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TO INTERACT OR NOT TO INTERACT: WHY STUDENTS PRINT INTERACTIVE INSTRUCTIONAL MULTIMEDIA? PROBLEM OF READING OR REVIEWING?

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ABSTRACT

Interactive digital Learning objects are the core of eLearning systems. Although multimedia learning theory support learning via multimedia. Surprisingly, a significant number of students change interactive learning objects to static printed text. The aim of this study is to find what factor(s) influence changing interactive learning objects to print. To achieve the goal, a survey conducted in Iran University of Science and Technology (IUST) E-Learning Centre. Qualitative content analysis revealed “reviewing problem” as a main theme. To find key factors related to the problem, 169 online learners, voluntary completed an online questionnaire. To analyse quantitative data Educational Data Mining (EDM) were used. Finding from the decision tree and rule induction that conducted by WEKA, confirmed that “problem of reviewing” is the most important factor which interpret student behaviour in printing interactive digital learning objects.

Keywords: multimedia reading; screen reading; learning object; Electronic book; interactive learning.

INTRODUCTION

E-learning technologies are widely integrated into educational systems, especially in higher education and universities. These technologies include, but not limited to Learning Management system (LMS), digital Learning Object (LO), social networks, handheld technologies, simulations and educational games. The main goal of integrating traditional teaching methods with technology enhancements is the improvement of teaching and learning quality in large university courses with many students (Dyckhoff et al. 2012). In developing countries such as Iran, universities are the pioneer in integrating e-learning technologies in their teaching and learning. *Iran University of Science and Technology* (IUST) is one of them that established the e-learning centre in 2005 (Rostaminezhad et al. 2013).

The focus of this study is reusable digital learning object and the problem associated with using this kind of content in Iranian e-learning centre. According to Willy (2007), several terms have been used for reusable electronic learning material such as *knowledge object*, *instructional object*, *sharable content objects (SCO)*, and *resources*. He prefers the Learning Object (LO) term and defines it as “a digital resource that can be reused to mediate learning” (Wiley 2007). Any LOs that develop according to the Advanced Distributed Learning Initiatives are named SCO. Theoretically, multimedia principles extracted from cognitive theory of multimedia learning (mayer 2005) advocates Multimedia LO’s instead of text based LO’s (i.e., e-book) or audio based LO’s (i.e., podcast). In addition to theory, in practices the investigation like Delimont et al. (2016) showed students prefer to use open educational resources (OER) instead of buying textbooks for their courses; more especially in reading and literacy skills empirical studies such as Karemaker et al. (2010) revealed multimedia software

can be more effective than traditional printed texts. Despite the strong theoretical foundations, the use of multimedia in education faces challenges. Learning with multimedia poses new questions and limitations; meta-analyses, reviews and evaluations clearly show, that learning with multimedia is not efficient per se, but depends on numerous moderators like learning strategy, knowledge level, computer experience or method of instruction (Wiemeyer 2001: 42). Mayer (2014), Park et al. (2014) and Leutner (2014) studied Motivational challenges in multimedia learning. The literature showed that some factors like “slow reading speed in monitor”, “quality of resource”, and “accessibility to resource” are main problems associated with digital contents. Stemler (1997) focuses on the reading speed in monitors and reports “People read text on a computer screen at a rate. 28% slower than reading from a book. It is recommended that developers utilize as many screens as needed and not fill individual screens with text information” (Stemler 1997). The finding of Kerr and Symons (2006) confirm this problem that reading from computer take more time; therefore reading from print is more efficient; In addition, the reading rate depends on other factors such as cognitive speed of the reader (Fraser, 2007). Some findings revealed that there is no difference between e-book and print in student retrieval rate (Liang and Huang 2014). The quality of the resources, and the abilities of teachers and students to access and use them are other reported factors by researchers, (Recker et al. 2004).

As mentioned, using SCO LOs from technical view and developing them in multimedia format are supported by multimedia learning theory. Therefore, the IUST e-learning center production group and other universities in Iran develop their content in multimedia format based on SCORM. Accordingly, as a legislation in Ministry of Science, Research and Technology of Iran, to present an online course for each credit, it is necessary to produce 5 hours Multimedia SCOs. Surprisingly, the researchers’ observations indicated that some university students (e-learners) work in reverse and reproduce Multimedia LOs to print format by using print screen technique. After printing and writing narrations in the corner of each page. The findings of this study confirmed observations. As will be reported in findings, 53.8% of IUST e-learners print digital learning objects and study their manuscripts instead of digital format of content. Thus, the main concern and problem of this study is to find the underlying factors which causes the problem of printing multimedia and find the most critical factor that causes this unexpected behavior. To clarify research objective, this study tries to identifying the factors that affect printing multimedia learning objects by e-learners and more especially identifying most important factor among identified factors. Following questions have been studied in this study:

RQ1: From students' point of view, what causes students to print interactive LOs (SCOs)?

