Personalised Learning Design in Moodle

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Abstract— **In this paper, we explore the affordances of learning management systems like Moodle for the learning design of personalized courses. To this end, results from an empirical study with thirty-eight (38) student-teachers attending a postgraduate course on technology enhanced distance learning, are presented. Initially students used a dedicated Learning Design tool to design personalized courses and then they implemented them in Moodle. Various data sources have been analyzed such as courses created by the students, students' perceptions on the learning design experience and a self-assessment TPACK questionnaire. The results provide evidence about the potential of the proposed approach in cultivating students' ability in efficiently integrating technology and personalization in e-learning. Finally, strengths of Learning Design tools and Moodle in supporting the design of personalized courses as well as future goals for their development are discussed.**

Personalisation; Learning design; Moodle; Virtual learning environments

I. INTRODUCTION

Virtual learning environments (VLEs) that enable real class processes are widely used in online or blended learning contexts for administering courses, developing and distributing course content and allowing communication among students and teachers while overcoming time and place boundaries. Contemporary VLEs like Moodle [7] or LAMS [6] allow the design of activity-based content, providing a variety of tools such as activity tools, resource tools, collaboration and grouping tools. Course design decision making in such VLEs, is a demanding process requiring high levels of pedagogical & technological expertise [15].

Aiming to explore the potential of VLEs for personalized learning, we have been experimenting with several environments, such as LAMS and INSPIRE*us* [24]. Positive evidence indicating the added value of authoring personalized courses in these VLEs has emerged from this research at various teacher education contexts [23][26]. Following up these positive results, in this paper, we extend our research on exploring the cultivation of learning design skills while developing personalized courses in Moodle. In particular, we explore the appropriateness and adequacy of the tools/features provided by Moodle for implementing adaptive courses based on learner individual differences as sources of personalization. To this end, we analyze the courses that student-teachers developed at a postgraduate teacher education course on technology enhanced distance learning as well as their perceptions on the knowledge that they developed as regards TPACK (Technological Pedagogical Content Knowledge) [17].

II. PERSONALISATION DESIGN & LEARNING MANAGEMENT SYSTEMS

Learning design (LD) is considered as a valued professional activity in the teaching profession [2][15]. Consequently, recent approaches adopted in teacher education courses on technology enhanced learning (TEL) highlight the role of student-teachers as active designers focusing on cultivating design skills through appropriate frameworks and tools as well as on building a sense of community [15]. Various tools/environments are currently available to support different aspects of the LD process [4][5]. Specialized LD environments like Learning Design, ILDE, PeerLAND, aim at prompting teachers to think about the structure, the activities, the context while designing courses. Some of these LD environments provide support for the design of courses (learning designs) based on specific pedagogical principles like Conversational Framework [15] for the Learning Design tool [16] or collaborative learning for ILDE [11] or New Learning [13] for PeerLAND [25]. In these environments personalization is still a challenge [28]. Currently it can be approached through the grouping tools taking into account that students are organised in groups of common characteristics where each group undertakes different activities like in ILDE.

On the other hand, learning managements systems (LMS) provide the environment for the implementation of learning designs and most of them have features for supporting personalization. Research in the area of LMS focuses either on the use of LMS for personalisation or on the development of extra tools as add on functionalities [3][14][21][26]. Moodle is one of the most commonly used LMS. Personalisation inside a Moodle course, can be implemented using restrictions of access at the level of every single activity or resource. The restrictions can be based on the user profile, the student grades, the group or grouping that a student belongs to or the completion of other activities in the course. Additionally, complex restrictions can be implemented combining the above constraints. Another feature of Moodle which may support personalization is the lesson activity. The lesson activity is a set of HTML pages that can contain multimedia learning

