

TEACHER TRAINEES AS LEARNING OBJECT DESIGNERS: PROBLEMS AND ISSUES IN LEARNING OBJECT DEVELOPMENT PROCESS

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ABSTRACT

Learning objects (LOs) can be defined as resources that are reusable, digital with the aim of fulfilling learning objectives (or expectations). Educators, both at the individual and institutional levels, are cautioned about the fact that LOs are to be processed through a proper development process. Who should be involved in the LO development process and how should we train them to become proficient LO designers are one of the major challenges for instructional designers. Addressing to this challenge, this study aims to identify problems and issues teacher trainees experience when designing LOs. A course was re-designed for prospective teachers (n=49) to experience LO design process for 14 weeks. From a qualitative paradigm, this paper reports the findings of qualitative data derived from the first cycle of a two-cycle design based research study. The findings indicated that teacher trainees experienced content development related issues (such as, understanding LO paradigm, development software and environments, content packaging and repository) the most. In addition, project management and copyright related issues were emerged, as well. As Becker (2000) puts it well, teachers' beliefs and philosophies impact their use of resources. Therefore, starting the process with prospective teachers and integrating LO design as part of their training curricula, where these issues and problems are addressed, would be beneficial in the long term.

Keywords: Learning objects, teacher training, learning object development, content design

INTRODUCTION

Learning objects (LOs) can be defined as resources that are reusable and digital with the aim of fulfilling learning objectives. By integrating LOs in educational setting, educators may create a dynamic learning environment in which collaboratively developed learning resources are shared with learners both in formal and informal learning settings. In order to create a mutually beneficial environment; however, educators are cautioned about the fact that LOs are to be processed through a proper development process (Wiley, 2006). It would be a challenge for researchers to question that educators who are willing to integrate LOs into their teaching process, don't have the answers of some essential questions like "What is an LO?", "How can you use an LO?", "How an LO can be produced?" (Laverde, Cifuentes and Rodriguez, 2007). It is implied that effectiveness of LOs in education becomes better if LOs were developed with their main characteristics and have diverse usage in education (Fritz, King & Boren, 2005).

Who should be involved in an LO development process is another one of the salient questions for instructional designers. According to Di Nitto, Mainetti, Monga, Sbattella, and Tedesco (2006), three types of users emerge in LO development process: "authors (content writers)", "teachers" and "learners". Teachers and learners can take a role in the process of developing content as authors. Moreover, teacher trainees are at an excellent position to experience LO development and LO use in learning processes both as a learner and a prospective content writer (teacher).

At the institutional level, there are various initiatives (ADL, IMS, IEEE, etc.) to create awareness and improve the effectiveness of LOs, drawn from educational software and standards. Inviting teachers and/or prospective teachers to the process of LO development can increase the effectiveness of and awareness about LOs at the individual level. Kremers and van Dissel (2000), for example, expressed that the value of a technology lies beneath its' efficient and effective usage, and depends on its intended users (Igbaria, Zinatelli, Cragg & Cavaye, 1997) like teachers, learners and/or prospective teachers. Both individuals and establishments aim more effective and efficient software (LOs) to be developed, well-accepted, educationally sound, effective and efficient for educational purposes so that they can be accepted and incorporated by teachers, learners or prospective teachers into learning and teaching processes.

LO development is a complex and problematic process with various challenges and difficulties (Gonzalez-Barbone and Anido-Rifon, 2008). In their study, Gonzalez-Barbone and Anido-Rifon (2008) draw researchers'

attention to the limitations and constraints of learning objects, specifically when developed by using the existing content generation software applications. In order to overcome these limitations, they describe the content packaging, which is one of the phases in LO development process, in a step-by-step approach for content developers. As a conclusion, they warn researchers that such software applications do not provide machine-readable learning objects; however, they are not functional enough for further adaptations (that is, for educational purposes). This functionality might be explored from LO developers' perspective.

