological result of perception, learning and reasoning.

Cognitive Load: The degree of cognitive processes required to accomplish a specific task.

Cognitive Science: The field of science concerned with cognition and includes parts of cognitive psychology, linguistics, computer science cognitive neuroscience and philosophy of mind.

Cognitive Tool: A tool that reduces the cognitive load required by a specific task.

Interactive System: Any computer delivered electronic system that allows users to insert information and reacts to users' choices according to a preprogrammed fashion.

Taxonomy: Division of materials into categories or ordered groups.

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