content. The pages can contain close ended questions. Each student may follow a personalized navigation path through the pages of a lesson activity, depending on his/her answers to these questions. The AdaptiveLesson module [18] has been developed as an extension of the Lesson Module, in order to facilitate teachers in the creation of adaptive lessons based on learning styles. In [14], adaptation of the Moodle theme and blocks has been implemented according to the student learning style following the Felder and Silverman model. LAMS is an open-source LMS for the design, management, and delivery of online lessons that take the form of sequences of learning activities. LAMS has been used for designing personalized courses in a few cases [20][21][26]. In [26], student-teachers used LAMS in various ways in order to develop personalised courses and elaborate on issues such as the source of adaptation, the adaptation method and the adaptability opportunities offered in their designs. Improvements on LAMS have also been proposed to facilitate the authoring process, personalization, and to further support learner control. In [23], the value of authoring personalized courses in the adaptive educational hypermedia system INSPIRE*us* is discussed for cultivating knowledge on learning design, personalisation and distance learning. Students successfully faced several issues about the content nature, structure, form of presentation, interactivity, student individual characteristics, and finally developed courses that effectively combine technology, pedagogy, and content. Compared to LMS like Moodle or LAMS, INSPIRE*us* is an adaptive learning environment where personalization is inherent in the authoring environment providing structure in the design process towards personalization [1]. In our effort to explore further the integration of learning design in teacher education and specifically the affordances of LMS like Moodle for the implementation of personalised courses, in this research, we address the following questions: (1) Research Question 1 (RQ1): *How can personalized courses be implemented in Moodle based on learners' individual characteristics?* (2) Research Question 2 (RQ2): *How useful is the design of personalized courses using LD environments before their implementation in Moodle?*

III. EMPIRICAL STUDY

In this section we present an empirical study investigating the integration of Moodle in learning design tasks in a teacher education context. Moodle was used by thirty-eight (38) student-teachers attending a postgraduate course on technology enhanced distance learning at the National and Kapodistrian University of Athens in four subsequent academic years starting from 2016 until 2019. Students coming from various disciplinary areas such as Greek Philology, English Literature, Computer Science, Engineering, Physics and Mathematics, intended to follow a teaching career (student-teachers from now on). The students had a limited prior knowledge on learners'

individual differences and they were naïve in adaptive learning environments and personalization.

The course was organized based on the main design principles of the framework for constructivist pre-service teacher education on TEL proposed in [22], promoting active and gradual involvement in TEL design, focusing on the cultivation of synthetic knowledge domains of TPACK. TPACK has been extensively used as a lens to the complex, synthetic fields of knowledge needed by teachers in order to integrate content, pedagogy and technology in the educational praxis: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

During these four academic years, the course was organized in the same way. In the first three weeks, the participants are introduced to the main concepts of distance learning, current trends in web-based learning, adaptive learning environments and educational frameworks that could support the design of distance or blended learning courses. Afterwards, throughout the following eight weeks, the participants are acquainted with LD environments & Moodle working at the same time in groups to carry out a LD project as the main course assignment.

The LD project is structured in four phases. In the *first phase*, the participants collaboratively (in groups of two or three) develop a learning design for personalized e-learning taking into account the learners' individual characteristics using Learning Designer or ILDE or PeerLAND. Although various characteristics are discussed about their impact on learning, learning styles usually dominate the students' designs. The topic of the project may focus on one discipline or, ideally, be interdisciplinary. In the *second phase*, students participate in a peer review activity using the workshop activity of Moodle in order to provide as well as receive peer feedback on their designs and redesign them if needed. In the *third phase*, they have to implement the learning design as a course in Moodle. Finally, in the *fourth phase* students participate in a second peer review activity to evaluate the implementation of the designs in Moodle. In both reviews (of the design and implementation), the TPACK framework is used as the theoretical basis for the evaluation criteria adopted.

At the end of the LD project, student-teachers fill in (a) an on-line questionnaire about the LD experience, (b) the TPACK questionnaire [27] addressing teachers' self-assessment on the seven knowledge domains of TPACK which has been adapted to include the particular technologies introduced in the course.

IV. DATA COLLECTION & ANALYSIS

The data collected and analyzed was a) the student-teachers' courses implemented in Moodle (18 courses in total), b) their perceptions about issues arisen, when they implemented their design in Moodle, collected through the LD questionnaire (fulfilled by 29 student teachers), c) the

scores on the TPACK questionnaire (fulfilled by 30 student teachers).

Data analysis was organized as follows.

<u>Step 1</u>. In order to explore the ways in which adaptation was introduced in the courses (RQ1), we conducted an analysis of the personalized courses and their documentation concerning (a) the learner characteristics used as sources of adaptation, (b) the adaptation approach adopted i.e. the course characteristics differentiated according to the learner profile as well as the adaptability features offered, and (c) the Moodle tools used for implementing adaptation.