Since LOs are interactive and multimedia-rich resources, they have the potential for educational institutions. González-Videgaray, Hernández-Zamora and del-Río-Martínez (2009) examined in-house developed LOs in a virtual learning environment by comparing them with the most common LO definitions and attributes. In their study, they indicated that teachers develop and use LOs effectively; however, they had little adherence to prescriptive definitions. They conclude by saying that supporting teachers to use interactive and multimedia contents instead of static contents is paramount. Yet, teachers' LO development process and the issues emerged during the LO development process remain detached.

Griffiths, Stubbs and Watkins (2007) examined how to aggregate LOs from existing course contents. They proclaimed that aggregation should be in consistent with the existing LO definition, LO planning, granularity, reusability and LO categories for novice developers. Although the researchers did not conduct their study with content developers, they urge novice developers to work in collaboration as a team work throughout the process. They further call for a need for more research to outline what issues would emerge when content developers, especially novice content developers, are at work.

In their research, Akpınar and Şimşek (2007) examined the effect of pre-service teachers' experience in information and communication technology (ICT) use on their learning object development with the participation of 76 pre-service teachers. The researchers analyzed participants' learning objects with Learning Object Review Instrument and found that novice and experienced information technology users were able to develop learning objects similar in size and features. They further reported that there was a significant correlation between the quality of the LOs measured with the LORI items and some elements of the developed LOs. However, the LOs developed by novice and experienced groups did not differ neither in overall ratings nor at nine individual items of the LORI. The researchers further suggested that more research is needed to understand LO quality, creation of different types of learning objects and reporting on the LO development process with learner feedback.

Akpınar (2009), in his experimental study on learning design of interactive LOs, had prospective teachers develop LOs for K-11 schools. He found that prospective teachers displayed various roles; the role of a teacher, of an expert designer or of an ordinary LO user. Akpınar (2009) also asked the prospective teachers to reflect upon their experiences both in face-to-face and web-based discussions modes. Based on their reflections, he indicated that such a reflective experience helped them understand instructional and learning problems and improve their instructional and learning object design skills.

These studies indicate that, first, software applications alone do not provide an ultimate solution nor produce pedagogically sound LOs. Secondly, including teachers and/or prospective teachers as potential LO content developers is a necessity. In addition to these, educational institutions require teachers to develop LOs for their prospective students. Cohen (2006) indicates that e-learning systems cause changes in the roles of teachers, students, and administrators. According to Cohen (2006), in the new emerging system, teachers are considered as course creators. Therefore, prospective teachers should be trained as course creators or designers, as well.

In order to meet this requirement, teachers need to develop these skills; hence, prospective teacher education programs need to address such a change. Moreover, some research findings indicate that when students are confronted with appropriate instructional challenges, they develop their instructional and learning object design skills. As emphasized in the literature, more research is needed to explore what types of issues and problems occur during LO development process. Therefore, the main purpose of this study is to determine and report issues and problems during the LO development process from the views of prospective teachers.

METHOD

Two cycles of design based research (DBR) of LO development have been completed. DBR is considered as an effective and efficient method to explore the processes in educational settings where artifacts are produced (Wang & Hannafin, 2004). DBR involves an iterative process involving design, analysis and re-design phases (Shavelson, Phillips, Towne, & Feuer, 2003). This study reports the findings of qualitative data derived from the first cycle of design based research.

Study Context and Participants

Study group consisted of 8th semester senior students (prospective teachers) at the department of computer education and instructional technologies (CEIT) program at Hacettepe University. CEIT aims at training prospective computer teachers and instructional designers. Some of the courses related of instructional technology are: Computer-based Education, Use of Internet in Education, Distance Education and Design, Development and Evaluation of Educational Software (DDEES), and project development and evaluation.

The participants were selected based on convenience sampling method in order to give researchers to have the advantage of being in a high interaction and in collaboration with study group (Brown, 1992; Cobb, et al., 2003). The group took courses in instructional design, software development, and educational software development in their previous terms. Therefore, it is assumed that they had developed an appropriate background enough to be LO developers. The data was gathered during the DDEES course since the course was designed to introduce the participants developing software as a learning object. Considering that learning objects have been prioritized by the Ministry of Education and other education-related sectors, it is thought that this group of students would be at a perfect situation to reflect upon their experiences. Ultimately, these findings would provide data for the second cycle of the study. The course model in DDEES is presented in Figure 1.

