Using explanations for Recommender Systems in Learning Design settings to enhance teachers' acceptance and perceived experience

Soultana Karga[1] & Maya Satratzemi[1]

Abstract

The reuse of Learning Designs can bring significant advantages to the educational community such as the diffusion of best teaching practices and the improvement of teaching quality and learning outcomes. Although various tools, including Recommender Systems, have been developed to implement the notion of reusing Learning Designs, their adoption by teachers falls short of expectations. This paper investigates the results of providing explanations for Learning Design recommendations to teachers. To this end, we designed and implemented an explanatory mechanism incorporated into a Recommender System, which propose pre-existing Learning Designs to teachers. We then conducted a user-centric evaluation experiment. Overall, this study provides evidence that explanations should be incorporated into Recommender Systems that propose Learning Designs, as a way of improving the teacher-perceived experience and promoting their wider adoption by teachers. The more teachers accept and adopt Recommender Systems that propose Learning Designs, the more the educational community gains the benefits of reusing Learning Designs.

Keywords: explanations, recommender systems, learning design, technology enhanced learning

[1] Soultana Karga
tania.karga@gmail.com
Maya Satratzemi
maya@uom.edu.gr
[1] Department of Applied Informatics, University of Macedonia, 156 Egnatia Street, GR-54636 Thessaloniki, Greece

1. Introduction

Even until today, the assurance of teaching quality and the improvement of learning outcomes consist the Holy Grail in the e-learning field. This quest has led research to focus on the relatively new sector of Learning Design, since it has the potential to capture and disseminate not only educational content but also the underlying pedagogical approaches in e-learning courses, thus affects positively the quality of both teaching and learning (Beetham & Sharpe, 2007; Conole, 2013; Dalziel et al., 2016; Hernández-Leo et al., 2018; Laurillard, 2012; Lee, 2014; Lockyer, Bennett, Agostinho & Harper, 2009; Maina, Craft & Mor, 2015). The major aim in the Learning Design field is to support teachers to design pedagogically sound e-learning courses, with the recognition that this is a complex task (Agostinho, 2009).

In this context, the idea of reusing Learning Designs has emerged, with the ultimate goal of supporting teachers in the designing process (Bennett, Agostinho & Lockyer, 2005; Wills & McDougall, 2009; Wills & Pegler, 2016). Although various technologies have been already developed so as to implement the notion of reusing Learning Designs, the pace at which these technologies have been adopted by teachers in their daily practice falls short of expectations (Bennett, Agostinho & Lockyer, 2017; Celik & Magoulas, 2016; Hernández-Leo et al., 2018; Hernández-Leo, Chacón, Prieto, Asensio-Pérez & Derntl, 2013; Maina et al., 2015). There are numerous reasons for this, including such obstacles as, reduced usability of the available tools and the fact that the daily teaching processes are rarely incorporated into the available tools. Thus, there remains much to learn on how to enhance the widespread adoption of technologies which permit the reuse of Learning Designs. In this context, it is of interest to examine how the various design characteristics of these technologies affect on the one hand, teachers' experience with them, and on the other how widely teachers accept them.

This paper focuses on Recommender Systems (RSs) as a promising technology in conjunction with explanations as a design feature, to promote the idea of reusing Learning Designs. The present study is organized around the following research questions: (RQ1) Do explanations increase teachers' acceptance of RSs that propose Learning Designs? (RQ2) Do explanations improve the teacher-perceived experience with RSs that propose Learning Designs in terms of (a) decision effectiveness,

(b) decision confidence, (c) perceived system understanding and (d) user control? More specifically, we have designed, implemented and evaluated an explanatory mechanism that has been integrated into an RS, we designed and implemented which exploits pre-existing Learning Designs and proposes to teachers the most suitable of them in a particular application context. This study's major contribution is the proposal to incorporate explanations into RSs that propose Learning Designs, as a way of improving the teacher-perceived experience and promoting their wider adoption by teachers. The importance of this contribution is that it expands the understanding of researchers and developers on how to improve the design of technologies that allow the reuse of Learning Designs, with the ultimate goal of encouraging the wider adoption of these technologies by teachers. As a chain reaction, the educational community as a whole will reap the benefits of reusing Learning Designs.

This paper's structure is as follows: after the Introduction, section 2 overviews the study's background concerning both Learning Design and explanations in RSs. Section 3 introduces the implemented explanatory mechanism, while section 4 presents the experiment conducted and section 5 presents the corresponding results. Section 6 discusses the results, while the implications and limitations of this study are reported in section 7. Lastly, section 8 describes the main conclusions and outlines the future work.

2. Background

The Learning Design term is used throughout this paper, but also in the international literature, to refer both to the design process of learning experiences and to the documented design's outcome (Conole, 2013; Donald, Blake, Girault, Datt & Ramsay, 2009; Koper & Bennett, 2008; Mor & Craft, 2012; Simon, Pulkkinen, Totschnig, & Kozlov, 2011). Paradigms of Learning Designs are presented in Prieto et al. (2013).

It is also important to highlight the difference between the Learning Design and the instructional design domain on which a significant amount of work has been done. The two terms reflect a relatively different philosophy. More specifically, instructional design focuses on the instructional process and systematic planning, coming from a behavioral perspective, whereas Learning Design focuses on the learning process and pedagogically informed decision making, and coming more from constructivist theory (Maina et al., 2015).

