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Reflection Tools in Teaching the Design of Interactive Learning Objects: A Case Study

Etkileşimli Öğrenme Nesneleri Tasarımı Öğretiminde Yansıma Araçları: Bir Pilot Çalışma

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Abstract

To help learners with varying learning needs and preferences requires instructional designers to follow both prescribed methodologies and creative approaches. It also requires considering variety of viewpoints without being influenced by individual preferences. To encourage and teach reflection in instructional design education, this research experimentally studied the effects of reflective action instructional design (RAID), a learning object review instrument (LORI), classroom and online discussions, and learning style on senior instructional design students' design and development of learning objects (LOs). In this regard, the study examined: (1) the participants' reflections through RAID questions in making design decisions, (2) the role of the LORI in improving LO design and (3) interactions between the participants' learning styles and quality of their designed LOs for K-12 learning units. The effect of interaction and evaluation tools on prospective instructional designers' decision making was analyzed both through statistical tests and qualitative methods. The data analysis showed that reflection tools, to a large extend, assist teaching objective design decisions in learning object development. The paper discussed how the reflective toolkits contributed learning of designing learning objects.

Keywords: Reflection tools, instructional design, learning object, learning style, discussion board

Öz

Öğrencilerin farklı öğrenme gereksinimleri ve farklı öğrenme tercihleri, öğretim tasarımcılarının hem yerleşik yöntemleri hem de yaratıcı yaklaşımları kullanmalarını gerektirmektedir. Ayrıca, öğretim tasarımcılarının kendi bireysel tercihlerinden etkilenmeksizin farklı görüşleri dikkate almaları gerekir. Öğretim tasarımı eğitiminde yansımayı öğretmek ve yansıtıcı süreçleri artırmak amacıyla, bu araştırma aşağıdaki araç ve süreçlerin öğretim tasarımı öğrencilerinin öğrenme nesnesi tasarım ve geliştirmelerine etkisini incelemiştir: (a) yansıtıcı eylemsel öğretim tasarımı (RAID) soruları, (b) öğrenme nesnesi değerlendirme aracı (LORI), (c) sınıf içi ve çevrimiçi tartışma, (d) öğrenme stili. Araştırma, (1) katılımcıların tasarım kararlarını verirken RAID sorularına verdikleri yanıtlardan elde ettikleri yansımaları, (2) öğrenme nesnesi tasarımları geliştirilirken LORI aracının rolünü, (3) katılımcıların öğrenme stilleri ile K-12 öğrencileri için geliştirdikleri öğrenme nesnelerinin nitelikleri arasındaki ilişkileri incelemiştir. Etkileşim ve değerlendirme araçlarının öğretim tasarımı öğrencilerinin karar verme süreçlerine etkisi nitel ve nicel yöntemlerle incelenmiştir. Veri analizleri, yansıtıcı araçların öğrenme nesnesi geliştirmeyle ilgili nesnel karar verme sürecine büyük ölçüde yardımcı olduğunu göstermiştir. Bu çalışma, yansıtıcı araçların öğrenme nesnesi tasarımının öğrenmeye nasıl katkıda bulunduğunu tartışmaktadır.

Anahtar Sözcükler: Yansıtıcı araçlar, öğretim tasarımı, öğrenme nesnesi, öğrenme biçimi, tartışma ortamı.

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Introduction

Instructional design (ID) is the science of generating in-depth specifications for the development, implementation, evaluation, and maintenance of situations that facilitate learning subject matter at all levels of complexity. ID is a process with complex relationships between the elements of design (Botturi, 2005). Design, development, and organization of adaptive materials to students' needs and preferences is a multifaceted task which is normally carried out by a team of teachers, designers and subject matter experts. According to the International Board of Standards for Training, Performance and Instruction (Richey, Fields & Foxon, 2001), it is a principle competency for designers to take students' diverse needs into account.

ID decisions have to be grounded on both desired learning outcomes and motivational and cognitive views of learning from the students' perspectives (Mcloughlin, 1999). The learners have their own framework the given task. While they study the given materials, they try to solve real world problems they have (Honebein, Duffy & Fishman, 1993). Thus the learners are cognitively problem solving in the area of application when studying a learning task. According to Honebein et al (1993), the context of application becomes the frame of reference that the learners generates or envisions. This argument is supported by Mcloughin (1999) that, learning styles (LSs) research is significantly important for instructional designers (IDs) to establish the learners' context of application and learning, and to ensure that these understandings may be considered in the design process.

Learning Style and Instructional Design

Learning style, defined as individual preference for organizing, representing and making sense of provided information (Choi, Lee & Jung, 2008; Felder & Silverman, 1988; Jonassen & Grabowski, 1993; Kolb, 1984) can explain how and why students do or do not derive benefits from instructional materials. There are different approaches to LSs. Each approach defines LSs differently and concentrates on special dimensions of learning process models. These model categories were based on learning process (Kolb, 1976); orientation (Enwistle, 1979); cognitive skill development (Keefe, 1987); and instructional preferences (Dunn, Dunn & Price, 1989). LSs provide concrete information and facilitate more inductive reasoning compared to traditional didactic lectures (Choi, Lee & Jung, 2008). This will help IDs to develop more individualized, adaptive and effective environments (Jonassen & Grabowski, 1993).