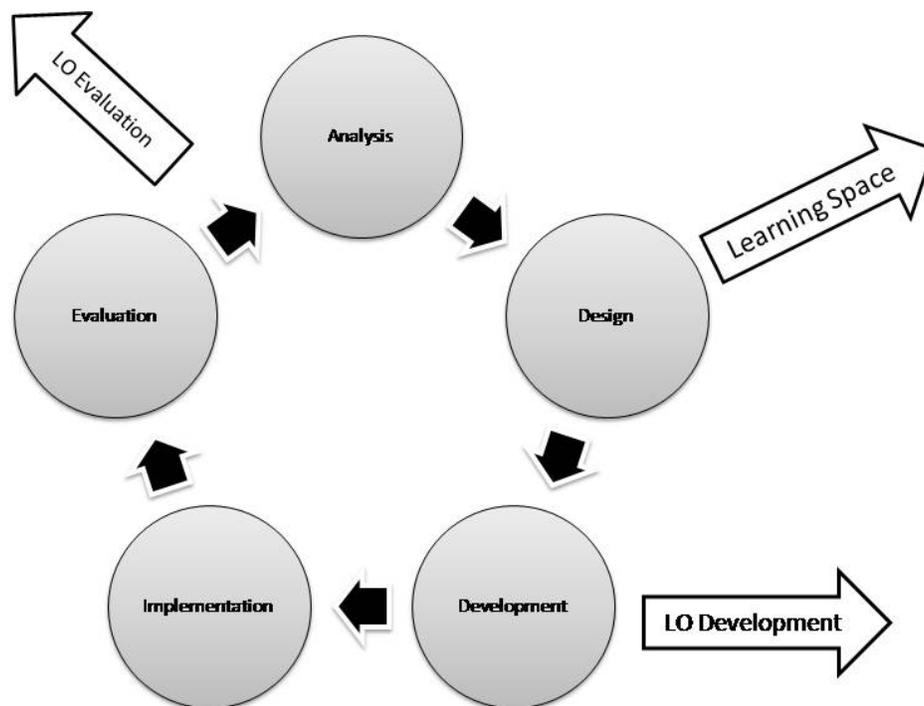


Figure 1: Course model for DDEES

Han and Bhattacharya (2001) emphasized that applying learning by design strategies in design based research is convenient. Therefore, it is decided to use learning by design strategies in DDEES course. It is a common practice to divide study group into project groups (Enkenberg, 2001; Han & Bhattacharya, 2001). It was considered suitable for this study to build up project groups. In the process, teacher trainees (n=49) are divided into 12 project groups. It was explained that each group had to develop LOs by the end of the term (14 weeks).

The groups were assigned tasks to develop LOs based on a learning expectation articulated in K-12 curriculum. The scope of LOs is determined based on Altun and Aşkar's (2008) "Learning Space" metaphor. The metaphor suggests that content is dictated by educational expectations, which can further be deconstructed as concept and/or skill. In this study, the groups were limited to develop their LOs only for skills, articulated in expectations. The skills groups needed to focus on were provided by the course instructor at the very beginning of the course. However, groups were set free to choose the content from math, science, social sciences and Turkish content areas from the primary school curriculum.

The course started with lectures about the definitions and nature of LOs. At the second step, analysis and design processes were introduced. The last major step included the packaging process of LOs. The study group was

familiar especially with the second step; whereas, LO approach as a new paradigm and packaging process was quite novel for the students.

DATA COLLECTION AND ANALYSIS

Qualitative data collection process was employed during the process. During all theoretical and laboratory courses, the researchers were together with the study group in the same environment, having interaction and making observations and interviews.

DDEES course was processed in a blended way, both face to face and online using MOODLE LMS system. MOODLE gave the opportunity to make online interviews with and collect data from the participants. Members of study group were able to contact researchers on behalf of themselves or their project group to get help during the process. Records of these communications were used as data sources.

