How Authoring Content for Personalised Learning may Cultivate Learning Design Skills?

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Abstract—In this paper we investigate how authoring content for personalized learning may cultivate learning design skills. Especially, we initially present the authoring environment of INSPIREus focusing on the flexibility it offers in designing learning scenarios. Then learning scenarios developed for INSPIREus by the students of an MSc course at the University of Athens reflecting alternative pedagogical design approaches, are presented and discussed. Students through the authoring process had to deal with issues about the content nature, structure, form of presentation, interactivity, personalization, and finally develop artifacts that effectively combine technology, pedagogy, and content. Although authoring is a quite demanding process, its added value was acknowledged by the students and reflected to the increase of the possibilities of reusing the system as indicated through the SUS questionnaires they submitted before and after the authoring process.

Keywords—content authoring; adaptive learning environments; learning design; personalised learning

I. INTRODUCTION

A main challenge in teacher education on the effective integration of digital technologies in the educational process is their engagement in the learning design process [1] [2]. In this paper we approach content authoring from the user-teacher or trainee-teacher perspective investigating how this process may cultivate e-learning design skills enabling teachers to develop engaging and effective learning settings enhanced with technology. A main issue when designing authoring content is that although educational theory has advanced the practice of more constructivist and authentic approaches to e-learning, many technology-supports and authoring environments promote the use of more conventional, structured and linear approaches [1]. On the other hand teachers are looking for theoretical and practical guidance in the design of effective e-learning strategies and activities.

Lately we experiment with several e-learning design environments, such as LAMS and INSPIREus on how learners use them in order to author content. We also explore how we could organize this type of activity to make it happen in a constructive manner promoting reflection, collaboration, and discourse [3]. In this paper we discuss the results of a study on how the authoring process of personalized content through INSPIREus may cultivate learning design skills allowing teachers to experiment with pedagogical and technological issues underlying learning design. Moreover we explore how the content authoring process affects the possibility of reusing a learning environment.

II. CONTENT AUTHORING IN INSPIREUS

INSPIREus is the latest version of INSPIRE, extended with collaborative functionalities and a flexible authoring process allowing learners to act as content authors and reflect their pedagogical perspective on the designs they produce. At the same time the system organizes the authoring process around a hypermedia structure under specific pedagogical principles -e.g. need to structure the content based on a particular learning theory or a taxonomy of learning outcomes, to design assessment, to develop content for a variety of student profiles- assuring that through this process the users (even naïve ones) will deal with main issues of learning design and will produce pedagogically and technologically sound artifacts. Content modules can be combined in educational material pages according to the learning design prototype proposed by the system or created by the content author. Authors are allowed to select or create a learning design prototype according to the learning theory they adopt or just reflecting their pedagogical perspective and proposing specific categories of educational material pages comprised of specific modules. They are also allowed to propose an adaptation algorithm for each content page category inspired by learners’ individual characteristics.

INSPIREus supports authors to use the authoring cycle as a conceptual framework for thinking about the structure and content of the domain knowledge as well as the way this will be delivered to the student. Authors are provided with a design approach for building a hypermedia perspective of the domain taking into account learners’ needs and preferences. To this end, INSPIREus provides several tools and forms that support authors through the different stages of creating content for an AEH system [4] [5] and especially for (a) structuring the domain model and the hyperspace, based on a learning design prototype, (b) propose an adaptation algorithm that matches learners’ varying needs and styles.

For example, in Figure 1 the structure of the concept ‘The multiple selection structure’ of the ‘The multiple forms of selection structure’ scenario, is illustrated. This
structure is based on the learning design prototype of ‘New Learning’ [6]. According to this prototype the educational content of the scenario is organised around specific page categories that correspond to various knowledge processes based on the conceptualization of ‘New Learning’. This framework introduces eight ‘knowledge processes’ (i.e. forms of action inspiring various types of activities) each one representing a different way of making knowledge [6]: (i) Experiencing the known (drawing on learners prior knowledge and experience) and the new (introducing learners to new experiences from learner’s perspective), (ii) Conceptualizing by naming (identifying new concepts/ideas/themes as a first step toward understanding) or with theory (generalizing and synthesing concepts by linking them together, making sense of how they contribute to the whole), (iii) Analyzing functionally (examining the function or rationale of knowledge, action, an object or represented meaning) or critically (interrogating human purposes, intentions, thinking about who benefits/loses), (iv) Applying appropriately (acting upon knowledge in an expected, predictable or typical way based on what has been taught) or creatively (doing things in interesting way by taking knowledge and capabilities from one setting and adapting them to a different setting).