It is widely recognized that Learning Design can potentially advance the quality of both teaching and learning outcomes and also bring significant benefits to teachers who adopt the role of learning designer (Beetham & Sharpe, 2007; Conole, 2013; Dalziel et al., 2016; Hernández-Leo et al., 2018; Laurillard, 2012; Lee, 2014; Lockyer et al., 2009; Maina et al., 2015). In particular Learning Design empower teachers to deconstruct their teaching strategies, reflect on them, document and scaffold innovative learning activities and share and reuse teaching practices (Cameron, 2009). Despite the advantages, the widespread integration of Learning Design practices into teachers' daily work remains a challenge (Bennett et al., 2017; Celik & Magoulas, 2016; Hernández-Leo et al., 2018; Hernández-Leo et al., 2013; Maina et al., 2015). One well-documented cause for this is that the Learning Design, as a process, is extremely time-consuming and requires expertise in making decisions on how to use Information and Communication Technologies (ICTs) in order to effectively implement contemporary learning theories (Agostinho, 2009).

Reusing Learning Designs that have been created by colleagues or experts is proposed in the literature as a way of supporting teachers in the arduous task of designing for learning (Hernández-Leo, Harrer, Dodero, Asensio-Pérez, & Burgos, 2007), since it can conserve both time and effort by "providing scaffolding and mentoring for new teachers; becoming a source of inspiration to even experienced teachers, as well as facilitating collaborative review, reflection and evaluation of Learning Designs" according to Cameron and Campbell (2010). Additional advantages are that reusing Learning Designs can facilitate the diffusion of best teaching practices, help teachers feel more confident as designers and eventually improve the quality of teaching and learning (Agostinho, 2009; Agostinho, Bennett, Lockyer, Jones & Harper, 2013; Wills & McDougall, 2009).

In order to put the idea of reusing Learning Designs into implementation, experts in the field have developed a wide range of software tools, such as online repositories, communities, RSs and microworlds (Conole & Culver 2010; Hernández-Leo, Asensio-Pérez, Derntl, Prieto & Chacón, 2014; author/s, masked; Verbert et al., 2012). For example, the Learning Designer environment is a microworld that allows teachers to create and share Learning Designs (Laurillard et al., 2013). The

Learning Designer environment integrates an RS which proposes pre-existing Learning Designs, taking into consideration the features (e.g. aims of the Learning Design) that are best matched in particular application contexts.

Despite the wide range of available tools, their adoption by teachers remains low. Field specialists are in agreement that there is a need for more research on ways to encourage teachers to adopt these tools (Bennett et al., 2017; Celik & Magoulas, 2016; Hernández-Leo et al., 2018). Ways that have been suggested in the literature to increase the acceptance of these tools are to investigate usability and their design characteristics (Celik & Magoulas, 2016). Our work is a contribution to this particular research area, since we suggest the use of explanations as an innovative design element of RSs that propose Learning Designs, in order to both improve teachers' experience and make teachers accept them. The incentive for focusing our work on explanations came from teachers themselves. It appears that in teachers' daily practice, an important source of design ideas is through the informal channels of discussion, suggestion and explanation exchanges with other colleagues (Bennett et al., 2011). Furthermore, another reason for focusing on explanations was that according to Bennett et al. (2017) teachers are more likely to adopt Learning Design tools if they are connected to their existing practices.

2.1. Explanations in Recommender Systems

RSs recommend items to users that are likely to match their interests (Resnick & Varian, 1997). Explanations in RSs can be defined as descriptive features which make the qualities of the recommended item easier for the user to understand, thus facilitating the decision whether or not it is relevant to him/her (Tintarev & Masthoff, 2012).

Several different goals for providing explanations in RSs have been identified in the literature, which include, revealing how the system works, helping users to make good decisions, as well as being able to make those decisions faster, and convincing users to try or buy (Gedikli, Jannach, & Ge, 2014; Tintarev & Masthoff, 2011; Tintarev & Masthoff, 2015). According to the milestone study by Herlocker, Konstan and Riedl (2000), the most important reason to incorporate explanations in RSs was that it greatly enhanced their acceptance. This finding triggered our investigation into whether or not explanations can also enhance the acceptance of RSs which propose Learning Designs.

According to Quijano-Sanchez et al. (2017) and Tintarev and Masthoff (2011), explanations can be classified on the basis of their style that depends on the underlying algorithm by which they are computed. Examples of explanation styles might include: collaborative, content or demographic. A novel hybrid style of explanations combines different sources of information (e.g. rating data in combination with content data) in order to generate explanations (Kouki, Schaffer, Pujara, O'Donovan & Getoor, 2017). Regarding the explanation interfaces, several have been proposed in the literature such as tag-cloud interfaces (Gedikli et al., 2014), sentiment bars and explanatory texts (Muhammad, Lawlor & Smyth, 2016).

Reviewing the literature on studies that evaluate user-perceived experience of incorporating explanations into RSs, revealed that much work has been devoted to this in various application areas, such as entertainment, e-commerce and tourism. One of the first projects which inspired much of the subsequent work in the field of explanations for recommendations has been written by Herlocker et al. (2000). Herlocker et al. (2000) conducted a study with 210 participants, who were asked to interact with the MovieLens web-based RS and answer online questionnaires. The results showed that improving user-acceptance of collaborative filtering RSs is one of the greatest benefits for consolidating explanations for recommendations. Another important finding reported by Herlocker et al. (2000) in a pilot study through interviews with some of the users of the MovieLens web-based RS, was that explanations influence the user's perceived understanding of the system.

Another important study was conducted by Cramer et al. 2008 in order to evaluate the user-perceived experience of incorporating explanations into RSs that suggest art items. Sixty (60) participants were recruited and asked to interact with the proposed system. The study instruments were task observation, interviews, usage log files and an online questionnaire. The results of the analysis showed that the proposed explanation mechanism: (a) increases user-perceived and actual understanding of the RS, (b) has no effect on user-perceived competence of the RS, (c) has no effect on intention to use the RS; however, it increases user acceptance of the recommendations, and (d) has no effect on user trust in the RS.