At the end of the training process, the artifacts that project groups produced were evaluated by the researchers. During the evaluation phase, project groups were interviewed about their LO development process and its outcomes, i.e., the artifacts. The interview questions included questions regarding (a) the most difficult task in the process, (b) the most different thing they faced during the process and (c) their general reflections about LO development process. The interview sessions were recorded on a video tape to be analyzed.

Collected data were analyzed by using nVivo 7 qualitative data analysis software. Content analysis method was utilized. The data analysis process started during the data collection process. All data were transcribed with observation notes. Thematic framework was developed and applied in analysis. Each transcript was repeatedly read, annotated, and coded to reflect the issues as and problems from the emergent content and conceptual themes related to the LO development process. During this process, three conceptual themes existing in the LO literature (ADL, 2004, Di Nitto, Mainetti, Monga, Sbattella, & Tedesco, 2006; Laverde, Cifuentes and Rodriguez, 2007; Churchill, 2007; Mavrommatis, 2008) were applied to the data. Then, the emergent content was revisited to observe how they fit across these conceptual themes, which eventually formed the basis of the coding strategy.

The data was first coded by the first author. To ensure validity, the second author independently coded randomly selected 15 percent of the data again. A percentage agreement was sought and the process lasted as both of the authors agreed fully on the findings listed in the results.

To ensure trustworthiness, first, the data relevant to each category were identified. Secondly, constant comparison was utilized to examine whether these categories are represented by the relevant data. This process was repeated in the light of new emerging themes. Thus, the whole data with the corresponding categories gave the researchers greater insight into the full picture. These themes and the issues were exemplified by a limited number of representative quotations and included in the results section.

For reporting the findings, pseudonyms were assigned to the participants. The following table summarizes the data and the coding convention for each data source:

Table 1: Abbreviations in data analysis

Data source	Abbreviation	Amount of the collected data
Observation Note	ON	166 Pages of word document
Interview Notes	IN	97 Pages of word document
Video Recording Notes	VRN	1 Hours and 24 Min
E-mail Correspondence	EC	37 E-mail (approx.)

FINDINGS

The data collected during the LO development process are coded into three broad themes. The content analysis revealed nine sub-themes, representing the problems and issues teacher trainees experienced. Figure 2 shows the themes schema as a tree.

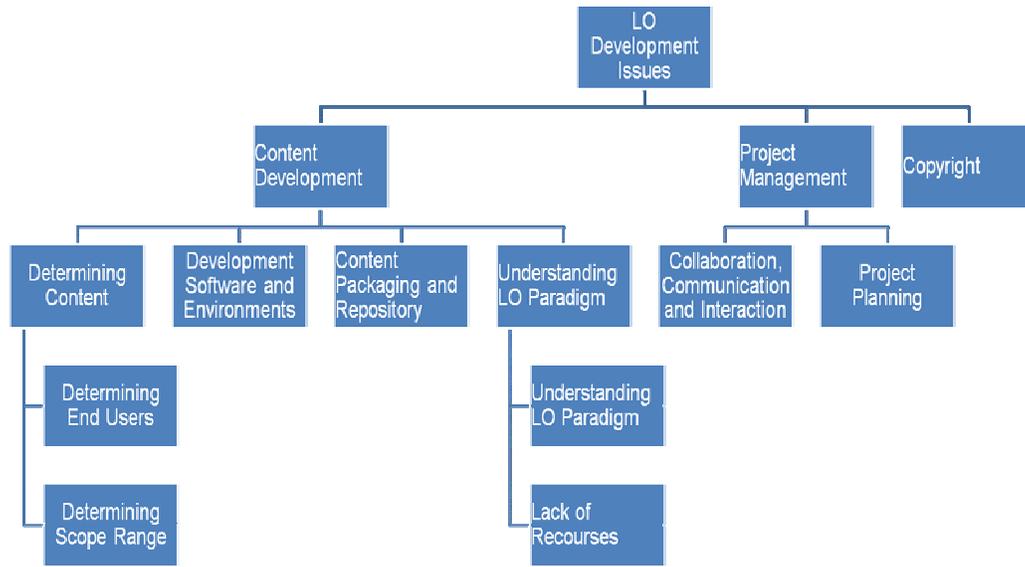


Figure 2: Themes tree schema

Coding data was only done for node themes in order to make themes clearer and specific. Table 2 shows the corresponding qualifications with sample statements across the node themes.