Accordingly authors may also propose the structure of each page category for different student profiles, resulting to an adaptation algorithm.

III. EMPIRICAL STUDY

Thirteen postgraduate students, enrolled in a semester-long course on distance learning at the University of Athens at the academic year 2012-2013, participated in this study. They following a particular collaboration script in order to author content for INSPIREus, participating in individual and collaborative tasks.

A. Method

Students worked individually and in groups undertaking multiple roles. They initially worked as learners studying a particular learning scenario through INSPIREus. Then they worked as domain experts developing educational content, proposing a particular learning design and an adaptation algorithm. In particular, students’ work organised in two phases as follows.

1st Phase: Students work as learners (duration: two weeks). Initially, students worked as learners on a specific learning scenario delivered through INSPIREus. They were organized in four groups. Each group worked with a particular scenario. The members of each group had to work (a) individually all the activities, exercises, examples, questions of the scenario, and (b) collaboratively in specific group activities of the scenario. At the end, each group had to present the design principles of their scenario and how these were reflected in INSPIREus e.g. through the structure and content of the scenario, the digital tools/resources involved, as well as to comment on the best practices they identify in the scenario and issues that need improvement. At the end of this phase the students completed the System Usability Scale (SUS) [7], and particularly the Greek version of the questionnaire [8], that reflects the possibility of reusing the system.

2nd Phase: Students work as content authors (duration: two months). At this phase students had to work in groups in order to develop their own learning scenario for a topic of their choice. They had to select two or three main concepts that they considered important for their scenario, propose a learning design prototype as well as an adaptation algorithm, and finally author the learning scenario to INSPIREus. Especially they had to propose an adaptation algorithm based on specific learner individual characteristics of their choice. Appropriate resources were
given to students. In this process, the members of each group had to undertake the following three specific roles:

- **Distance learning expert**: responsible for developing content for distance learning (writing, interface design, content of high interactivity enhanced with simulations, Web 2.0 tools/objects, video, tools of INSPIREus),
- **Learning design expert**: responsible for the content structure and the design of various content page categories based on the theory of ‘New Learning’,
- **Personalization expert**: responsible for the selection of learners’ individual characteristics important for learning, as well as for the adaptation algorithm of the content pages based on these characteristics.

At the end of this phase students had to submit a documentation about their design decisions in which each student had to argument about their contribution to the whole product based on their role. They also completed an evaluation questionnaire about their learning experience as content authors, as well as the SUS questionnaire reflecting the possibility to reuse the system.

### B. Data Collection and Analysis

The data that was collected and analyzed were students’ learning scenarios with their documentation, questionnaires evaluating the content authoring experience, and the SUS questionnaires before and after the content authoring process. Data analysis was organized as follows.

Step 1. Initially we analyzed students’ learning scenarios and their documentation based on three dimensions, corresponding to the roles of the members of each group, learning design, personalization, and distance learning principles adopted. The aim was to assess the skills that students developed through the content authoring process.

Step 2. In order to assess students’ perceptions about the usefulness of the content authoring process we developed the Likert-like questionnaire of Table I, consisted of 10 items that were rated on a 0 (very much) to 4 (not at all) response scale. Students’ responses to this questionnaire were analyzed for each student and then average values were calculated for each group.

<table>
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<th>TABLE I. QUESTIONNAIRE EVALUATING STUDENTS’ PERCEPTIONS ABOUT THE AUTHORING PROCESS OF PERSONALISED CONTENT</th>
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<td><strong>The content authoring process ...</strong></td>
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Step 3. Our aim was to check if students’ perceptions about the system change while working with INSPIREus as authors. To this end, students’ responses to the SUS questionnaire, before and after the content authoring process were calculated and compared. SUS is a 10 item questionnaire with 5 response options, with a weighted scoring range of 0–100 and which has been shown to be a reliable measure of usability with a small sample (8 to 12 users) and fairly confident as an assessment tool of how people see a system [9]. Bangor, Kortum, and Miller [10] have also shown it to be applicable over a wide range of systems and types of technology.