RQ2: What is the critical factor which classifies students in the group that print interactive LOs?

METHODOLOGY

In order to answer the research questions, this study applied a mixed-method research design (Creswell, 2004). Study collected both qualitative and quantitative data to address research aims. This study mixed finding of following phases:

Qualitative phase: interviewing IUST e-learners’ opinions to find critical factors related to the problem of changing SCO to print. This interview will reveal context related factors.

Quantitative phase: Cross Industry Standard Process for Data Mining (CRISP-DM) (Shearer, 2000) Used to find the main factor (rule) that explains the problem of changing digital LO’s to print. This popular methodology provides a systematic and structured way of

conducting data mining studies, and hence increasing the likelihood of obtaining accurate and reliable results, (Delen, 2010).

The participants of this study were the students of Iran University of Science and Technology eLearning centre; Therefore, further explanation of the context and the participants is necessary. This university is one of the pioneer of integrating ICT initiative in Iranian higher education. The Learning Management system in IUST eLearning centre is Moodle. Digital learning content developed based on Sharable Content Object Reference Model (SCORM) is used for asynchronous teaching; furthermore, Adobe Connect online classroom technology is used for synchronous teaching.

As this study is about SCORM Based digital learning content it is necessary to explain some more about this kind of content. "SCORM is a collection of standards and specifications for web-based learning. It allows the development of educational content that is flexible to incorporate instructional components in multiple applications and contexts. SCORM defines communication between client and server, and also defines how content may be packaged into a compressed transferable file" (Santos and Figueira 2010: 676). Each SCO in the context of this study contain 5 to 10-minute multimedia sharable content object which uploaded in Moodle LMS.

The participants in qualitative phase are 5 e-learners that selected with purposeful sampling method to participate in an interview session. The data for educational data mining was collected from the electronic questionnaire that was sent to 250 e-learners at IUST e-learning centre. Among those students, 169 contributors (107 male and 62 female) responded to the questionnaire.

After reviewing some basic manuscripts like Friesen's paper entitled "three objections to learning object and e-learning standards" (Friesen 2004), some problems and challenges of using LOs were identified. Five interviews conducted individually by using purposive sampling with semi-structured open ended questions to gather students' opinions about digital learning objects and rations for changing SCOs to print.

Based on the literature and interview, a questionnaire which consisted of 14 items in 5 scale likert type from very low (1) to very high (5) was constructed (Table 2). The content validity of questionnaire confirmed by subject-matter experts in the research area and construct validity measured by exploratory factor analysis. Result of factor analysis revealed instrument explain 54.47% of variance of students openions. . Alpha analysis for reliability revealed that the instrument is reliable ($\alpha=.751$). Questionnaire was sent to 250 students via the LMS message sending panel; of which 196 students completed the questionnaire. Data gathered from the questionnaire was analyzed. To find the main important factor that can classify and distinguishes students who print LOs from those who don't, rule induction and decision tree algorithm from educational data mining models were used by WEKA open source data mining software. This paper select JRIP and Simple Cart algorithm because this two algorithm is very simple to understand, in addition this two algorithms identify the most important critical factor that can learn to clasify student in two groups.

RESULTS

RQ1: From students' point of view, what causes students to print interactive LOs (SCOs)?

In relation to RQ1 some contextual factors extracted from the student interview that were related to Irninan elearning systems. For example a female E-learner proclaimed:

"Maybe some of the students use SCO, but many [students] like me don't. Because of eyestrain and sitting for a long time behind the monitor, I don't use SCOs although I know they are important. In my

opinion, it is better to attach a pamphlet to the [online] course. From my perspective, the pamphlets are more helpful.”

It is obvious from adverbs “some” and “many” in this statement that the SCOs usage rate is low and this phenomenon is a researchable problem. Also, factors like “eyestrain” and “sitting behind the monitor for a long time” are reported as an important factors for preferring pamphlets to multimedia SCOs.