In their related study Gedikli et al. (2014) examined the following possible factors affected when explanations were incorporated into RSs: (a) reduce the time and/or the cognitive effort needed by users to make a decision (efficiency), (b) convince users to accept or decline certain recommended items (persuasiveness), (c) help users to understand why a particular recommendation is made (transparency), and (d) change the users' perceived quality of recommendations and explanations (satisfaction). Overall, 105 participants were asked to interact with a movie RS in which different explanation interfaces had been incorporated. In order to measure efficiency, Gedikli et al. (2014) used the mean time needed by users to submit their ratings after an explanation was displayed to them. For persuasiveness the mean difference of users' explanation-based ratings and users' extensive information-based ratings were used. For transparency and satisfaction users were asked to rate these factors on a scale of one to seven. The analysis showed that explanations have the potential to positively influence all the aforementioned factors.

Chen and Wang (2017) evaluated explanations for RSs in e-commerce settings regarding some aspects of users' subjective perception with the proposed system through two studies with a total of 94 participants. The study instruments were questionnaires and user log files. The results showed that the proposed explanation mechanism has the potential to increase: (a) decision effectiveness: refers to users' product knowledge and preference certainty, (b) perceived system competence and trustworthiness: refers to perceived information usefulness, recommendation transparency and quality, and (c) behavioral intention: refers to purchase intention. Chen and Wang (2017) also argued that using explanations can increase the confidence of users in the decisions they make.

In their study on explanations, incorporated into an RS that proposed hotels to its users, Muhammad et al. (2016) argued that using explanations can help users to make more informed decisions. The results, with 181 participants demonstrated high user satisfaction with the proposed explanation mechanism in terms of explanation clarity and utility, which were rated directly by the users on a scale of 1 to 10. Symeonidis, Nanopoulos, and Manolopoulos (2008) also conducted an online survey, on 42 students, whose objective was to assess user satisfaction from the explanations that accompanied movie recommendations. The participants were asked to directly rate the provided explanations on a scale of one to five. The results showed the high user satisfaction in the proposed explanation mechanism. The researchers supposed but did not confirm that user satisfaction in explanations leads to increased user acceptance of the RS. Lastly, O'Donovan, Smyth, Gretarsson, Bostandjiev, and Höllerer (2008) conducted a study in order to assess the effects of incorporating explanations into movie recommendations on user-perceived understanding of the RS and user satisfaction. Twenty-five (25) participants were asked to fill out a pre and post study questionnaire, the results of which showed that explanations can enhance both user-perceived understanding of the RS and user satisfaction.

In spite of the above, much less work has been done on explanations in Technology Enhanced Learning (TEL) settings. The most relevant work is that of Santos and Boticario (2011) who proposed a theoretical recommendation model for guiding learners in personalized inclusive scenarios within existing e-learning platforms. The proposed model provides, inter alia, explanations to learners on why the recommendations were delivered. The researchers acknowledge the important role of explanations in educational RSs and highlight the potential for improving user satisfaction and increasing user trust in the system. Additionally, the study by Muñoz, Penalba and Sánchez (2016) has demonstrated the positive attitude of teachers towards explanations for RSs in TEL settings. More specifically, Muñoz et al. (2016) implemented an RS that recommends to teachers solutions on ICT problems, based on teachers' ICT profile. The proposed RS was evaluated by 17 teachers regarding its usability. Interestingly, the majority of the teachers requested explanations about the recommendations. Following the review of the related literature, we can state that there is a gap regarding the research of explanations' application in TEL settings and especially in the sub-field of Learning Design.

From the literature review, it can be concluded that there is no agreement on a common set of evaluation variables used in studies on explanations for RSs in various application areas. Furthermore, no consensus seems to have been established regarding the terms used to essentially express the same concepts. For instance, some researchers used the term 'transparency' while others used the word 'understanding' to refer to the same factor. Furthermore, some researchers appear to use the terms 'satisfaction' and 'behavioural intention' as being equivalent to 'acceptance'. In choosing the evaluation variables for the present study, we based our decision on covering the range of variables that have already been used in relevant work, from the most common to the rarest. Table 1 depicts the evaluation variables used in our study, as well as in which related studies these variables were used, or researchers have made reference to. It must be mentioned that although in our study 'perceived competence' was not used as a standalone variable, it was incorporated into another variable on which more information is given in the materials section. Furthermore, even though the variable 'sense of user control' is not present in other related research, our decision to include it was based on the grounds that a series of studies demonstrated that allowing users more control is an important factor when evaluating RSs (McNee, Lam, Konstan & Riedl, 2003; Pu, Faltings, Chen, Zhang & Viappiani, 2011; Yoo & Gretzel, 2011).

Table 1
Evaluation variables used in studies on explanations for RSs in various application areas

Reference	Acceptance of the RS	Decision effectiveness	Decision confidence	Perceived system understanding	Control sense
(author/s, masked)	√	√	√	√	√
(Chen & Wang, 2017)	√	√	√	√	
(Cramer et al., 2008)	√			√	
(Gedikli, Jannach & Ge, 2014)	√	√		√	
(Herlocker, Konstan & Riedl, 2000)	√			√	
(Muhammad, Lawlor & Smyth, 2016)	√	√			
(O'Donovan, Smyth, Gretarsson, Bostandjiev & Höllerer, 2008)	√			√	
(Santos & Boticario, 2011)	√				

(Symeonidis, Nanopoulos & Manolopoulos, 2008)	√

Although it is evident from the above that explanations have been successfully applied to diverse domains, bringing significant benefits, such as an increase in the acceptance of RSs and the improvement of user experience, the application of explanations in TEL settings is still in its infancy. These findings motivated us to explore whether the incorporation of explanations into RSs that propose Learning Designs can improve teacher-perceived experience and acceptance of them. Until now, this particular research area has not been investigated.