LSs are important factors in individual differences that may need to be considered to result in meaningful learning and effective learning outcomes (Riding & Rayner, 1998; Choi, Lee & Jung, 2008). Felder and Silverman (1988) pointed out that college instructors' teaching styles did not match with college students' LSs. They further asserted that applying the data about students' LSs into the redesign of teaching strategies could significantly increase learning outcomes. In a meta-analysis of experimental studies on LSs, Lovelace (2005) pointed out that instruction taking LSs into account usually increased the students' motivation and achievement. Choi et al, (2008) recently reported that the benefits of a particular multimedia lesson are mediated by students' different LSs, and recommended the design of adaptive and flexible interfaces of multimedia that may provide individual students with learning resources in ways that will accommodate their diverse LSs and thus facilitate more meaningful learning experiences for them, thus maximizing the benefits of multimedia (p.23). They confirmed the earlier reports (Baldwing & Sabry, 2003; Jonassen & Grabowski, 1993; Lovelace, 2005).

Literature on LSs recommends designing teaching materials and methods grounded in learners' LSs in order to maximize learning outcomes. IDs' task should then be to fit lesson organization and materials to be used in the lessons into the learners' LSs so that students can perceive, process, organize and concretize the information in their preferred ways. However, how IDs will avoid being influenced by their own LSs is to be answered, and there is little research on the relationship between desginers' LSs and quality of their development of learning materials (Akpinar, 2007).

Role of Reflection in Learning Instructional Design

To avoid influence of IDs' subjective decisions in the organization of learning materials to be designed, reflective thinking generally addresses practical problems allowing for doubt and perplexity before possible solutions are reached (Hatton and Smith, 1995; 34). A component worthy of investigation is the role of reflection which can play a role to provide a framework for engagement with the design process to enhance learning outcomes for the ID students (Ellmers, 2006). Reflections as a means to enhance learning in education has been well documented (Dewey, 1933; Eraut, 1994; Labosyky, 1994; Luppicini 2003; Schon, 1983, Tonkinwise, 2005). Reflection in learning is defined similarly by different authors; for example, Baud, Keogh and Walker (1985; 19) state it as activities in which individuals' engagement to explore one's own experiences to lead to new understandings and appreciations. Similarly, Hatton and Smith (1995; 34) outline reflection as an active and deliberative cognitive process involving sequences of interconnected ideas which take account of underlying beliefs and knowledge. These two definitions refer to the use of experiences and existing knowledge in dealing with problems, and such interaction between new case and use of experience will lead to learning. Quayle and Paterson (1989) define reflection as the re-consideration of an idea or experience, and list its facets as consciousness, retrospection, introspection and self-knowledge. They outline four groups of technique for encouraging reflection in design education: (a) Instructor-centered (post-design lecture; demonstration); (b) Individualized (thinking mode changes, programmed instruction; computer programs, measured activities and drawings); (c) Interactive (individual critique, questions, comparative analysis, peer learning, group discussion); (d) Experiential (design re-consideration, role playing, gaming, field testing).

Schon (1983) addresses reflection as a critical element of professional design activity and articulates two types of reflection: Reflection-in-action and reflection-on-action: Reflection-in-action takes place when the design professional experiences a unique situation during the development of the design solution whereas reflection-on-action involves the review of actions from the recent past. Reflection-on-action is the process of making sense of action after it has occurred and possibly learning something from the experience which extends one's knowledge base (Eraut, 1994; 146). Schon (1983; 1987) outlines the concept of reflective practitioner as a means of engaging in professional activity; providing a framework for understanding and plotting the process of design practice and activity. Schon (1987) maintains that reflection is intimately bound up with action and design practice is action-oriented and relies on an implicit knowledge that resists definition in the paradigm of technical rationality (Ellmers, 2006; Valkenburg & Dorst, 1998).

Quayle and Paterson (1989) suggest that students can be encouraged to reflect on their own design learning through informed reflection which is the conscious reconsideration of a thought, idea or experience with expressed objectives. Informed reflection elicits information about the nature and quality of a student's design learning which includes components of creative behavior and the design process as well as theoretical, ethical and practical aspects of design. During informed reflection, these aspects of design are reinforced through self-criticism, peer-criticism and critical analysis of process and product. In this view, design learning focuses on long term learning. Informed reflection helps both teacher and learner view individual learning characteristics. Students' design intuition can develop through exposure to more objective information, and in turn, reflection during projects is encouraged. Informed reflection therefore is a strategy for design learning which creates a bridge from one project to the next.

Understanding the design process is an important aspect of becoming a professional designer as this can provide a platform to transfer expertise to different design contexts. Kinzie, Hrabe and Larsen (1998) recommend a case approach where students work in teams, and communicate and collaborate with team members in both face-to-face and web based fashion. They report that the collaborative case approach is a motivating factor for the design students. Shambaugh and Magliaro (2001) confirm the case approach and suggest that ID instruction should include four elements as authentic tasks, modeling of design expertise, reflective activities and feedback.