Table 2: Qualifications across themes

Theme	CORRESPONDING QUALIFICATIONS	Sample statements
Understanding LO Paradigm	About how to develop educational software with LO paradigm	“In previous courses or project we developed linear educational software but this approach is not suitable for LOs and we were not familiar LO approach. Therefore, we had some hard time back there”
Development Software and Environments	About software and environments to develop LOs with and deployment	S.Y: We have no idea about which development environment we can use to develop LOs.
Project Planning	About project development and management	AA: We were supposed to handle skills separately but we didn’t plan like this. The most significant problem we had was structuring the process.
Lack of Recourses	About lack of recourses on LOs and skill instruction	BŞ: The term “LO” was very strange to us and there are not any recourse about LOs that written in Turkish. Therefore we couldn’t get some extra help.
Content Packaging and Repository	About packaging LOs into SCORM packages and repository (metadata, RELOAD)	AD: After learning LO definition we have to aggregate parts of an LO but we had difficulties to understand and accomplish this task.
Collaboration, Communication and Interaction	About human relationship (between/within project group or with other people)	AA: During the analysis phase, some people couldn’t answer our questions about skill instruction and we didn’t know what to do.
Determining End Users	About artifacts being usable by end user	ID: During the LO development process we tried hard to prepare suitable LOs for our target group and this was a challenge for us.
Determining Scope Range	About LO size and scope	AA: First of all we had to define skill/s. We came up with a very specific definition and the definition made our task harder. We had to define skill/s and determine objectives and this

Copyrights	About using materials that developed by someone else	was hard to do. GÇ: We had to rearrange templates that we found from elsewhere and this caused some problems for us.
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These themes were further analyzed to observe how often they were raised during the LO development. The findings indicate that Understanding LO Paradigm is the most frequently articulated issue during the process, whereas copyright was raised as the least one. Table 3 displays the frequencies (coding count) and percentages across the theme schema given in Table 2.

Table 3: Counts and percentages of coding themes

THEMES	CODING COUNT	PERCENTAGE
	(f)	(%)
Understanding LO Paradigm	61	33
Development Software and Environments	31	17
Project Planning	23	12
Lack of Recourses	14	7
Content Packaging and Repository	13	7
Collaboration, Communication and Interaction	12	6
Determining End Users	11	6
Determining Scope Range	11	6
Copyrights	11	6
Total	187	100

In the next section, the coding themes are described and exemplified with the selected statements from the data.

Understanding LO paradigm: LO paradigm and LO development were new and unfamiliar to the LO developers especially at the beginning of the process. It was difficult for them to understand this paradigm and develop LOs. They express this issue by stating;

“Skill instruction was not a familiar subject to us. Especially in evaluation part of skill instruction LOs, we had difficulties. First of all we didn’t know anything about LOs then skill instruction. We developed many educational software and we got used to that but this approach and this subject gave us hard times.” (AA: IN # 43)

“While determining granules for LOs we had a big chaos about relationship between LO definition and features of granules” (SD: IN # 47)

“In analysis phase, who would we interview with? (EK: ON # 6), and what kind of questions should we ask?” (FÇ: ON # 7)

“How many LOs do we have to develop?” (HCB: ON # 13)

Development software and environments: Participants had developed couple of educational software during their training program earlier. But, LO and LO development was a new paradigm for them. They had experienced some difficulties during software development process. Students raised questions about LO development such as;

“Which environment will we use to develop LOs?” (AS: ON # 4)

“Does it matter to use video files according to LOs’ size?” (FS: ON # 4)