3. The Implemented Explanation Facility

The implemented explanation facility was incorporated into a hybrid RS, which we designed and implemented. The major aim of the proposed RS is to recommend the most suitable pre-existing Learning Designs to teachers. Each recommended Learning Design can lead to a new one after teacher intervention, which saves teachers the trouble of having to author Learning Designs from scratch. It is worth adding here that the proposed RS has been integrated into LAMS (Dalziel, 2003). LAMS is a widespread Learning Design tool that supports designers to create, manage and deliver Learning Designs. The “Start authoring” option in the implemented interface (see Fig. 1), enables teachers to ask for Learning Design recommendations. The proposed RS has been thoroughly presented in our previous work (author/s, masked). The description of the operation of the proposed RS is out of the purposes of the current paper.

Fig. 1 The RS interface

For each Learning Design in the recommendation list, the RS provides explanations to teachers. The adopted explanation style was based on content data in combination with rating data (hybrid style) taking into consideration that several surveys have suggested that this combination leads to more valuable explanations in terms of effectiveness and user satisfaction (Gedikli et al., 2014; Jin, Zhou & Mobasher, 2005; Salter & Antonopoulos, 2006; Symeonidis et al., 2008).

The rating data were gathered directly by asking teachers to rate the proposed Learning Designs by applying a 5-star system. A piece of text was included as explanations concerning the community rating score for the proposed Learning Design.

The content data were derived from the Learning Designs in the form of the following features, which derived both from the MISA and the Dialog Plus projects (Paquette, Teja & Lundgren-Cayrol, 2006; Conole & Fill, 2005):

- the subject domain to which the Learning Design is related,
- the cognitive level of the students to whom the Learning Design is addressed (e.g. Introductory, Intermediate, Advanced, Not assessed),
- the evaluation model that may be Diagnostic (is generally conducted before teaching takes place to identify the learners' strengths and weaknesses so as to adapt the teaching process), Formative (is generally conducted during the learning process so as to adapt future activities according to results) or Summative (takes place after learning has been completed to assess the learning outcome),
- the delivery model that is used for delivering the Learning Design (e.g. Synchronous and Asynchronous), and
- the approximate time that is needed for the Learning Design to be executed by learners.

Each feature of the proposed Learning Design was associated with an explanatory text that demonstrates how the proposed Learning Design corresponds to the teacher's preferences. The leveraging of item features in order to make up explanations is well-known in related work (Chen & Wang, 2017; Gedikli et al., 2014; Muhammad et al., 2016). At this point we should note that the techniques that were used to extract the features for each Learning Design were presented in detail in our previous work (author/s, masked).

The implemented explanatory interface was based on textual presentations. Explanations consisted of a set of natural language sentences, an example of which is shown in Fig. 2. The textual interface design was selected based on the following findings in the literature:

- According to Pu and Chen (2006), users prefer detailed sentences for high-risk recommended items. In the case of Learning Designs we assume that they are high-risk items for teachers because they can affect the quality of their teaching and thus their professional profile. This assumption is consistent with ICOPER's (Interoperable Content for Performance in a Competency-driven Society) confirmation that Learning Designs can facilitate learning and also can be used for documenting, sharing and analysing quality controlled teaching practice (Simon et al., 2011).

- In regard to what users prefer, whether textual or graphical presentation, there are findings indicating that users did not have a clear preference (Tintarev, 2010).
- According to related work, there were some cases where explanations which included texts in natural language gained advantage compared to other interfaces (Muhammad et al., 2016).