Ellmers (2006) further underlines that many design students focus on the project outcome with limited ability to articulate the design process. Reflective actions involved in carrying out an ID project are important to make objective design decisions. Design tools and guidance for promoting designer discourse and reflective dialogue between the designer and the context have been the focus of attention for some researchers. Recent research efforts (Bannan-Ritland, 2001; Luppicini, 2003; Moallem, 1998) explore association between reflective actions and practice with ID procedures. Mastering the process of reflection in action is inherent in the design process and an imminent aspect of becoming an instructional design professional (Rowland, 1993; Schon, 1983). Winn (1997) also identified "improvement of ID through reflective dialogue between the designer and the context" as an innovative strategy. Luppicini (2003) addressed that reflection provides information concerning where ideas come from, which is essential for improving learning or eliminating habits that prevent learning. Further, Luppicini emphasizes that developing a tool for promoting IDs' discourse and reflective dialogue could aid IDs in order to become more aware of creative processes and decision making strategies when engaged in actual projects; he, then, proposes an ID tool, Reflective Action Instructional Design (RAID). It stresses multiple areas of consideration: The design processes and products, the design situation, and the implication of self and others in the design. The RAID topology of reflective design questions is intended to be used as a baseline for any ID project, and points three set of questions of reflective practices as: Actor referenced, action referenced and situation referenced (p. 78). The reflective design questions to be used in different design contexts can be self-administered to (1) aid designers in situating their design ideas in a community of designers as well as the designers' personal attachment to those ideas and willingness to compromise their artistic vision; (2) probe for design thinking that may not be typically communicated in group discussions; (3) help rationalizing situational constraints in design decision making. Applying the RAID framework in LO design is new to the field of ID and is not adequately studied in the design literature. Recently Akpinar (2007) carried out a pilot study with the RAID questions and a Learning Object Review Instrument (LORI) as reflection tools in a set of learning materials design and development activities by student instructional designers: The study demonstrated that those reflection tools were helpful to learn design issues, however it suggested that other strategies and/or reflection tools should also be used to experience and learn elaborating design ideas and taking others' opinions into consideration.

Problems of the Study

To encourage and teach reflection in ID education, this research studied the effects of RAID framework, LORI, classroom and online discussions, and learning style on senior instructional design students' design and development of LOs. In this regard, the study examined: (1) the prospective instructional designers' (PIDs) reflections through RAID questions in making design decisions, (2) the role of the LORI in improving LO design, and (3) interactions between the PIDs' learning styles and quality of their designed LOs for K-12 learning units with different: (a) number of assets (picture, animation, simulation, sound file, hyperlink, game, video, downloadable-file), (b) text density (small amount, moderate amount and large amount of text), (c) number of instructional elements (advance organizers, questions and didactical directions), (d) number of screen orientations (templates, picture orientation, font types and font sizes, colors, sharable content object).

Methodology

Subjects

To investigate the PIDs' design and development of LOs, a series of studies were conducted with final year ID students (n=23) in the fall semester of 2007. These students study their BSc degree in four years after one-year English Language preparation. All subjects study at the Department of Computer Education and Educational Technology, and before this experiment they complete courses including instruction, learning, analyzing performance problems, and design, development, implementation and evaluation of instructional strategies and products. In those previous courses, the participants complete at least one ID activity for computer assisted learning, coding and producing their materials. The study was conducted in a compulsory course, Internet for Educational Purposes containing web based instructional content development activities.

Study Materials and Procedure

The materials of this study were course materials in "Internet for Educational Purposes course", the LOs for K-12 to be designed, developed and implemented by the subjects, and several other tools. They include:

1- a learning content development and management system BU-LCMS (Akpinar & Simsek, 2007) to be used by the participants to aggregate their design and develop LOs,

2- a discussion board of a learning content management system to provide an elaborative argumentation platform for the prospective IDs.

3- the Learning Object Review Instrument (LORI, version 1.5 by Nesbitt & Li, 2004) to be used to examine quality of the designed LOs,

4- the Felder-Silverman Learning Style Index (Felder, 1993; Felder & Spurlin, 2005) to be used to measure the subjects' learning style and

5- the RAID questions (given in Table 1) to be used to assist reflective design decisions.

Table 1.

RAID questions (Luppicini, 2003: 78)

Actor referenced reflective practices
Reflections-on-others: What is the role of others involved?
Reflections-from others: What do they think?
Reflections-on self: What do I think of myself and my role in practice?
Action referenced reflective practices
Reflection-to action: What led to this action?
Reflection-in-action: What is happening now?
Reflection-on-action: What brought you to this?
Reflection-from-action: What could work?
Situation referenced reflective practices
Reflections-to-situation: What expectations do I have about the setting?
Reflections-on-situation: What do I think about the setting?
Reflections-from-situation: How would I change the setting?

First, online version of the Felder-Silverman Learning Style Index was administered to the subjects to study their learning styles. Then, they were instructed to select a K-12 science learning task from a given list for which learning difficulties and possible misconceptions were also provided to each participant. They spent four weeks for the design of their materials and four weeks for the development and implementation of their materials. They were instructed to design interactive LOs meeting the following requirements (inspired from learning environment design principles by Akpinar and Hartley, 1996):

(1) Once designed sharable content objects (SCOs) are sequenced in a certain order, the LO they constitute must form a scenario.

(2) The scenario must make sense for the target students and employ their previous knowledge in overcoming learning difficulties in the content of the LO.

(3) The SCOs must have particular tools to enhance interactivity through encouraging students to try out their ideas, hence allowing students learn from mistakes as well.

(4) The SCOs must have facilities to concretize the content and respond to individual differences.

(5) The LO facilities and scenario must give clear objectives and feedback to students and motivate them with cognitive tools and challenging tasks.

(6) The sequence of SCOs must be from concrete to abstract to connect different knowledge representations.