Another male student pointed out that students are more convenient in reviewing courses with printed materials:

If the photo comes with animation, it will help good and fast understanding, but not necessarily always! Because for retention, it is necessary to review and reviewing from the printed text is far much faster and easier [than SCOs]. Therefore, sophisticated SCO with printed documents finalize the work [are enough to understand]. Otherwise, both learning and reviewing encounter their own problems. Furthermore, if the aim is student learning, the best way to save the time and accelerate learning is to provide the possibility of downloading content and online class archives from the beginning of the semester.

Contextually, at the IUST eLearning center to observe copyright, students cannot download SCOs. This problem becomes more severe when accessing to high speed Internet is limited anywhere and anytime.

Another M.S student in the field of informatics confirms the problem of “reviewing multimedia learning objects”:

Digital contents should effectively use the capabilities of the digital world for learning. Effective contents for learning can include animation, illustrations and educational movies that can't be used in a book or printed article. If the elements of digital contents are limited to text and graphs that can be found in books and [printed] articles, it is preferred to read the printed texts; because someone can read printed textbooks anywhere and in any position; in addition, reviewing printed texts can be done in a shorter time.

In addition to problem of reviewing SCOs, this student indirectly refers to the problem of poor artistic and technical quality of the SCOs. This problem is another context related factor that can be obviously seen in the following comment by the female student:

One problem that I encountered in some lessons is that some professors teach in uniform and inexpressive tone; so it is clear that they just reread a specific text. In this condition, animations not only do not help the audience, but also it seems that we are watching a documentary of unknown concepts.

Surprisingly, this student analogizes SCOs to the documentary because of poor design, especially in narrations. The next student adds the problem of downloading and overloading of SCOs:

A big problem is that SCOs can't be downloaded in order to be used anywhere without any need for internet, like a PDF which can be used with our tablets or smart phones. Another problem is that in most courses SCOs are very short and compact, but a high number of them are listed that makes downloading each of SCOs boring.

To finalize the interview report, the comments of the last student show the contrast between teacher-centric nature of Iranian higher education and the learner-centric nature of eLearning system:

In most cases, SCOs are not produced by the professor of the course, so professors don't refer us to the SCOs [SCOs aren't references of the course]. In spite of low course hours, I've read them many times. To review them for the exam, I found their PDFs with great hardship; because the centre [IUST eLearning centre] didn't give them to me and also rewriting them are time consuming. Furthermore, SCOs are too long and it isn't possible to study all things from SCOs. I prefer to study PDFs and the archives of virtual classrooms again and again instead of studying boring SCOs that I should download them for a long time.

According to this student, the SCOs are produced previously by another professor that he/she doesn't teach the course in the current semester. Therefore, the new teacher rejects the pre-recorded SCOs and refers students to other content like textbooks or pamphlets. To summarize, teacher-centric nature of Iranian higher education challenges the reusable feature of SCOs.

In order to analyse the results of before mentioned qualitative data, qualitative content analysis approach that recommended by Graneheim and Lundman (2004) was used. Main theme categories and sub-categories and codes summarized in Table 1. Numbers in parentheses indicated the frequencies of codes in student comments and main theme was selected based on frequencies.

TABLE 1. Theme and categories for printing digital learning objects

Theme	Printing Digital Learning objects because of reviewing problem and seeking for downloadable and printable version to fix problem									
Category	Problem of low use	Doubt in educational value of SCOs versus printed material		Bad instructional Design			Contradiction with Cognitive strategies	Physical harms	solutions	
Sub-category	Frequency of use	Educational value of SCO	Educational value of printed material	Poor quality	Cognitive load problem	The problem of Online streaming	Teacher related problem	Reviewing problem	Eye strain and Prolonged sitting	Suggestion to fix problem
Codes	<ul style="list-style-type: none"> • some of the students use SCO, • many don't use 	<ul style="list-style-type: none"> • I know they are important • it will help good understanding 	<ul style="list-style-type: none"> • reading textbook in shorter time • read printed textbooks anywhere and in any position • no need to computer and Internet • prefer to study PDFs 	<ul style="list-style-type: none"> • problem of limiting SCO to text and graphs (2) • boring SCOs • SCOs uniform and inexpressive tone • SCO's documentary of unknown concepts 	<ul style="list-style-type: none"> • SCOs are too long • high number of LOs 	<ul style="list-style-type: none"> • The problem of downloading SCOs 	<ul style="list-style-type: none"> • producing SCO by another person • SCOs aren't references of the course 	<ul style="list-style-type: none"> • The problem of reviewing in SCO(3) 	<ul style="list-style-type: none"> • Sitting for a long time behind computer • Eye strain 	<ul style="list-style-type: none"> • Attach a printed version(3) • providing the possibility of downloading(3)

As can be seen in Table 1 based on qualitative content analysis the main important factor for printing digital learning objects (SCOs) is the problem of reviewing. To confirm this finding, this research conducted a quantitative study that reported in reminding of this paper.