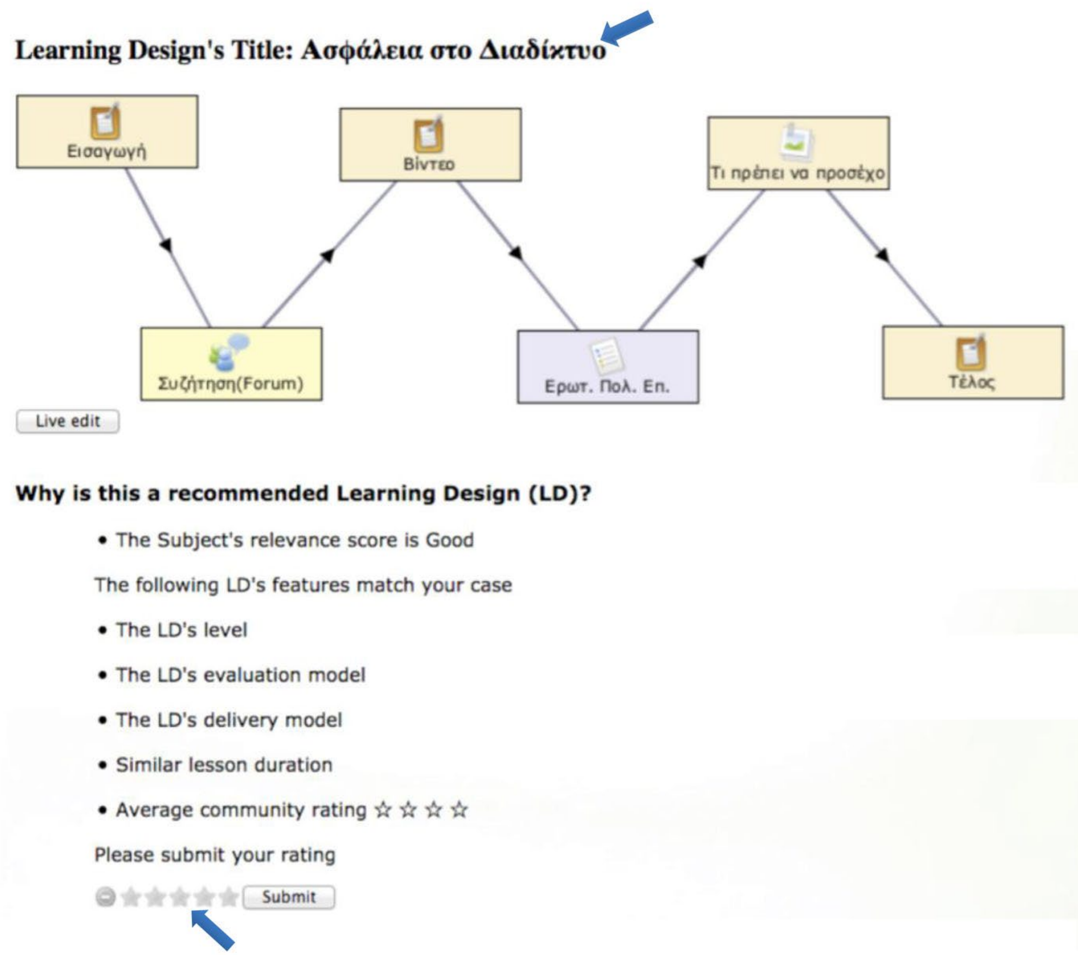

Fig. 2 The implemented explanatory interface

4. Method

4.1. Participants

62 teachers (19 males and 43 females) took part in the study voluntarily. The majority were in the age categories of 31-35 and 36-40 (77.4%). The participants were recruited from the two following sources:

- an electronic announcement on the notice board of the Greek Educators LAMS community (http://blogs.sch.gr/groups/lams/) which asked the members of the community to contact the researchers should they wish to participate in the study, and
- an email invitation that was sent to randomly selected users of the LAMS service of the Greek School Network (http://lams.sch.gr/lams/) which asked the recipients to reply should they wish to participate in the study. We chose to send the email because the site does not have a noticeboard. The LAMS service enables teachers in the public education system to create Learning Designs.

It should be noted that the above sources were selected after taking into consideration that the implemented explanatory facility had been integrated into the LAMS environment, as well as in order to rule out participants who may need training in the basics of LAMS.

The investigators consistently reminded and motivated participants to follow all the steps of the study procedure whenever it was deemed necessary. Thus, there were no dropouts and no participant had to be excluded from the analysis.

Teachers' demographic characteristics are presented in Table 2.

Table 2
Demographic characteristics of teachers

Variable	Total	Control Group	Experimental Group
Gender			
Female	69.4%	71%	67.7%
Male	30.6%	29%	32.3%
Age			
31-35	43.5%	45.2%	41.9%
36-40	33.9%	32.3%	35.5%

41-45	6.5%	3.2%	9.7%
46-50	3.2%	-	6.5%
>51	12.9%	19.4%	6.5%
Academic Discipline			
Formal sciences (i.e. informatics, mathematics etc)	82.3%	80.6%	83.9%
Humanities & Social sciences (i.e. pedagogy, philosophy etc)	11.3%	12.9%	9.7%
Natural sciences (i.e. physics, chemistry etc)	3.2%	6.5%	-
Other sciences	3.2%	-	6.5%
Teaching level			
Elementary	8.1%	-	16.1%
Secondary	53.2%	80.6%	25.8%
Higher	16.1%	3.2%	29%
Lifelong learning	17.7%	16.1%	19.4%
Other	4.8%	-	9.7%
Experience in LAMS			
Minimal	17.7%	25.8%	9.7%
Limited	19.4%	19.4%	19.4%
Basic	11.3%	16.1%	6.5%
Moderate	33.9%	19.4%	48.4%
Extensive	17.7%	19.4%	16.1%

4.2. Materials

The research instrument was an online questionnaire consisting of two parts: (a) measuring the dependent variables and (b) measuring the demographic variables of the teachers.

The questions used for measuring the dependent variables are presented in Table 3. According to Cronbach's alpha results the questions that measure a dependent variable were highly related and could be unified to one scale (see Table 3). Moreover, the scales were stable given that the factor loadings that resulted from a principal component factor analysis were high (see Table 3). Additionally, the scales were not longer than six items conforming with the recommendations of (Hinkin, Tracey & Enz, 1997). All the questions were Likert scale, ranged from 1 which means strongly disagree to 5 which means strongly agree.

The first part of the questionnaire explores user acceptance of the RS. To this end, six questions - Q1 to Q6 (see Table 3) - were adopted from the ResQue model, an evaluation framework that assesses users' attitudes towards and acceptance of an RS (Pu & Chen, 2011). The four-layer structure of the ResQue model is as follows: (a) perceived system qualities: refers to user opinion on the RS's objective characteristics, (b) user beliefs: refers to user perception on the interaction with the

RS, (c) user attitudes: refers to the user's overall feeling about the RS, and (d) behavioural intentions: refers to user acceptance of the RS, as well as the agreement to use it in the future. Each layer has a positive influence on the following one, which means that the perceived quality layer has positive effects on user beliefs, which in turn positively affects users' attitudes, and as the chain reaction continues, will have a positive impact on users' behavioral intentions. Questions 1 and 2 come from the perceived quality layer, Q3 comes from the beliefs layer, Q4 is from the attitudes layer, and Q5 and Q6 come from the behavioral intentions layer. The selection of Q1 to Q6 was made so that all the ResQue layers were represented, as according to the theoretical foundation of the ResQue model, all layers affect user acceptance of the RS. It is worth noting that Q1 can assess user-perceived competence of the RS, since according to (Cramer et al., 2008) competence refers to the RS's ability to suggest the right recommendation to its users.