They then coded their design ideas in Flash Action script, and compiled and aggregated their LOs in the LCMS. After their initial design activities, they met under supervision of the researcher to discuss their design features and justify each screen components they produced. The discussions focused on the pragmatics of the screen elements and their contribution to overcome a specified learning difficulty or misconception in the selected learning task. During the meetings, the PIDs presented and shared their design ideas and sketches with the class to receive reflective information from others. The class discussed requirements of interactive LOs in general, and the following issues regarding a design presentation: the scenario, learning activities in the story, particular tools to enhance memory, presentation of knowledge representation means, enabling meaningful learning and linking knowledge patterns, individual differences, motivation, feedback, screen design and originality in the design. The discussions for each participant's design were extended and made more systematic on a web based discussion form. All the designs were stored in a server, and all had to be inspected by five different peers from the class. On the discussion board, those five peers provided their confirmations; criticisms and suggestions over a particular student's learning material design in more detail. On the board, they had to convince each other on the correctness or incorrectness of the properties of the designed components. Because active teacher participation to the online discussion can limit the kinds of students' contribution and their opportunity to develop ownership of discussion management and constructive critiquing roles (Mercer, 1995; Pilkington & Walker, 2003), the teacher in this study did not interfere the process of online discussions after making the discussion tasks clear.

The quality of each participant's production was then evaluated using the LORI by five peers and three expert IDs (see Table 2). The student IDs' and the expert IDs' ratings were averaged. The LORI results were shared with the LO designers and they then took further developmental actions in the following four weeks time. To systematically reflect the discussions over a participant's design, and to help the participant to re-consider and review his/her design ideas or experience, each participant then replied questions of the RAID.

Table 2.

Evaluation of the first and second version LOs using the LORI

	LO version 1		LO version 2		Version 1-2					Effect size
LORI item	Mean	Std. Dev.	Mean	Std. Dev	Mean difference	Std. Dev	t	df	Sig. (2-tailed)	(Cohen's d)
Content quality	3,59	0,74	3,71	0,53	-0,12	0,40	-1,41	22	0,17	0,18
Learning goal alignment	3,45	0,75	3,70	0,57	-0,25	0,46	-2,56	22	0,02*	0,37
Feedback & Adaptation	3,23	0,75	3,72	0,67	-0,49	0,42	-5,64	22	0,001**	0,67
Motivation	3,44	0,60	3,60	0,71	-0,16	0,46	-1,68	22	0,11	0,24
Presentation design	3,45	0,68	3,68	0,61	-0,24	0,44	-2,55	22	0,02*	0,35
Interaction usability	3,24	0,69	3,62	0,54	-0,37	0,37	-4,84	22	0,001**	0,60
Accessibility	2,59	0,75	2,96	0,89	-0,38	0,46	-3,95	22	0,001**	0,44
Reusability	2,94	0,57	3,24	0,57	-0,29	0,41	-3,40	22	0,001**	0,52
Mean	3,24	0,62	3,53	0,56	-0,29	0,29	-4,69	22	0,001**	0,48

** Difference is significant at the 0.01 level (2-tailed); *. Difference is significant at the 0.05 level (2-tailed).

Following the use of reflection tools, class discussions, online group discussion and self reflection through written answers to the RAID items, development and implementation of the materials were completed. The participants' objects were again placed in the server, and analyzed in terms of number/amount of assets, text and instructional components by the researcher to examine the instructional features of the objects. Also, the quality of each participant's product was evaluated by the five participants and the three expert IDs independently using the LORI (see Table 2). The student IDs' and the expert IDs' ratings were averaged. At last, a final meeting was organized to discuss the use of RAID questions, the online activities and the LORI.

Data Analysis

The data included (1) the participants' written answers to the RAID questions and their oral comments made in the meetings addressing the use of reflective strategies, (2) the participants' learning style measured by the Felder-Silverman Learning Style Index, (3) evaluation of the participants' first and final version objects using the LORI, (4) analysis of the participants' final version objects in terms of (a) number of assets (b) text density (c) number of instructional elements (d) number of screen orientations.

Results

The participants' style of learning preferences are observed as visual, active, sensing and global among the four main categories of LSs. The participants' most preferred LSs is visual (100%; mean 7.22); then active (73,9%; mean 4.00), sensing (73,9%; mean 3.00), global (60,9%; mean 3,36), sequential (39,1%; mean 3,11), reflective (26,1%; mean 5,33) and intuitive (26,1%; mean 3,5), and verbal is not a preferred style by the participants. Most participants prefer to be active learner rather than reflective learner who prefer thinking about issues quietly first and prefer working alone.

The interaction between the participants' LS and quality of their first and final version LOs were studied with correlation studies. The participants' LO qualities in the first version did not remarkably correlate with their most learning styles; however, the intuitive preference of learning style had remarkable correlation with the item 1, content quality, ($r= -0.88$; $p<0.05$) and item 3, feedback and adaptation, ($r= -0.85$; $p<0.05$) of LORI evaluation of the first version of the LOs, and with the number of instructional elements of the first version LOs ($r= -0.84$; $p<0.05$). Those remarkable relationships were not observed in the final version. Also, a series of ANOVA tests ($F= 0.23$ to 1.37 and $p>=0.29$) revealed that the PIDs' firstly and secondly preferred learning styles did not have any significant impact on use of text density, instructional elements, assets and screen orientation in the final LOs.