“Do LOs need to be accessible via the Internet?” (FK: ON # 39)

“Do LOs have to be flash files? (GK: ON # 65)

”Can we use visual basic to develop LO?” (GÇ: ON # 66)

“Is it possible to develop LO in MOODLE?” (HY: ON # 66)

“We have some problems about Authorware software web publish options, how can we get over it?” (MB: ON # 29)

“Does Authorware© need any special plug-ins?” (ID: ON # 72)

Students' reflections were not only limited to the software development, but also they were concerned about the environment where the software was to run. The following statements, for example, indicate that this is an issue for them during this process:

“We have no idea about which development environment we can use to develop LOs” (NA: IN # 11)

“The most biggest problem for us was determining environment at the beginning. We were confused about first but we assume we can use an LMS but we realized that the LMS couldn't satisfy our needs.”

(MB: IN # 29)

Project planning: Planning and organizing the entire project was a difficult task for LO developers. They mentioned these difficulties as follows;

“We write a story that related to all project then we realized that we have to handle each part separately and this task was tiring” (AA: IN # 51)

“At the beginning of the process we couldn't decide to number of files for our project” (BŞ: IN # 90)

“During content authoring, we had some problems with organization to reflect requirements analysis outputs to LO content” (EK: VRN # 43)

Lack of recourses: LO is relatively a new subject (Wiley, 2002) and there isn't a lot of recourses that can help LO developers especially written in Turkish. Therefore participants had some difficulties to reach recourses. They vocalized these difficulties.

“We found a lot of things via the Internet but most of them weren't LOs. At least we couldn't distinguish” (BŞ: IN # 88)

“Most of things we found that were supposed to be LOs didn't match our theoretical knowledge that we learnt in course” (ID: IN # 23)

Content packaging and repository: Packaging content and repository were unfamiliar terms for LO developers. They didn't know about packaging and packaging software as well as the repository where LOs are stored. LO developers mentioned their troubles in content packaging and understanding repository as in the following:

“Preparing suitable LOs to LCMSs like MOODLE was one of the difficult parts in process.” (AD: IN # 8)

“Packaging LOs's content to be appropriate for aggregation and repository gave us hard times” (MB: IN # 25)

“How do we package?” (SÇ: ON # 128)

“How can we arrange navigation in RELOAD? (AA: ON # 131) and How can we edit/insert metadata with RELOAD?” (EK: ON # 132)

“How can we upload packages to MOODLE environment?” (HY: ON # 41)

Collaboration, communication and interaction: Each LO developer was a member of a project group throughout the process. The groups had been assigned a task to develop their LOs in a project based approach. During the project development process, they needed to communicate and interact with each other and prospective end users (i.e., learners and teachers at schools). Members of groups also had to collaborate to finish tasks and develop a successful project. Some of them had experienced problems on this. They mentioned this issue as in the following statements:

“I do know some technical stuff like using Photoshop but I am not so good at animating and I didn't know about my group members' skills”. (AA: IN # 14)

“During the analysis phase, some people couldn't answer our questions about skill instruction and we didn't know how to reach them and get the answers” (GÇ: IN # 59)

Determining end users: Learners, end users or target group are very important in almost all production processes. LO developers had some difficulties about their prospective learners. They mentioned these difficulties as in the following statement:

“During the LO development process we tried hard to prepare suitable LOs for our target group and this was a challenge for us”. (İD: VRN # 24)

They also asked questions during the process regarding this problem. For example;

“Which courses or degrees are in the range to determine objectives?” (GK: ON # 19)

Determining scope range: Participants had to develop LOs for specific subjects within a specific scope. But, all they had was the name of a cognitive skill. They were required to develop an operational definition for these skills and to determine the scope according to that definition. Some students had hard time during this task and they expressed their struggle with the following statements:

“First of all we had to define skill/s. We came up with a very specific definition and the definition made our task harder. We had to define skill/s and determine objectives and this was hard to do” (AA: IN # 15)

“Do we have to have only one objective?” (YY: ON # 7)