### C. Results

**Students’ learning scenarios.** Students were organized in four groups, three groups of three students and one of four students. The scenarios they developed were of various subjects such as Mediterranean nutrition, discriminations in society, participatory educational techniques, and natural protected areas. We briefly present below the design approaches adopted in each scenario, based on the study of the scenarios’ content and their documentation.

The first project was about Mediterranean nutrition. The authors proposed a learning design prototype that maps all the four knowledge processes to content pages, resulting to four page categories that correspond to experiencing, conceptualizing, analyzing, and applying. The pages comprise of various content modules depending, in most cases, on the knowledge process they support. The authors use the ‘New Learning’ theory in order to argument about the sequencing of the pages in each concept, starting from experiencing then going to conceptualizing, then to analyzing and finally to applying, crossing the cycle in a sequential order. They adopt the learning style categorization of Kolb as the theoretical background for the adaptation algorithm. Actually, the adaptation algorithm that guides the ordering of the knowledge modules on each page category is the one proposed by the system (‘by default’). However, the authors in the documentation of the scenario, use the various characteristics of each learning style in order to argument about the design of the modules and their sequencing in each page, focusing on the first module and mapping the knowledge process of the page to the specific learning style characteristics. They also try to link specific page categories and knowledge processes to each style, e.g., accommodators to applying, assimilators to conceptualizing, exploring interrelations among both theories/approaches.

The second project was about discriminations in society like ethnic, sexual, disability. The learning design prototype
proposed by this group, combines more than one knowledge processes to each content page category. Especially they proposed three categories of pages focusing on experiencing (the known and the new), analyzing-conceptualizing, and applying (appropriately and creatively). By developing the prototype, students elaborate on the contents and outcomes of each page. The adaptation algorithm that they proposed uses as source of adaptation the cognitive styles proposed by Allinson and Hayes and particularly the two dimensions of intuition and analysis. The authors used the characteristics of both styles for determining the ordering of the content modules on each page category resulting to specific strategies for analytic and intuitive learners.

The third project was about participatory educational techniques. The learning design prototype proposed mixed knowledge processes to each content page category. Especially they proposed three page categories focusing on experiencing-conceptualising, experiencing-conceptualising -analyzing-applying, analyzing. The adaptation algorithm they proposed uses as source of adaptation the cognitive styles proposed by Hermann. This categorization is inspired by the four main quadrants of mental activity, proposing four styles: theorists-rational/logical, organizers/safe-keeping, humanitarians/the feeling self, Innovators/the experimental self. In the documentation of the scenario, the authors seem to acknowledge the added value of styles for designing teaching “…it is worthwhile and effective while teaching a new concept to address all the four styles in order to exploit students’ abilities”.

The fourth project was about natural protected areas. The learning design prototype proposed mixed knowledge processes to each content page category. Especially this group proposed three categories of pages focusing on experiencing (the known and the new)-conceptualising by naming, analyzing-conceptualizing by theory, applying (appropriately and creatively)-experiencing the known. The adaptation algorithm they proposed uses also as a source of adaptation the cognitive styles proposed by Hermann. Especially this group was inspired by the style characteristics on the development of the content in addition to the ordering of the modules within each page category. The following comment of the authors indicates how styles influenced the content development process ‘the engagement of learners with artistic texts of Kazantzakis through the scenario aims at appealing to their feelings’ or “the ‘analyzing’ page for the humanitarians start with activities that include music as this style is stimulated by music and is very emotional”.

In Table II, the decisions that students took through the content authoring process are summarized.

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<th>TABLE II. STUDENTS’ DECISIONS THROUGH THE CONTENT AUTHORING PROCESS</th>
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- **Learning Design decisions:** design the content structure which was organized around various categories of pages that comprise of specific modules based on a learning theory/teaching approach
  
  Stimulated reflection/argumentation about
  - the proposal of specific categories of pages comprised of specific modules (e.g., example, theory, question, activity) based on the various knowledge processes that need to be cultivated
  - the structure of the content at page level i.e., the sequencing of the pages across the concepts
  - the scope/outcomes of content pages
  - the assessment procedure

- **Personalization decisions:** design page presentation focusing on the ordering of the modules for the various learning/cognitive styles
  
  Stimulated reflection/argumentation about
  - the learners’ individual characteristics to be accommodated in the content
  - the design of the content modules to accommodate the various style characteristics
  - the mapping of style characteristics to modules’ ordering in each page

- **Distance Learning decisions:** design content that will be delivered through the web, enhance content with visual aids, appropriate guides, objects that promote interactivity
  