The LORI scores of the participants' first and final version LOs were compared. Distribution of the data was considered, and accordingly t tests were conducted. Scores for independent items of the LORI and the overall LORI score of a LO (Table 2) were examined. The item nine of the LORI was about standard compliance and the scores were the same in two versions, hence eliminated from the analysis. Improvements on the LORI measured LOs were observed on both features measured by first eight items of LORI and on the average LORI scores of the LOs. Statistically significant improvements were observed on most features of LOs (i.e., items 2, 3, 5, 6, 7 and 8, and average LO scores), except item 1 and 4. Effect size estimations revealed that Cohen's d effect sizes are small on content quality and motivation items, and are moderate on rest of the items as well as on the means.

4.1 The LO designers' argumentation on the discussion board

The analysis of the designers' discussion threads on the web board showed the issues they raised and focused on their discussions. A total of 115 discussion threads were read and frequency of all issues raised was tabulated (see Table 3). In the discussions, most criticisms and suggestions (about one-third of the threads) were on questions and answers on rationalization of the designed object components, functions of each object components, the way the content reified in the objects, layout and scenario of the objects. Also, in the objects, about one-seventh of the discussions focused on suggesting additional screen components, instructional directions provided, student control over the components, help menu facilities and content, type and timing of feedback, Further, eleven threads recommended alternative ways of constructing a seamless connection between tasks and/or components of the objects, six threads suggested the use of additional media type, two threads suggested to use specific cues in the LOs, and one thread criticized navigation features in the LOs.

Table 3.

Frequency of raised issues in the discussion threads

Issues used in arguing the features of a LO	Frequency	Issues used in arguing the features of a LO	Frequency
• Rationalization of designed components	46	• Language pattern	18
• Criticisms and suggestions on functions of components	46	• Suggestions on additional components	17
• Criticisms and Suggestions on concretizing the content through LO	45	• Instructional directions	17
• Layout design	40	• Color usage	14
• LO scenario	39	• Connection between tasks/components of the LO	11
• Help menu features	28	• Media type used	6
• Student control features	20	• Cues used	2
• Feedback content, type and timing	20	• Navigation	1

Answers to RAID Questions

The PIDs' written answers to RAID questions were categorized and analyzed on the basis of items. First, in answers to Reflections-on-others: (1) most participants found others' role in design of the LOs as "to help see design errors"; (2) about half of the participants also reported others' role as "to improve the scenario of the LO" and (3) as "to recommend alternative LO components"; (4) one fifth of the participants thought that others "helped to pinpoint usability errors in the LO design". In answers to reflections-on-self: Two-thirds of the participants saw their role in pedagogical component specification, scenario development and technical configuration of the objects. Also, about one-third saw their role in specifying learning activities. In answers to reflection-on-action: All participants expressed that mostly reflection-on-self through self-criticisms and peers' suggestions led their design decisions. One-fifth of them expressed that they made those decisions to make object implementation easy.

Second, in answers to Reflection-in-action: Two-third of the participants declared that they were developing and improving screen components for their LOs, One-third of them were increasing number of learning activities/tasks in the LOs, developing technical components and debugging designed configurations. In answers to Reflection-on-action: All participants first showed their peers' criticisms and suggestions as a primary source of reason for their design decisions: One-fifth of them showed their review of other similar products as a source of reason; half of them showed their own evaluation of the material design causing those design actions. One of the participants (D.K.) specifically pilot-tested her design with a target user and she commented that she was influenced by the target user's feedback more than the peers' suggestions and LORI evaluations. Further, in answers to Reflection-from-action: Two-thirds of them also showed a need for improving some of pedagogical features (i.e. feedback messages, didactic explanations and wordings of the questions) of the LOs.

Third, in answers to Reflections-to-situations: One-third replied that with their LOs, more misconceptions will be corrected and more students' learning difficulties will be overcome. Half of the participants also wrote that they will have more usable LOs. In answers to Reflections-on-situations: More than two-thirds of the participants marked that the LOs will be more effective when they do certain changes pinpointed in the peer reviews and evaluation studies with LORI.

Additionally, the participants were asked to write down what their reviewers and reviews taught them about LO design. About half of the participants indicated that they confirmed and reinforced the LO development principles, and consulting others is critical to see alternative approaches in the design and to find out design errors. More than half of the participants stated that they become more aware of meeting diverse student needs, how to develop analogies that make sense for everyone, how to concretize abstractions for everyone, why to increase learning activities, and how to improve help facilities for students. Most participants stated that they learnt design principles that they neglected before, and confirmed their theoretical design knowledge and the design principles they applied in their object development. Further, the issues about which the participants claimed to learn something new during the LO design, development and reviewing activities are listed as: screen components, layout design, color selection, media usage, reusable component design, scenario development, analogy and metaphor development, meeting diverse student needs and preferences, taking alternative views into account in design, being objective in LO production, developing self criticisms and designing original objects.