The second part of the questionnaire assesses the decision effectiveness variable. To accomplish this goal questions 7 and 8 (see Table 3) were used. Q7 is from the ResQue model perceived quality layer and in particular from the information sufficiency dimension, which according to the ResQue model can be used to assess the capability of an RS to help users in making a decision. Q8 was designed by the authors in order to further investigate decision effectiveness, in regards to the time needed by the participant to make a decision.

The third part of the questionnaire evaluates the decision confidence variable by using two questions - Q9 and Q10 (see Table 3). Q9 question was adapted from the ResQue model attitudes layer and in particular from the confidence-trust dimension which according to the model can measure the RS's ability to convince users of the recommended items. Q10 was designed by the authors in order to further ascertain user confidence. The fourth section of the questionnaire includes questions Q11 and Q12 (see Table 3), which assess the perceived system understanding variable. Both these questions come from the ResQue model belief layer and in particular from the transparency dimension, which according to the model can help users to understand the RS's inner logic. The last part of the questionnaire includes Q13 and Q14 (see Table 3), which measure user control sense. Both questions come from the ResQue model belief layer and in particular from the control dimension, which according to the model can evaluate if users felt in control while interacting with the RS.

As Pu and Chen (2011) point out, the ResQue model was developed on the basis of the main principles of the well-known models TAM and SUMI, which have been widely used to evaluate usability and acceptance of software products (Weller, 2004; Wills & McDougall, 2009). For instance, the ResQue model has incorporated the original constructs of TAM as follows: (a) TAM's construct of the system's perceived ease of use and perceived usefulness have been incorporated into ResQue's beliefs layer, (b) TAM's construct of users' intention to use the system has been incorporated into ResQue's behavioral intentions layer. Similarly, some constructs from the SUMI model, such as learnability, have been incorporated into ResQue's beliefs layer.

Table 3
List of questionnaire items, Factor loadings and Cronbach's alpha values

Scale/Questions	Factor loading	Cronbach alpha
Acceptance of the RS		.856
(Q1) The Learning Designs recommended to me matched my interests	.593	
(Q2) I liked the RS's interface	.772	
(Q3) I became familiar with the RS very quickly	.740	
(Q4) Overall, I am satisfied with the RS	.858	
(Q5) I would use the RS again	.823	
(Q6) I would recommend the RS to a friend/colleague	.863	
Decision effectiveness		.739
(Q7) The information provided for the recommended items was sufficient for me to make a decision	.891	
(Q8) Finding a Learning Design to rely on for creating my own was less time consuming with the help of the RS than without it	.891	
Decision confidence		.754
(Q9) The RS made me feel confident about the Learning Design finally created	.911	
(Q10) The RS helped me find a worthy Learning Design to rely on to create my own	.911	
Perceived system understanding		.816
(Q11) I understood why the Learning Designs were recommended to me	.920	
(Q12) The RS helped me understand why the items were recommended to me	.920	
User control sense		.760
(Q13) I felt in control of telling the recommender what I want	.898	
(Q14) I felt in control to alter the outcome of the recommended items due to my preference changes	.898	

4.3. Design and Procedure

A single factor between-subjects design was implemented. Participants were blindly assigned to one of the groups: control (N1=31) or experimental (N2=31). The between-subjects design was chosen in order to minimize the participant fatigue-effects, taking into consideration that shorter sessions are less tiring and more appropriate for remote participants. In conjunction to this, exposure to only one condition means that participants can remain more unbiased and it minimizes carryover effects. The independent variable was the explanations. The dependent variables were as follows:

- acceptance of the proposed RS: refers to the user's intention to apply the proposed RS,
- decision effectiveness: measures the extent to which the user feels assisted in making informed decisions within a limited time,
- decision confidence: deals with how confident the user feels in decision making,
- perceived system understanding: refers to the user's perception of how well they understood the logic behind the recommendations, and
- user control sense: measures whether the user feels in control in their interaction with the proposed RS.

The teacher experience variables (i.e. decision effectiveness, decision confidence, perceived system understanding and user control sense) were inspired from related works and we have argued about them in the background section.

The study was conducted by comparing two conditions: (a) explanations provided: each recommended Learning Design was accompanied by explanations of the rationale behind the recommendation (experimental group), and (b) explanations not provided: no explanation facility was offered (control group). We expected the teachers in the experimental group to have significantly higher scores in, on the one hand, the acceptance of the proposed RS, and on the other, in the user experience variables (i.e. decision effectiveness, decision confidence, perceived system understanding and user control sense) in comparison to the control group.