“Will we chose a subject and then adopt our objectives to the subject?” (EK: ON # 7)

Copyrights: Copyrights is raised as another issue during LO development. The LO developers raised copyrights as an issue for them. They didn’t know whether they can or cannot use other LOs or materials or how can they use. The following statements represent how copyright is an issue for them:

“We had to rearrange templates that we found from elsewhere and this caused some problems for us”. (GÇ: IN # 60)

Some students asked questions like:

“Finding samples or developing samples, which one is better?” (AA: ON # 23)

“Can we use LOs developed by someone else?” (AŞ: ON # 83)

RESULTS, DISCUSSION AND RECOMMENDATIONS

The highest percentage of the issues in LO development process is understanding the LO paradigm theme with 33%. This finding reflects LO developers’ summative evaluation. It is evident that teacher trainees need to be trained for LO development (as suggested by Boot, van Merriënboer, & Theunissen, 2008). Such training is usually geared toward a particular software use and asset production. The findings in this study indicate that LO is a new paradigm for teacher trainees as learners and they need to be oriented toward LO design and development at the theoretical level in addition to software development.

Packaging and uploading the LOs to the repository is another issue emerged in this study. In order to store LOs properly and make LOs reuseable, it is essential to supply metadata and apply proper packaging processes. A generic packaging editor (such as RELOAD) or a content specific packaging editor (such as KOSIG) can be used for this purpose as suggested by many authors (i.e., Gonzalez-Barbone & Anido-Rifon, 2008; Güler, Altun & Aşkar, 2009; Atasayar & Altun, 2009). In addition, training on how to use these editors should be incorporate into the training process.

Teacher trainees experienced difficulties in the process of project management. LO development process needs collaboration of multi disciplines and expertise (Gonzalez-Barbone & Anido-Rifon, 2008). In the study, this requirement was tried to be met by forming project groups, involving people with different strengths. Theoretical side of project management was lectured and experiments were transferred to the project groups. The lecturing part was considered to be helpful to increase good collaboration, interaction and communication.

In the study, the project groups were given specific cognitive skills as a content to develop an LO about. An LO about skill instruction can have more than one objective. These kinds of LOs generally required aggregating more than one LO. Determining a specific objective is more suitable for LOs that are not combined from other LOs (Gonzalez-Barbone & Anido-Rifon, 2008).

Lack of recourses about LOs and LO development and confliction and contradiction between existing recourses are among the other issues that were raised by teacher trainees. This issue could mainly be attributed to the participants’ characteristics. Almost all LO developers in the study know only Turkish and could use Turkish recourses primarily. Therefore, more research would be needed to explore whether the lack of recourses is a language specific population or not.

Another issue that was faced during the process was copyrights. Using or editing materials developed by someone else is a problem. Copyrights are protected by laws. If someone wants to use materials developed by someone else, he/she has to have permission or know that it is already permitted. Permission types are also another issue. Whether it is allowed to edit or just use can constrain developers. Using such material has some