RQ2: What is the critical factor which classifies students in the group that print interactive LOs?

In response to RQ2, findings from interviews and literature review were extracted in a 5point Likert type questionnaire which presented in Table 2; Then, the questionnaire was administrated in LMS and sent to students. After describing the problem, they were asked:

Do you print SCOs? If yes, based on your experience in studding in IUST e-learning centre, please indicate that to what extent each of following factors influence your decision in print SCOs?

Participants’ response’s mean and standard deviation to in Table 2. Questioner item and Class attribute in Table 3.

TABLE 2. Questioner Item

Item	Mean	Std. Deviation	Location
1. Students’ habit to read books and pamphlets rather than SCOs	3.57	1.11	Input
2. Lower reading speed in SCOs than books and pamphlets	3.55	1.19	Input
3. The high brightness of the monitor causes eyestrain	3.44	1.32	Input
4. The problem of downloading or reading online	3.82	1.23	Input
5. SCO is not portable to read in different situations.	4.33	0.96	Input
6. Lower resolution of digital material than print material.	2.88	1.30	Input
7. Reviewing SCOs is more difficult than pamphlets and books	4.22	1.12	Input
8. Lack of familiarity with the methods and techniques of reading SCO.	2.85	1.39	Input
9. Animated texts and images cause eye strain.	2.26	1.20	Input
10. Poor artistic and technical quality of the SCOs.	2.94	1.22	Input
11. The problem of sitting behind a computer for a long time.	3.78	1.25	Input
12. The problem of overloading in reading SCO.	3.43	1.33	Input
13. Lack of familiarity with setting brightness and resolution of the monitor.	2.02	1.08	Input
14. teachers don’t focus on the SCOs in final exams	3.27	1.34	Input

TABLE 3. Class attribute

	Yes	No	Location
I am a student who prints the SCOs?	91(%53.8)	78(%46.2)	Output(class)

Descriptive statistics indicate that some factors like the “problem of reviewing”, “problem of downloading and reading SCOs in different situations” are the most important factors which makes the students print the SCOs. This research uses educational data mining or machine learning algorithms to answer the RQ2. There are many classification methods in data mining that include, but not limited to associated rule induction, neural networks, support vector machine and decision trees. The data set is the data that was collected through the questionnaire. The input attributes are 14 items of the questionnaire (see Table 2) and the class attribute is a question that was asked at the beginning of the questionnaire. In this question, students answered that whether they change SCOs to print or not? (See Table 3). This study, from decision tree models selected *simple cart* algorithm, and for rule induction models, JRIP algorithm were selected. It is necessary to explain that there are too many algorithms that aren’t the subject of this study. To estimate the performance of those models, 10-fold cross-

validation was used. This approach is proven in data mining studies (Delen 2010). Results of two selected data mining algorithm are reported in Table 4.

TABLE 4. Results from testing data mining algorithm

Algorithm	Rule	Correctly Classified Instances	Mean absolute error
<i>JRIP rules</i>	(reviewing ≤ 4) \Rightarrow SCO=no (89.0/31.0) \Rightarrow SCO =yes (110.0/34.0)	132(66.33%)	0.43
<i>CART Decision Tree</i>	reviewing < 4.5 : No(58.0/31.0) reviewing ≥ 4.5 : Yes(76.0/34.0)	128(64.32)	0.45

It is necessary to explain briefly the content of Table 4; the rule from two algorithms revealed that “the problem of reviewing SCOs” is the main and a critical factor that distinguishes students who print SCOs (yes category) from those who do not (no category). Based on JRIP rule, if the value of “reviewing problem” is equal or less than 4 (equal or less than High on Likert scale), it means that the students won’t change SCOs to print (no class). Also, if the value of “reviewing problem of SCOs” is more than 4 (very high in Likert scale), they will change SCOs to print. The simple cart decision tree algorithm can be interpreted like JRIP one, but it gets the value of 4.5.