Discussions

The analysis first showed that the PIDs with intuitive learning style tended to be influenced by their LS in designing LOs. Their first version objects had disproportionate number of instructional elements, compare to their strong intuitive preferences. As noted by Felder and Spurlin (2005), intuitive learners prefer discovering relationships and dislike repetition; they also do not like learning activities involving a lot of memorization and routine calculations. The intuitively learning PIDs in this study followed a way designing LO where they showed an entirely opposite of their own way of learning preferences, and constituted scenarios accordingly. Though they do not prefer repetitive tasks and routine memorizations, their first version had content presented routinely, delivered feedback without taking different user inputs into account. However, the intuitively learning PIDs did change their approach, and components and scenario of their final version LO did not show any meaningful correlation with their own learning preferences. It seems that the activities of class discussions, LORI evaluations of the designed LOs, web discussions for the LOs and self-reflection, RAID, helped the PIDs, particularly to the intuitively learning PIDs. Those activities clearly marked the design errors, and web discussions provided specific suggestions.

The statistical tests revealed that those activities helped the PIDs to improve many of LORI measured features of the designed LOs. Following the activities, the PIDs improved their LO design, learning goal alignment, feedback and adaptation, presentation, interaction and usability, accessibility and reusability properties of the final version LOs which remarkably differed from their first version. In addition, the ANOVA tests revealed that the PIDs' use of text density, assets, varying screen orientations and instructional elements in the final version were not influenced from their primarily preferred style of learning.

Groups of five PIDs for each LO discussed their designs in the discussion board where they questioned the LOs in terms of (1) functions and justifications of the designed elements, (2) the way a particular designer reified the content with a chosen scenario, (3) how students would control the designed facilities and interact with its components, (4) the type, content and timing of feedback given to students, and language used in, (5) instructional directions, types of media or type of content representation employed, cues used in, and (6) type of navigation. The PIDs also provided alternative ways of designing the objects, through (1) organizing and linking the components, (2) connecting and re-sequencing of the tasks in the objects, (3) improving interaction paths through modifying or extending scenarios and (4) correcting layout errors. The PIDs' discussion threads were specific to each objects and included both praises and criticisms and suggestions. Since the participants' design had to meet requirements of interactive LOs, they took a collaborative approach under the given guidelines. Their discussions provided a reflection setting where a particular PID may find out design errors and verify her design decisions.

The PIDs selected a problematic learning unit and were required to design an authentic LO with highly interactive features and assets. They assessed and questioned their own and others' design work, and reflected new ideas to the design of their own LOs. Through discussions and negotiations with other peers, they removed inconsistencies in the LO, corrected design errors, modified learning activities and made their design to meet diverse student needs. Further through the requirements of LO component rationalization and through taking others' opinions and verifications as well as using structured evaluation tools like LORI, the PIDs had the opportunity to have design experience. The material and its interactive approach encouraged questions and feedback, hence ongoing recursive reflectivity with different toolkits (Conole, Dyke, Oliver & Seale, 2004) helped the PIDs gain an understanding of instructional and learning problems and the designed LO features, along with an appreciation for the ID process (Shambaugh & Magliaro, 2001).

Students play different roles when there is no lecturer present in the learning environment such as self taught e-learning communities (Laghos & Zaphiris, 2007). In this study, whilst the students discuss online about their designed LOs, they sometimes played role of a teacher, of an expert designer and of a typical object user in their small social network of designers. In use of online discussions for learning purposes, the composition of the group and the roles participants undertake in the group affect the effectiveness of discussion (Guldberg & Pilkington, 2006). Also the nature of tasks or discussion questions themselves and students' assigned discussion roles affect learning from discussions (Salmon, 2002). The discussion groups in this study became a community of reflective practitioners sharing similar identities and feelings of togetherness as suggested by Fuchs (2007). To contribute one's design ideas requires others to take a collaborative and constructive approach (Kinzie et al, 1998; Shambaugh & Magliaro, 2001; Quayle & Paterson, 1988), it is not always easy to reach the level of cooperation in such communities (Fuchs, 2007). However, the participants in this study fruitfully and responsibly used the discussion board and assisted each others' design decisions through either critiques and/or suggestions, as demonstrated by answers to items of the RAID. That may have been achieved through clear requirements from the LOs, guidelines in evaluating LOs, and small group dynamics (five PIDS for each LO design) of this study. Compare to a recent pilot study (Akpinar, 2007) where design students completed similar learning activities: a larger group (21 students) rated each LOs once and discussed issues only in a face to face environment without web based discussions, the current study formed smaller groups for LO ratings and employed web based discussions. The final rating of both studies shows (see Table 4) that the current study, in general, helped the PIDs more to elaborate design ideas.

As the quality of first and final version LOs demonstrated, and as some of the PIDs stressed in their answers to RAID items that they reflected ideas from peers and from peers' work, the PIDs benefited from online discussions. At the beginning, the course tutor's supportive approach makes him an enabling participant who supports the PIDs to become a member of the community of reflective practitioners. These results confirm the findings reported by Guldberg and Pilkington (2007). The data from the activities revealed that the PIDs valued the activities for becoming aware of others' progress through criticisms, reflecting individually to improve his/her LO design, and receiving feedback on the design from others. The PIDs' positive comments also agreed with the findings of a study which used a specific online software design environment to collect comments and peers' feedbacks in a more structured and directed manner (Conanan & Pilkard, 2001), but their negative comments on the discussion activities were much less than the ones in Conanan and Pilkard's study where many participants failed to provide feedback to others' work of courseware design.

Table 4

Comparing LOs developed with and without online discussions.