- Akpınar, Y. (2009). Conventional and web based reflection tools in learning the design of interactive learning objects. *Procedia - Social and Behavioral Sciences*, 1(1), 215-218.
- Akpınar, Y. & Şimsek, H. (2007). Pre-service Teachers' Learning Object Development: A Case Study in K-12 Setting. *Interdisciplinary Journal of Knowledge and Learning Objects*, 3.
- Altun, A. & Aşkar, P. (2008). *An Ontological Approach to Designing Learning Objects*. Paper presented at E-Learn, November 17-21, Las Vegas, Nevada, USA.
- Altun, A. & Atasayar, A. (2009). Kavram Öğretiminde İçerik Geliştirme Yazarlığı İçin Üstverilerin Belirlenmesi. *International Educational Technology Conference (IETC)*, Ankara, Hacettepe Üniversitesi, 6-8 May 2009.
- Becker, H. (2000). Findings from the Teaching, Learning, and Computing Survey. *Education Policy Analysis Archives*, 8, 51. Retrieved from <http://epaa.asu.edu/ojs/article/view/442>
- Brown, A. L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *Journal of the Learning Sciences*, 2(2), 141 - 178.
- Boot, E. W., van Merriënboer, J. J. G., & Theunissen, N. C. M. (2008). Improving the development of instructional software: Three building-block solutions to interrelate design and production. *Computers in Human Behavior*, 24(3), 1275-1292.
- Churchill, D. (2007). Towards a useful classification of learning objects. *ETR&D-Educational Technology Research and Development*, 55(5), 479-497.
- Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design Experiments in Educational Research. *Educational Researcher*, 32(1), 9-13.
- Cohen, E. B. & Nycz, M. (2006). Learning objects and e-learning: an informing science perspective. *Interdisciplinary Journal of Knowledge and Learning Objects*, 2,(23-34). Available at <http://ijklo.org/Volume2/v2p023-034Cohen32.pdf>
- Di Nitto, E., Mainetti, L., Monga, M., Sbattella, L., & Tedesco, R. (2006). Supporting interoperability and reusability of learning objects: The virtual campus approach. *Educational Technology & Society*, 9(2), 33-50.
- Enkenberg, J. (2001). Instructional design and emerging teaching models in higher education. *Computers in Human Behavior*, 17(5-6), 495-506.
- Fritz, S., King, J. & Boren, A. (2005). Principles of Sustainable Learning Object Libraries. *Interdisciplinary Journal of Knowledge and Learning Objects*, (1).
- Gonzalez-Barbone, V., & Anido-Rifon, L. (2008). Creating the first SCORM object. *Computers & Education*, 51(4), 1634-1647.
- González-Videgaray, M., Hernández-Zamora, G., & del-Río-Martínez, J. H. (2009). Learning objects in theory and practice: A vision from Mexican University teachers. *Computers & Education*, 53(4), 1330-1338.
- Griffiths, J., Stubbs, G., & Watkins, M. (2007). From course notes to granules: A guide to deriving Learning Object components. *Computers in Human Behavior*, 23(6), 2696-2720.
- Güler, Ç., Altun, A., Aşkar, P. (2009). *Developing reusable learning objects: Hacettepe University case*. Paper Presented at the Third International Conference on Internet Technologies and Applications (ITA 09) Conference, 8 - 11 September, Wrexham, North Wales, UK.
- Han, S. & Bhattacharya, K. (2001). Constructionism, Learning by Design, and Project-based Learning. In M. Orey (Eds.), *Emerging perspectives on learning, teaching, and technology* Available from <http://www.coe.uga.edu/epltt/LearningbyDesign.htm>.
- Igbaria, M., Zinatelli, N., Cragg, P. & Cavaye, A. L. M. (1997). Personal computing acceptance factors in small firms: a structure equation model. *MIS Quarterly*, 21(3), 279-306.
- Kremers, M. & van Dissel, H. (2000). ERP system migrations. *Communication of the ACM*, 43(4), 53-56.
- Laverde, A. C., Cifuentes, Y. S., & Rodriguez, H. Y. R. (2007). Toward an instructional design model based on learning objects. *ETR&D-Educational Technology Research and Development*, 55(6), 671-681.
- Mavrommatis, G. (2008). Learning objects and objectives towards automatic learning construction. *European Journal of Operational Research*, 187(3), 1449-1458.
- Shavelson, R. J., Phillips, D. C., Towne, L., & Feuer, M. J. (2003). On the Science of Education Design Studies. *Educational Researcher*, 32(1), 25-28.
- Wang, F. & Hannafin, M. (2004). *Using design-based research in design and research of technology-enhanced learning environments*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.
- Wiley, D. & Edwards, E. (2002). *Online self-organizing social systems: The decentralized future of online learning*. Retrieved February 27, 2008 <http://wiley.ed.usu.edu/docs/ososs.pdf>.
- Wiley, D. (2006). *RIP-ping on learning objects*. Consultado en 01, 15, 2006 en. Retrieved December 2, 2008 from <http://opencontent.org/blog/archives/230>.