<u>Step 2</u>. In order to assess students' perceptions about issues arisen when they implemented their designs in Moodle (RQ2), we set two open questions in the LD questionnaire concerning the usefulness of the process and the difficulties they faced: (1) "Reflecting on the implementation of your learning design to Moodle, how do you think the design process in the LD tool enhanced the implementation?" and (2) "Reflecting on the implementation of your learning design in Moodle which difficulties did you face?". Students' responses to these questions were analyzed and categorized based on the frequency of appearance.

<u>Step 3.</u> In order to assess the teacher-students' knowledge developed through the course (RQ2), we analyzed their TPACK scores.

V. RESULTS

RQ1: How can personalized courses be implemented in Moodle based on learners' individual characteristics?

Aiming to provide evidence about the Moodle potential in implementing personalized courses, we analyzed the courses developed by student-teachers in three dimensions: (1) regarding the learner characteristics used as a *source of* course *adaptation*, (2) the *adaptation methods* adopted, and (3) the *Moodle tools/features* used by students in order to implement adaptation.

In all the courses analyzed, learning style was the main *source of adaptation.* Various models of learning styles have been adopted. Particularly in five courses, adaptation was based on Honey and Mumford [12], in three courses on Kolb, in five courses on Felder and Silverman [8] and in four on VARK categorization [9]. Only in one course, adaptation was based on a combination of the Kolb learning style model and the knowledge level. The course authors prompted their students to assess their learning style using the relevant questionnaires. In the course that adaptation was based on knowledge level, the learners were asked to fulfill a moodle quiz. Depending on the score, the learners were characterized as novice or experts leading accordingly the content adaptation process.

As far as the *adaptation methods* adopted, two main strategies were observed: a) adaptation of the content presentation and b) content adaptation. In particular, in cases that personalization was based on the Honey and Mumford, the Kolb and the Felder and Silverman models, the adaptation of the content presentation was mainly adopted

whereas in courses that adopted the VARK learning style categorization, the content adaptation method was adopted for each type of the VARK model.

Table 1 summarizes the adaptation approaches adopted in the teacher-students' designs. More specifically, the courses in which the Honey and Mumford model was adopted as a source of adaptation, personalization was based on content sequencing. For example, the course suggests to pragmatists to start with active experimentation while to theorists with studying theory. The courses using the Kolb model adopted a similar approach, as assimilators, convergers, accomodators and divergers have access to the same learning material but in a different sequencing. The learning material in all cases appeared gradually.

Almost all the designs that adopted the Felder and Silverman model (with one exception explained below) considered only the *sequential/global* dimension of the model. Learners that were characterized as *global* (in their profile) had access to all the available learning material. On the other hand, access to only one resource or activity per time was given to learners characterized as *sequential,* whilst the rest of the material appeared gradually, one by one. Only one course of those that adopted the Felder and Silverman model, uses as source of adaptation all the four dimensions of the model, resulting in sixteen different learning profiles. In this course, adaptation was implemented, sometimes by content sequencing and others by adapting the content. Finally, both adaptation methods of content adaptation and content presentation were also adopted in the course that used as sources of adaptation both learning style (Kolb model) and knowledge level.

TABLE 1. ADAPTATION APPROACHES

Source of adaptation	Adaptation methods			No of courses
	Content presentation		Content adaptation	
	Content Sequencing	Gradual appearance		
Honey & Mumford	YES	YES	-	5
Kolb	YES	YES	-	3
Felder & Silverman 1 dimension	-	YES	-	4
Felder & Silverman 4 dimensions	-	YES	YES	1
VARK	-	-	YES	4
Kolb & Knowledge Level	YES	YES	YES	1

Adaptability features have been provided in almost all the courses as the adaptation was usually based on the user profile fields which could be edited by the teacher-students themselves. Only in two courses the students' learning style was automatically estimated by a Moodle quiz and in this case no adaptability options have been provided to the users.

The *Moodle functionalities* used by the student-teachers to implement personalization were mainly the *restriction access* and *activity completion features*. In order students to implement adaptation of content presentation, a common

approach was the use of complex restrictions based on the user profile and the activity completion option. Learners had to update their profile with a value indicating their learning style. In these cases, learners were promoted to find and fulfil the relative questionnaire i.e. the Kolb or the Honey & Mumford or the Felder and Silverman questionnaire, in order to identify their style. Automated identification of learning style was implemented in two courses, using the quiz tool. Learners had to fulfill a learning style quiz (developed by the student- teachers) before undertaking the activities of the course. The restrictions in these courses were based on the quiz score instead of the student profile.