The evaluation procedure was as follows: after an individual had responded to the initial invitation, they received an email regarding the method of research implementation and the terms of participation with which they should agree in order to be able to proceed to the next stage, which involved participants watching a short video tutorial about the use of the RS. The video tutorial was available online throughout the procedure. Next, each participant had to login to a LAMS installation where the RS was incorporated, and through interaction with the RS, create a Learning Design on the topic of Internet Safety. In order to create the Learning Design, with the use of the RS, the participants had to follow the steps below (see Fig. 1): (a) use the RS's tab, (b) select the "Start authoring" option, (c) fill in the preference form, (d) click on the "Get the recommendations" button, (e) inspect the recommendation list before deciding which Learning Design to select for adaptation, and (f) adapt the selected Learning Design. Before and after the implementation of the aforementioned structured scenario, participants were free to interact with the system (i.e. to ask for recommendations, edit recommended Learning Designs, rate the recommendations, etc) without any time limit. Moreover, there was no constraint concerning the maximum number of created Learning Designs or the number of Learning Designs that were rated. The minimum number of created Learning Designs required was one. At the end, participants should complete the aforementioned online questionnaire.

The database of items was filled with Learning Designs from the Greek LAMS repository of Learning Designs available under the license "Attribution, NonCommercial-ShareAlike, https://creativecommons.org/licenses/by-nc-sa/2.0/ at http://lamscommunity.org/lamscentral/?language=el".

The described procedure was applied on teachers in both groups, with the difference being that the recommended Learning Designs were accompanied by explanations for the experimental group.

4.4. Data Analysis

The Mann-Whitney analysis was chosen based on the small sample sizes (N1=N2=31) and the fact that the parameters had non-normal distribution in either the experimental or control group according to Shapiro-Wilk's tests ($p<0.05$). The statistical software used was SPSS version 23.0.

5. Results

The following sections report the findings of the current study based on the methodology outlined above. Table 4 presents descriptive statistics for all the questionnaire items, while Table 5 summarizes in advance the Mann-Whitney test results for the dependent variables.

Table 4
Descriptive Statistics on questionnaire items

	Control group (Valid N=31)		Experimental group (Valid N=31)	
Question	Mean	SD	Mean	SD
Q1	4.00	0.365	4.48	0.508
Q2	4.26	0.773	4.84	0.374
Q3	4.58	0.502	4.97	0.180
Q4	4.45	0.506	4.84	0.374
Q5	4.68	0.475	4.94	0.250
Q6	4.68	0.475	4.90	0.301
Q7	3.97	0.547	4.65	0.486
Q8	4.35	0.661	4.81	0.402
Q9	4.35	0.608	4.45	0.506
Q10	4.00	1.033	4.55	0.506
Q11	4.06	0.442	4.84	0.374
Q12	4.03	0.180	4.97	0.180
Q13	4.06	0.727	4.71	0.461
Q14	3.97	0.657	4.68	0.475

Table 5
Mann-Whitney test results for the dependent variables

Dependent Variable	Group	N	Mean Rank	U	Z	p (two-tailed)
Acceptance of the proposed RS	Experimental	31	41.45	172.000	-4.453	0.00
	Control	31	21.55			
Decision effectiveness	Experimental	31	40.79	192.500	-4.259	0.00
	Control	31	22.21			
Decision confidence	Experimental	31	34.92	374.500	-1.557	0.122
	Control	31	28.08			
Perceived system understanding	Experimental	31	46.18	25.500	-6.948	0.00
	Control	31	16.82			
User control sense	Experimental	31	41.35	175.000	-4.482	0.00
	Control	31	21.65			

5.1. Results of explanations on acceptance of the RS (RQ1)

Based on the Mann-Whitney U test results the teachers in the experimental group (Mean=28.97, SD=1.566) reported having significantly higher scores ($p<0.01$) in the acceptance of the RS than those in the control group (Mean=26.65, SD=5.837). This finding shows that providing explanations for the recommended Learning Designs to teachers increases their acceptance of the RS.

5.2. Results of explanations on teacher-perceived experience (RQ2)

5.2.1. Decision effectiveness (RQ2a)

The Mann-Whitney U test indicated that the scores in decision effectiveness were significantly higher ($p<0.01$) for the experimental group (Mean=9.45, SD=0.523) than for the control group (Mean=8.32, SD=1.159). This illustrates that providing explanations for the recommended Learning Designs assists teachers in making informed decisions on which Learning Design to select within a limited span of time.

5.2.2. Decision confidence (RQ2b)

Contrary to our assumption, the provision of explanations for the recommended Learning Designs has not been confirmed to have an impact on teachers' confidence on their decisions. The Mann-Whitney U test shown that there was no difference at the 0.05 significance level between the teachers of the two groups ($p=0.122$).

5.2.3. Perceived system understanding (RQ2c)

Based on the Mann-Whitney U test results the teachers in the experimental group (Mean=9.81, SD=0.161) reported having significantly higher ($p<0.01$) scores in perceived system understanding than those in the control group (Mean=8.10, SD=0.290). This indicates that providing explanations for the recommended Learning Designs facilitates teachers' understanding of the RS.

5.2.4. User control sense (RQ2d)

Based on the Mann-Whitney U test results the teachers in the experimental group (Mean=9.39, SD=0.645) reported having significantly higher scores ($p<0.01$) on the user control sense than teachers in the control group (Mean=8.03, SD=1.432). This finding shows that providing teachers with explanations for the recommended Learning Designs strengthens their sense of control of the RS.