Other two columns compare the power of each rule in those two models. It can be seen that the JRIP algorithm rule is better than a CART decision tree because the correctly classified instance of JRIP is more than CART and its mean absolute error is less than CART. To discuss the findings related to data mining phases, it can be said that it confirms the findings of the qualitative phase of this study. In other words, the students who believe that reviewing SCOs are too harder than printed materials they will actually print SCOs. These results will be concluded in the reminding of this paper.

DISCUSSION

Over emphasis on SCORM, which is only a technical standard is the basic problem of developing LOs not only in the IUST E-Learning centre but also in all Iranian eLearning communities. Also, Friesen (2004) criticized LOs because of neglecting pedagogical and instructional design principles. Therefore, to optimize the efectivness of SCOs it is necessary to pay attention to instructional design and technology considerations in developing and implementing SCOs that include, but not limited to considerations such as teaching and learning culture, learning style, teaching style, and habit. However, convincing practitioners and managers to invest in this area is very difficult. The root of this problem is the cultural interpretation of the term “STANDARD” accompanied by SCORM, which is considered anonymous with the term “perfect”.

Teacher-centric nature of instruction in Iran is another problem which severely threat the reusability principle. Each university teacher has his/her own method of teaching. In some cases, the teacher has his/her own book or pamphlet. Therefore, he/she does not accept the method and content of other teachers. In this regard one of the students stated that:

“In my opinion, the reason is that in most cases the previously prepared content does not match new teacher’s presentations and in many cases, the professors state it is not necessary to study SCOs because they are produced by another professor”.

To solve the problem, this student adds that:

“Electronic Content should be updated in accordance to the syllabus of each course. Considering the fact that the reading printed format for final exams is easier and much faster than its electronic version, therefore, their PDF files should be provided for printing. So, the students can refer to audio files [SCO] when he/she faced with a problem in understanding the PDF material”.

Oh et al. (2013) indicate that page-flipping enhances recall memory when it is perceived as natural interaction and induces greater feeling of presence and leads to positive attitudes and finally it creates greater behavioural intention toward the site and the content. Based on this finding, providing page-flipping options will improve the effectiveness of SCO. Possibility of page-flipping in SCOs makes them more similar to book and pamphlet flipping (make it natural).

Personalization technology can improve technology adoption and diminish gender differences in reading an e-book (Huang et al., 2013). In the context of the current study students cannot personalize their content, this may be one assumption for printing SCOs to. Developing content with personalization features can solve this problem and using the personalization features of the LMS can be effective in this regard. Paying attention to students’ learning styles can be an effective way to improve the LOs effectiveness (Mestre 2010). Adopting content delivery system based 13 frequent factor like bandwidth, which presented by Thalmann (2014) will manage the causes related to download problems.

According to Li et al. (2014), annotation map significantly improves reviewing and navigational performance so the problem of reviewing may be managed by adding annotation capabilities to LOs. Meanwhile, according to Jamet (2014) adding visual cues can direct attention to the right areas of the screen at the right time, thereby promoting learning. Digital textbooks instead of stream multimedia is a good solution for students who adopted to textbooks. Furthermore as Fischer et al. (2015) revealed Open Educational Resource (OER) in digital textbook format reduce withdraw rate in some fields.

According to Liu (2005) becoming a digital native can improve the technology acceptance. In the context of this study, university students are aged students that they are not digital natives; so they are not familiar with digital age competencies. Undoubtedly, in developing and also developed countries a significant number of students are not digital natives; therefore, blended learning may be the main solution. Offering courses in print format (self-study textbook) with little electronic LO for juniors and gradually increasing the amount of digital LOs for senior students is a good solution for the problem and highly recommended to instructional designer. Based on findings of Lee, Baek, and Han (2017) it seems this strategy is more necessary for contents which require high cognitive load

Another recommendable solution based on the finding of Jian (2017) is to provide electronic content for students who are readers with good performance, because they spend significantly more reading time on text section and diagram section of reading materials than readers with poor performance. Personalization software can help to eLearning system manager to recognize students reading performance level. Providing downloadable and printable material for student is justified by new finding that revealed longer digital media use led to reduced sleep (Orzech et al. 2016). Based on this finding over emphasize to digital learning media can have a negative effect on student sleeps especially for those who prefer to study at night.

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