The access restriction feature of Moodle was very efficient in the case of the content adaptation method and mainly when the VARK model was adopted. Various types of content were available, but learners could access only the content suitable for their style. The implementation of the gradual appearance of the learning content for learners with the sequential learning style of Felder and Silverman was implemented by the *activity completion feature*: new material appeared once the current resource or activity was completed.

On the contrary, the restriction access feature could not fully support the implementation of content sequencing in cases of the Honey and Mumford or the Kolb learning styles. In these courses, the type of content appearing to learners entering the course, depends on their learning style. Once the first resource or activity is marked as complete, the next resource or activity appears. However, although content sequencing is efficiently controlled by the restrictions, the final order of the resource/activity appearance on the course page is always the same for all the learning styles.

RQ2: How useful is the design of personalized courses using LD environments before their implementation in Moodle?

Aiming to get feedback from student-teachers about their experience in designing personalized courses and implementing them in Moodle, we analyzed their answers to the open ended questions concerning their experience in designing a course in the LD tool and implementing it in Moodle. Twenty-nine (29) out of the thirty-eight students-teachers answered these questions. The majority of them (17) acknowledged that the learning design process in the LD tool helped them to put all their ideas in a frame and structure the course. Six (6) of them consider that the LD tool helped in getting an overview of the course and facilitated them to continuously improve it during the development process. Interestingly enough is the comment of three (3) student-teachers who remarked that the learning design process helped them to think on the personalization of the course.

Among the difficulties encountered was the mapping of specific features of the design to the Moodle course using the particular tools (resources and activities) provided (7 student teachers) as well as the metadata of each activity. For example, although in the LD tool, student- teachers had to define the duration of each activity or the role of the teacher in the activity, then they couldn't map this information in Moodle (4 students). Two students found that the implementation of the complex restrictions for the personalization was a time consuming process.

Evidence about the potential of the proposed approach preceding course design in a LD tool to implementation in Moodle, is provided by the high levels of TPACK knowledge developed by the student-teachers. In Table 2, the TPACK mean scores appear per knowledge dimension. All means are above 4.0 with the highest score of TPACK that reflects the synthesis of the three dimensions i.e. technology, pedagogy and content knowledge, being 4.22.

TABLE 2. DESCRIPTIVE STATISTICS

	N	Minimum	Maximum	Mean	Std. Deviation
TK	30	3,20	5,00	4,2117	,52665
CK	30	2,80	5,00	4,1533	,60727
PK	30	3,18	5,00	4,0797	,54284
TCK	30	3,00	5,00	4,1917	,57866
TPK	30	3,00	5,00	4,1600	,65685
TPACK	30	3,00	5,00	4,2200	,54419
Valid N	30				

VI. CONCLUSIONS

In this study we examine how personalized courses can be implemented in Moodle and how student-teachers can be supported to design and implement such courses. Promoting student-teachers to design a course using appropriate LD tools before implementing it in Moodle can certainly improve the final products. Nonetheless, the personalized courses developed in this study used learning style as the main source of personalization. Although a controversy on the value of learning styles exists, their impact on the design of adaptive learning environments is still under investigation [1][10][18][19]. In the future we intend to confront these results to the appropriateness of LD environments and Moodle to design and implement personalized courses based on other sources such as context variables.

The analysis of the courses provided evidence about the ability of student-teachers to design and implement personalized courses in Moodle adopting a variety of adaptation approaches. They also seemed to feel satisfied from the knowledge they developed through the course based on their high scores to all the dimensions of TPACK. This is quite important taking into account the diversity of their background. The Moodle feature mostly used, was the access restriction constrains which efficiently supported various adaptation methods. Only the content sequencing approach couldn't be appropriately implemented in Moodle since the order of resource/activity appearance on the course page could not be altered based on the learning style of the

learner. To this end, a more adequate tool or add on is needed.

Finally, student-teachers acknowledged the usefulness of a learning design phase prior to the course implementation in Moodle. They stress the fact that the learning design process helps to structure the course and put all their ideas in a frame. However, they would prefer a more direct approach in reflecting the metadata of the course activities designed in the LD tool to the course implemented in Moodle as well as more support (by the LD tool) in the design of the various aspects of the course personalization process.

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