DIGITAL DOCUMENTATION AND PLANNING OF STUDENT PROJECTS IN ENGINEERING AND PRODUCT DESIGN USING E-PORTFOLIOS

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ABSTRACT

The use of e-portfolios is very rare among academic teaching on engineering design and product design especially in Germany. Written exams and reports are not always suitable to evaluate competencies and skills of students gained through such projects. A wide range of competencies is required and a variety of results (sketches, 3D-CAD-models, real prototypes, user feedback, etc.) are generated, that cannot be adequately represented in a written exam or report. We see the use of e-portfolios as a solution to this problem. Our goal is to enable the documentation and planning of the entire product design process using e-portfolios for student projects in a course on product design - and thus also include the production and assembly of the individual parts until the real final product.

This short-paper will detail the necessary preparations and changes in content and organization to a course on product design and how the students are introduced to the use of e-portfolios. We develop a three-step process, that supports i) the preparation of e-portfolios (in advance to the course), ii) the design of individual e-portfolios (during the course) and iii) the evaluation at the end of the course.

The main findings of this work are seen in a provided recommendation on structure and design of an e-portfolio based course on product design (integrating required and useful software-tools and manufacturing machine interfaces) as well as the identified specific requirements of students and lecturers that need to be fulfilled to successfully implement e-portfolios.

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1 INTRODUCTION

The existence of e-portfolios and their use in the academic world are known and tested for many years [1]. In Germany however, e-portfolios are hardly used in academic teaching especially in MINT subjects [2]. Therefore we started to explore how to implement these personal, user centered online spaces to store data and project progress from student projects at our university. We use the open source e-porfolio software Mahara in a course on project-based product design within the bachelor's program on Sustainable Engineering to test and evaluate the use of e-portfolios as a digital option to document and grade student projects.

Until springtime 2022 students had to prove their acquired skills by a seminar paper at the end of the semester. From now on we plan to implement e-portfolios as a tool for documentation, reflection, and presentation of the acquired skills. The creation of an individual e-portfolio by each student as proof of the acquired skills will replace the seminar paper as the examination method.

This short paper is structured as follows. Section 2 details the necessary preparations and changes in content and organization to the existing course on product design. Section 2.2 will explain, how the students are introduced to the use of e-portfolios. Section 3 describes the evaluation of the changes implemented in the course and provides the results as well as conclusions and an outlook for the future of the project.

2 PREPARATIONS AND CHANGES TO IMPLEMENT E-PORTFOLIOS

To successfully implement e-portfolios as a new examination method and a new form of documenting and planning student projects in an existing course on project-based product design, changes to the course have to be made. These are detailed in the following sections.

2.1 Content and organizational changes to the course

The course on project-based product design for bachelor students used to test the use of e-portfolios during this research project is a mandatory course of the bachelor program on Sustainable Engineering at our university of applied sciences in Germany [3]. This is the only course focusing on product design in the curriculum of the bachelor program. In addition, there is no separate course in the students' curriculum that focuses on the fundamentals of project management. Therefore, we merged those two topics and designed a course that both satisfies the demands on product design education and provides an adequate first experience of project management for the students [4]. The students face a challenge to plan, design and build a first prototype of a wooden product for children (age: 3+) or a useful wooden product for teenagers (up to 16 years) [5]. They are free to decide on the target group for their product.

The course includes two 90-minute slots in the weekly curriculum over 14 weeks during each summer semester. The course is structured in two main parts, each spanning the entire semester and ends with a written seminar paper.

The first part is the theoretical part. It is assigned to the first 90-minute slot each week and includes seven lectures and five workshops that provide the content on relevant aspects of project management and product design, which are seen to be essential for the students and the success of their design projects.

The second and practical part is assigned to the second 90-minute slot each week. During these time slots, the laboratory for creative prototyping is open to all students to discuss their projects and designs with colleagues, the lecturer as well as the lab engineer. Furthermore, the students can get to know the available manufacturing machines and tools in the lab, take part in safety training and (usually rather later in the project) manufacture and assemble their prototypes.

These parts had to be shortened to make room for the workshops described in section 2.2. Therefore the lectures where shortened a little and the workshops on relevant aspects of project management were reduced to four. This makes room for a 60 minute time slot for the introduction of e-portfolios each week. Enough time to support the students with their task on planning and documenting their project as well as to answer their questions and collect feedback.

In preparation for the course and the added use of e-portfolios an e-portfolio system within the universitys network infrastructure was set up. We use the open source software Mahara combined with the learning platform moodle to provide the necessary infrastructure to digitalize the course and make everything accessible for students and staff members of the university. Within the moodle platform we set up a digital version of the mandatory safety instructions for the laboratory including a test to provide proof and documentation for further traceability. All operating instructions and safety instructions for the machinery within the laboratory like CNC carving machines, milling machines and different power tools are combined to an e-portfolio within the Mahara system. The necessary URLs for the different browser based design and manufacturing software tools to be used for the realization of the projects are also provided via a moodle course.

The legal aspects of a new examination method in the form of e-portfolios are also checked and discussed with the responsible people at the university.At the moment exists no final decision on this subject but a change of the general examination regulations to allow the use of e-portfolios seems inevitable. Our test within the research project is not affected by this.

2.2 Introducing students to e-portfolios

To introduce e-portfolios to the students we use weekly workshops and example portfolios as a source for inspiration. These weekly workshops are always led by the same person of the research team and supported by the others regarding student questions and technical issues with the system. The workshops are designed with a constant development of complexity and entitlement in mind. They provide the students with the necessary competencies to create their own e-portfolios out of their project task. Example portfolios show the students a selection of possible layout strategies and stored data (e.g. sketches, 3D-CAD-

models, time schedules, etc.). The example portfolios also outline the requirements of the lecturer regarding the contents of the e-portfolios. These have to be fulfilled by each student to get the e-portfolio graded.

3 RESULTS AND CONCLUSIONS

The regular evaluation of the project progress, the feedback from the students and the lecturer as well as the evaluation of the e-portfolios created by the students provide the information, if e-portfolios are a sufficient way to digitalize the documentation and planning of student projects. At the current time only the first student group of the course and the corresponding e-portfolio work can be evaluated. After some problems with the user authorization and the setup of the Mahara system the received feedback is consistently positive.

We found, that the use of e-portfolios has different advantages compared to written seminar papers. They allow parallel working on the design project and the exam and thus allow the students to safe time and effort at the end of the semester as well as optimize their available time to work on the project itself and the documentation. E-portfolios additionally allow a creative and free design of the documentation and support the reflection and cooperation skills of the students via the peer to peer and tutor feedback within the portfolio software. The global availability of the e-portfolio via the internet and the opportunity to share it easily with a selected audience are significant benefits. Students can proof their acquired skills to future employers based on data and facts instead of plain conversations. E-portfolios also provide a better understanding of relatively complicated projects or unstructured ideas.

The final e-portfolios of the projects done by the first student group lead to the conclusion, that e-portfolios are a suitable way to document and plan engineering related projects within university courses. The variety of opportunities and the added creativity have a positive impact on the quality of the students work. However, it must be mentioned that there is still room for improvement with regard to the possibilities for project panning and project management within the e-portfolio software (e.g. milestone planning).

Further the lecturer will reflect his own seminary based on the course proceeding, the e-portfolios of the students and their evaluation of the course. This comprehensive critical analysis is very important to further develop portfolio work and to increase common knowledge in the field of e-learning by sharing the experiences with others.

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