  Stimulated reflection/argumentation about
  - time schedule issues
  - study aids/guides: include outcomes, self-assessment questions with appropriate feedback, resources, and recapitulation possibilities
  - interface design: use of graphical annotation to underline important issues, use of multimedia
  - interactivity issues: use of digital tools such as web 2.0 tools/objects and authoring system tools

**Students’ perceptions about the authoring process.**
Analyzing students’ answers to the questionnaire about the authoring process, and calculating the average values of the 4 groups on each question, we distinguish those answers having more than 3 as average value (see Figure 2). Thus, we notice that students believe that the content authoring process for INSPIREUs promotes the development of interactive content that engage students in activities (see Figure 2, Q1, Average: 3.2), links theory with practice (see Figure 2, Q2, average: 3.2), promotes the development of content enhanced with multimedia (see Figure 2, Q3, Average: 3.7), promotes multiple representations enhanced design (see Figure 2, Q6, Average: 3.5).
Students agree that the content authoring process promotes authors/learners to elaborate on the domain knowledge concepts (see Figure 2, Q7, Average: 3). It is also interesting to annotate students’ reflections on the type of content they actually developed, as they acknowledge that the modularity of content that was imposed by INSPIREus promoted the development of content that cultivates experimentation and inquiry (see Figure 2, Q9, Average: 3) instead of highly theoretically content (see Figure 2, Q8, Average: 1.3). Lastly, most students did not acknowledge the influence of their own style in the content authoring process (see Figure 2, Q10, Average: 1.8) although 4 out of 13 students remarked that their style had a serious impact on the nature of the content they developed. However, even these students positively comment on the importance of group work for content authoring that can eliminate such influences as well as of the need to develop various types of modules such as examples, questions, exercises, activities.

**Usability Issues.** SUS score interpretation is usually based on data from over 5000 users across 500 different evaluations [10]. The average SUS score from all 500 studies is a 68. Thus, a SUS score above a 68 is considered above average and anything below 68 is below average. As far as the SUS results are concerned, we notice in Table III that in most cases (apart from two students’ that their SUS score has been slightly decreased) students’ SUS scores were increased after having developed content for INSPIREus.

**TABLE III. SUS RESULTS BEFORE (SUS_LEARNERS) AND AFTER (SUS_AUTHORS) THE CONTENT AUTHORING PROCESS**

<table>
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<tr>
<th>A/A</th>
<th>SUS_Learners</th>
<th>SUS_Authors</th>
<th>Score Difference</th>
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<tbody>
<tr>
<td>1</td>
<td>75</td>
<td>70</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>42.5</td>
<td>47.5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td>75</td>
<td>30</td>
</tr>
</tbody>
</table>

The correlation coefficient \( r \) between SUS_Learners and SUS_Authors is 0.62. Thus, as expected through the first phase, students just got familiar with the system, and this experience was useful to the second phase, after which they seem to acknowledge the system e-learning potential. Although the data are limited, this provides evidence about how working with INSPIREus as an author may add value to the system positively influencing students’ perceptions about the system and increasing the possibilities of reusing it in the future.

**IV. CONCLUSIONS**

In this study we investigate how training on learning design may happen in a constructive and authentic context through the process of authoring content for an adaptive learning environment. A main limitation of the study was the small number of participants. Considering this as a pilot study, we tried to explore alternative approaches adopted in the content authoring process from three perspectives, learning design, personalization, and distance learning. Actually, students managed to experiment with and finally combine several digital technologies under a pedagogical umbrella. Through this process they had to deal with issues about the content nature, structure, form of presentation, interactivity, student individual characteristics, and finally develop artifacts that effectively combine technology, pedagogy, and content. Although authoring is a quite demanding process [5], its added value was acknowledged by the students and this was also reflected to the increase of the possibilities of reusing the system as indicated through the SUS questionnaires.

**ACKNOWLEDGMENT**

We wish to thank the students who participated in this study. We also acknowledge the assistance of A. Nikolopoulos and K. Garganis for their contribution to the estimation of the SUS scores.

The research “Design, Implementation and Evaluation of Blended Learning Scenarios in a Teacher Training Context Accommodating their Individual Psychological Characteristics (BleSTePsy)” is implemented through the Operational Program “Education and Lifelong Learning” and is co-financed by the European Union (European Social Fund) and Greek national funds.
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