	LO development (without online discussions)		LO development (with online discussions)		Effect size
LORI item	Mean	Std. Dev.	Mean	Std. Dev	(Cohen's d)
Content quality	3.45	0.38	3.71	0.53	0.55
Learning goal alignment	3.01	0.52	3.70	0.57	1.24
Feedback & Adaptation	2.66	0.57	3.72	0.67	1.67
Motivation	2.86	0.61	3.60	0.71	1.09
Presentation design	3.31	0.54	3.68	0.61	0.63
Interaction usability	3.19	0.54	3.62	0.54	0.78
Accessibility	3.03	0.39	2.96	0.89	0.10
Reusability	3.08	0.47	3.24	0.57	0.30
Mean	*3.07*	*0.50*	*3.53*	*0.56*	*0.85*

The aim of online discussions was to create a student-centered learning environment with a focus on collaboration, communication and interaction. As suggested by Guldberg and Pilkington (2007), when the questions encouraged the PIDs to reflect on a particular concrete case (in this study the designed LOs) the participants had interactive debate. The discussion and exchange of design ideas in this study provided a social discourse which, in turn, provided perspectives and feedback that can be used for reflection (as suggested by Saito & Miwa, 2007). On the discussion threads, the PIDs not only directed very harsh criticisms to each other's design, but also offered suggestions to improve the designs as well as praised peers for some authentic design ideas (in 20 threads). Hence the learning environment also became a socialware for the PIDs.

Conclusions

The PIDs were held responsible for their own design decisions by reaching beyond their knowledge and experiences through making decisions on how this design should be constructed, enacted and evaluated. Arguments took place among the PIDs and the feedback a PID received from other PIDs, from the LORI and from the tutor was an imminent element of this study. The online discussion provided the PIDs with a new avenue of collaboration and feedback platform where learning from conflict resolution and from alternative ideas generated by peers becomes possible. The RAID questions used as a self-reflection tool also helped the PIDs to see and elaborate design errors, to improve the scenario and to get aware of alternative ideas relevant to their LOs. The RAID structured the PIDs reflection from the learning activities as of face-to-face discussions about their design, evaluating their product with an instrument, LORI, and web based group discussions for the designs. Finally, the learning effect of a reflective approach for the PIDs included (1) examining their belief about learning from LOs, (2) using the ID process to develop appropriate instructional interventions to promote learning from interactive LOs, and (3) mitigating undesired effects of IDs' learning preferences.

This study verified the effectiveness of combining multiple methods for advocating reflective design learning. In the designed learning environment, the PIDs could experience the three types of reflective practices, i.e. action referenced, actor referenced and situation referenced. The results of this study underline two primary issues for practitioners to consider when including reflective aid in their instructional design education. First, reflective and structured tools and discussions for developing design ideas are useful in producing LOs that target multiple learning styles. Second, the student IDs have provided some insight into how exactly the reflective tools might help them to achieve designing more concrete and interactive activities in the LOs. Nevertheless, two main limitations may constrain this study – one may be its non-random convenient sampling and the second is its relatively small sample size. The further work with larger randomly chosen samples must be aware of required time and energy for conducting experiments, and analysing intensive interactions between participants. Further work should investigate conditions and use of reflective toolkits in different types of learning designs and LOs; particular contribution of each reflective toolkit may help ID trainers to set their teaching/learning environments.

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References

Akpinar, Y. & Hartley, J. R. (1996). Designing interactive learning environments. *Journal of Computer Assisted Learning*, 12(1), 33-46.

Akpinar, Y. & Simsek, H. (2007). Pre-service teachers' learning object development: A case study in K-12 setting. *Interdisciplinary Journal of Knowledge and Learning Objects*, 3, 197-217

Akpinar, Y. (2007). Liberating learning object design from the learning style of student instructional designers. *Performance Improvement*, 46(10), 32-39.

Baldwin, L., & Sabry, K. (2003). Learning styles for interactive learning systems. *Innovations in Education and Teaching International*, 40(4), 325-340.

Bannan-Ritland, B. (2001). Teaching instructional design: An action learning approach. Performance *Improvement Quarterly*, 14(2), 37-52.

Baud, D., Keogh, R., & Walker, D. (1985). Promoting reflection in learning. In D. Boud, R. Keogh, & Y. D. Walker (Eds.), Reflection: *Turning experience into learning* (pp. 18-40). London: Kogan Page.

Botturi, L. (2005). A framework for the evaluation of visual languages for instructional design: The case of e2ml. *Journal of Interactive Learning Research*, 16 (4), 329-351.

Choi, I., Lee, S., & Jung, J. (2008). Designing multimedia case-based instruction accommodating students' diverse learning styles. *Journal of Educational Multimedia and Hypermedia*, 17(1), 5-25.

Conanan, D. M., & Pilkard, N. (2001). Students' perceptions of giving and receiving design critiques in an online learning environment. *In Proceedings of European conference on computer-supported collaborative learning, Maastricht*, 22-24 March. pp. 165-172.

Conole, G., Dyke, M., Oliver, M., & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. *Computers & Education*, 43, 17-33.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educational process*. Boston. Heath.

Dunn, R., Dunn, K., & Price, G. (1989). *Learning style inventory*. Lawrence, KS: Price Systems.

Ellmers, G. (2006). Reflection and graphic design pedagogy. Presented at Annual National Conference of Australian Council of University Art & Design Schools, Melbourne, Australia.

Entwistle, N. J. (1979). *Motivation, styles of learning and the academic environment*. Edinburgh, The University of Edinburgh, ERIC Document Reproduction Service No. ED 190 636.