6. Discussion

According to the findings of this study, an explanation facility incorporated into an RS that proposes Learning Designs can increase teacher acceptance of this RS (RQ1). This is coherent with previous studies results in the areas of entertainment, e-commerce and art application (Cramer et al., 2008; Gedikli et al., 2014; Herlocker et al., 2000; Symeonidis et al., 2008). Moreover, our findings indicate that an explanation facility incorporated into an RS that proposes Learning Designs can improve teacher-perceived experience in terms of decision effectiveness (RQ2a), and perceived system understanding (RQ2c). This is confirmed by prior studies, such as Chen and Wang (2017) and Muhammad et al. (2016) who also found that explanations help RSs users to make informed decisions in the areas of entertainment, e-commerce and tourism application. Moreover, Gedikli et al. (2014) found that explanations can reduce the time needed by users in making decisions. Lastly, Herlocker et al. (2000), Chen and Wang (2017), Gedikli et al. (2014) and O'Donovan et al. (2008) also stated that explanations could make an RS more understandable in the areas of entertainment and e-commerce application, while Cramer et al. (2008) confirmed this finding for the area of art application. Regarding the new-entry variable of user control, this study indicates that explanations can also improve the sense of user control (RQ2d) which, however, needs to be further validated by more studies.

In contrast to earlier findings by Chen and Wang (2017), whose study suggests that explanations can increase the confidence of users in the decisions they make, we found no such evidence (RQ2b). It may be that the different application areas affect the discrepancy in the results between the studies. Chen and Wang (2017) focused on explanations for RSs in e-commerce settings for recommendation of cameras and laptops. User knowledge about the recommended items should be taken into consideration in the interpretation of the results. It seems logical to make the assumption that the less knowledge users have about the recommended items, the less confident they will be in their decisions and as a consequence would more easily be persuaded by the explanations and thus feel more confident. In the case of Chen and Wang (2017), users' may have had little or no knowledge about cameras and laptops, so they may have been more naïve. Contrarily, in our study, teachers have professional knowledge about the recommended items, so it may be more difficult to use explanations as a means of increasing their confidence. Another reason for the discrepant results may be differences in the implemented explanatory interfaces. Chen and Wang (2017) implemented the category explanations in natural language, divided into pros and cons, whereas in our study, although the explanatory interface was also based on natural language, the explanations were not divided in any particular manner.

Lastly, the reasons why we decided to assess each evaluation variable by adopting questions proposed by the well-known ResQue model are presented. This decision was largely based on the need to adopt user-centric evaluation frameworks in the context of Technology Enhanced Learning as they have been shown to better appraise user perceptions of RSs, which is very important if we take into account that the ultimate goal of each RS is to satisfy its users (Erdt, Fernandez, & Rensing, 2015; Fazeli et al., 2017). According to McNee, Riedl, and Konstan (2006), asking users themselves is the best way to assess user-perceived experience. Furthermore, a significant factor which we took into consideration on making our decision was that in the literature review in the Explanations of Recommender Systems section, it was made clear that there was a wide variety of ways to measure the evaluation variables – even the same ones – in the relevant studies. For example, for the variable user acceptance of the RSs, some researchers asked participants to rate it directly (Symeonidis et al., 2008), others used relevant questions (Herlocker et al., 2000), while others still, implemented usage log files (Cramer et al., 2008). This means that there was no strict direction, or constraint for that matter, on how to measure the evaluation variables used in both our and related studies.

7. Implications and Limitations

The findings of this study have several implications. Specifically, we suggest that teachers' acceptance and perceived experience of RSs that propose Learning Designs can be increased with the use of explanations. Therefore, the researchers and developers in the Learning Design field should consider incorporating explanation facilities in the RSs they design and develop for teachers. The more teachers accept and adopt RSs that propose Learning Designs, the more the educational community gains the benefits of reusing Learning Designs. Moreover, the positive results of this study pave the way for additional research in the field.

Regarding the limitations of this study, the sample size is not large but this is common in similar user studies over the years, as has been mentioned in the literature (Erdt et al., 2015). Erdt et al. (2015) ascertained that the median of participants in 65 user studies published between 2000 and 2014 in the evaluation of TEL RSs was 25. Furthermore, it is critical to highlight that the findings of this study depend on the implemented explanatory interface. This limitation is also apparent in related works. For instance, Gedikli et al. (2014) among others, conclude that different explanatory interfaces lead to different effects on users regard on the efficiency and persuasiveness of the explanations.

8. Conclusion

Supporting the broader adoption of Learning Design technologies is a critical factor for helping the educational community to gain the significant benefits of the field. This paper focused on the Learning Design technologies that permit the reuse of Learning Designs and in particular on RSs that propose pre-existing Learning Designs. The subject of the study was to investigate if explanations, as a design element of these RSs, can lead not only to enhancing teachers' experience, but also to teachers adopting them broadly. To this end, a user-centric evaluation experiment was conducted (N=62).

The paper concludes by arguing that providing explanations in the context of an RS that proposes Learning Designs can increase teachers' acceptance and improve their experience in the following ways. It can: help teachers in the decision-making process as to which Learning Design to select within a limited time, make the RS more understandable to teachers, and make teachers feel more in control in their interaction with the RS. The findings, however, did not provide sufficient evidence to conclude that explanations can help teachers make more confident decisions.

The findings of this study, add new knowledge to the field that expands researchers and developers understanding on how to improve the design of technologies that enable Learning Designs to be reused, so as to both encourage teachers' acceptance of them and enhance teachers' experience. This knowledge can contribute to the development of more acceptable Learning Design tools, which is a major achievement for the educational community, as it is assumed that the widespread adoption of Learning Design tools by teachers can lead to a wide range of significant benefits, including the improvement of teaching quality and learning outcomes.

Future research in long-term authentic usage of the presented explanation facility is needed to further develop and confirm the initial findings of this study. In this context, the collection of qualitative data would be also valuable in supporting the findings about the usefulness of the recommendations. Additionally, the effects of different explanatory interfaces on the results of this study should be investigated in the future. It might be also helpful to learn what teachers consider to be a good explanation for Learning Design and what is not.

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