Eraut, M. (1994). *Developing professional knowledge and competence*. London, The Falmer Press.

Ertmer, P. & Cennamo, K. S. (1995). Teaching instructional design: An apprenticeship model. *Performance Improvement Quarterly*, 8(4) p. 43-58.

Felder R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, 78(7), 674-681.

Felder, R. M., & Spurlin, J. E. (2005). Applications, reliability, and validity of the index of learning styles. *International Journal of Engineering Educatio*n, 21(1), 103-112.

Felder, R. M. (1993). Teaching the second tier: Learning and teaching styles in college science education. *Journal of College Science Teaching*, 23(5), 286-290

Fuchs, C. (2007). Towards a dynamic theory of virtual communities. *International Journal of Knowledge and Learning*, 3(4/5), 372-405.

Guldberg, K. K. & Pilkington, R. M. (2006). A community of practice approach to the development of non-traditional learners through networked learning. *Journal of Computers Assisted Learning*, 22(3), 159-172.

Guldberg, K. K., & Pilkington, R. M. (2007). Tutor roles in facilitating reflection on practice through online discussions. *Educational Technology & Society*. 10(1), 61-72.

Hatton, N., & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education*, 11, 33-49.

Honebein, P. C., Duffy, T. M., & Fishman, B. J. (1993). Constructivism and the design of learning environments. In T. M. Duffy, J. Lowyck, D. H. Jonassen, & T. M. Welsh (Eds.), *Designing environments for constructive learning* (pp. 87-107). Berlin, Springer-Verlag.

Jonassen, D. H., & Grabowski, B. L. (1993). *Handbook of individual difference, learning, and instruction*. NJ: Lawrence Erlbaum Associates.

Keefe, J. W. (1987). *Learning style: Theory and practice*. Reston, VA, National Association of Secondary School Principals.

Kinzie, M. B., Hrabe, M. E., & Larsen, V. A. (1998). Exploring professional practice through an instructional design team case competition. *Educational Technology Research & Development*, 46(1), 53-71

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. NJ. Prentice Hall,

Kolb, D. A. (1976). *Learning style inventory*. Boston: McBer.

Laboskey, V. K. (1994). *Development of reflective practice*. NY, Teachers College Press.

Laghos, A., & Zaphiris, P. (2007). Social network analysis of self-taught e-learning communities. *International Journal of Knowledge and Learning*, 3(4/5), 465-482.

Lee, Y. B. B. (1992). Effects of learning style in a hypermedia instructional system. *In Proceedings of selected research and development presentations at the convention of the AECT*. Washington, DC. 505-509.

Lovelace, M. K. (2005). Meta-Analysis of Experimental Research Based on the Dunn and Dunn Model. *The Journal of Educational Research*, 98(3), 176-183.

Luppicini, R. (2003). Reflective action instructional design (RAID): A designer's aid. I*nternational Journal of Technology and Design Education*, 13, 75–82,

McLoughlin, C. (1999). The implications of the research literature on learning styles for the design of instructional material. *Australian Journal of Educational Technology*, 15(3), 222-241.

Mercer, N. (1995). *The guided construction of knowledge: Multilingual matters*. Philadelphia. Clevedon.

Moallem, M. (1998). An expert teacher's thinking and teaching and instructional design models and principles: An ethnographic study. *Educational Technology Research and Development*, 46(2), 37–64.

Nesbit, J. C., & Li, J. (2004). Web-based tools for learning object evaluation. *In Proceedings of the international conference on education and information systems*. Orlando, FL, 2, 334-339.

Pilkington, R. M., & Walker, S. A. (2003). Using CMC to develop a knowledge building community amongst post-graduates. *International Journal of Continuing engineering Education and Life-long Learning*, 13(3/4), 318-335.

Quayle, M., & Paterson, D. (1989). Techniques for encouraging reflection in design. *Journal of Architectural Education*, 42(2), 30-42

Richey, R., Fields, D. C., & Foxon, M. (2001). *Instructional design competencies: The standards*. Syracuse, NY. ERIC.

Riding, R., & Rayner, S. (1998). *Cognitive styles and learning strategies*. London: David Fulton Publishers.

Rowland, G. (1993). Designing and instructional design. *Educational Technology Research and Development*, 41(1), 79-91.

Rowntree, D. (1992). *Exploring open and distance learning materials*. London: Kogan page.

Saito, H., & Miwa, K. (2007). Construction of a learning environment supporting learners' reflection: A case of information seeking on the web. *Computers & Education*, 49, 214-229.

Salmon, G. (2002). *E-tivities: The key to active online learning*. London. Kogan Page.

Schon, D. A. (1983). *The reflective practitioner*. San Francisco: Jossey-Bass.

Schon, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. CA. Jossey-Bass.

Shambaugh, N., & Magliaro, S. (2001). A reflexive model for teaching instructional design. *Educational Technology Research and Development*, 49(2), 69-92.

Tonkinwise, C. (2005). The Idealist practice of reflection: Typologies, techniques and ideologies for design researchers. *Futureground: Design research society international conference*, 17 November, Monash University, Melbourne, Australia.

Valkenburg, A. C., & Dorst, K. (1998). The reflective practice of design teams. *Design Studies*, 19, 249-694.

Winn, W. (1997). Advantages of a theory-based curriculum in instructional technology. *Educational Technology*, 37(1), 34-41.