INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8–9 SEPTEMBER 2022, LONDON SOUTH BANK UNIVERSITY, LONDON, UK

A DIDACTIC LOOK ON THE INTRODUCTION OF E-PORTFOLIOS IN A PRODUCT DESIGN COURSE

Maria TYROLLER, Michael S. J. WALTER, Charlotte KAETZEL and Christian RIESS
University of Applied Sciences Ansbach, Germany

ABSTRACT
While e-portfolios are well established in several countries (57 % of U.S. colleges use e-portfolios), they are rarely found at German universities in courses on product design. Consequently, the use and applications of e-portfolios are new and unknown for students and lecturers alike. Fear about contacts with new technology, scepticism, inhibition thresholds, and technical as well as organisational barriers are therefore inevitable. In this paper, we dedicate ourselves to the fundamental analysis of the existing initial e-portfolio situation. This is done using a course on project-based product design for engineers at our university. In addition to the opinions of students and lecturers, the analysis also considers the perspective of administrative departments. Based on this, didactic strategies for the introduction of e-portfolios in the product design course will be developed. These strategies refer to the following three phases: preparation, implementation, and evaluation. The following factors have emerged as crucial for the successful implementation of e-portfolios: a comprehensive personal introduction, extensive information material that can be accessed at any time, continuous guidance, a clear structure and work instructions, room for flexibility and creativity to foster learners' individual strengths, and exchange and feedback between learners and teachers.

Keywords: E-portfolio, product design education, didactic strategies, communication, survey

1 INTRODUCTION
The manifold competencies that students acquire in courses on engineering design and product design cannot be meaningfully evaluated by questions in exams. According to Bloom's established taxonomy, ‘design’ activities are considered cognitively highly demanding and valuable [1]. Since design competencies are both cognitive and motivational/social in nature, study diaries or portfolios (or their digital form, e-portfolios) are suitable for evaluating students’ skills. E-portfolios, with their functional versatility, are ‘a tool for the structured collection, storage, and presentation of both the “path” (process, progress) and the “goal” (increase in knowledge, development of technical, methodological, or social skills) by means of digital information objects’ [2]. While e-portfolios are well established in several countries (57 % of U.S. colleges use e-portfolios) [3], they are rarely found at German universities [4]. So far, research on administrative issues related to the introduction of e-portfolios or on their suitability as an assessment tool has dominated. Less often, the perspective of students and how e-portfolios must be introduced didactically to bring real benefits to the target group has been considered [5]. Field research in the German-speaking area that refers to this topic so far comes mainly from two fields: teacher education (e.g., [6], [7]) and foreign language teaching (e.g., [8]). Research contributions from other disciplines can therefore offer new perspectives on the topic.
This paper deals with a perspective that has hardly been researched so far: the didactic introduction of e-portfolios in engineering science in the context of a product design course that is geared towards practical work. At our university, we have started to explore how to implement e-portfolios with the software Mahara in a course on project-based product design in the bachelor's degree programme for ‘Sustainable Engineering’. It is the only course focusing on product design in the curriculum of the bachelor programme. The students face the challenge to design and build a wooden product for children. In addition, each student must devise a 90-minute workshop, in which the product can be designed or built by the children themselves. Normally around 20 students take part at the course. One lecturer teaches the theoretical part that provides the content on relevant aspects of project management and product design (each week 90 minutes over 14 weeks). The practical part takes place in the lab and is accompanied by the lecturer and a lab engineer (also each week 90 minutes). Previously, students had

to demonstrate the skills that they gained through a seminar paper. In March 2022, when the next seminar starts, we plan to implement e-portfolios as a tool for the documentation, reflection, presentation, and proof of the acquired skills. The first step was the analysis of the initial situation. Students, lecturers, and an associate of the student service have been surveyed to formulate the needs of participants and identify the advantages and challenges of using e-portfolios in teaching. Based on this, didactic strategies for the implementation of e-portfolio work have been developed. A brief description of our research method follows. In the main part of the paper, our didactic strategies are described. We divided the relevant aspects of our didactic strategies into three stages: preparation, which takes place before our seminar and portfolio work start; implementation, which involves communicating requirements during our seminar; and evaluation, which takes place after the seminar, when the stakeholders will be able to provide a final evaluation of their experiences. Given the limited scope of this paper, we will not address the evaluation phase here. Nevertheless, it is an equally important part of our didactic approach and will be discussed in more detail elsewhere.

2 RESEARCH METHOD

To develop a concept that is appropriate for the social reality of our university, we chose the method of qualitative empirical research [9]. By conducting expert interviews with three students, two lecturers, and one administrative staff member, we gained important information about their respective perspectives and needs. In individual interviews based on semi-structured guidelines, we talked with engineering students who had participated in the course on project-based product design in the summer of 2020 about their personal experiences with the examination method (a seminar paper) at the time. To avoid influencing the interviewees, we asked open questions without mentioning e-portfolios as an alternative examination method at the beginning of the interview. At the end of the interview, we asked the stakeholders about the associations they have with e-portfolios and introduced them to the concept of e-portfolios. The assessment of the material gained has been done using typological analysis, as suggested by Misoch [10].

3 DIDACTIC STRATEGIES

The interviews showed that for all students, one lecturer, and the administrative associate, e-portfolios are an unknown tool so far. None of the students could associate anything with the word ‘e-portfolio’. Therefore, a good communication strategy is very important to making e-portfolios known and accessible to stakeholders. In the following, we outline some key points for the integration of e-portfolios into assessment practices and for the use of e-portfolios as working tools using the example of our course on project-based product design for engineers.

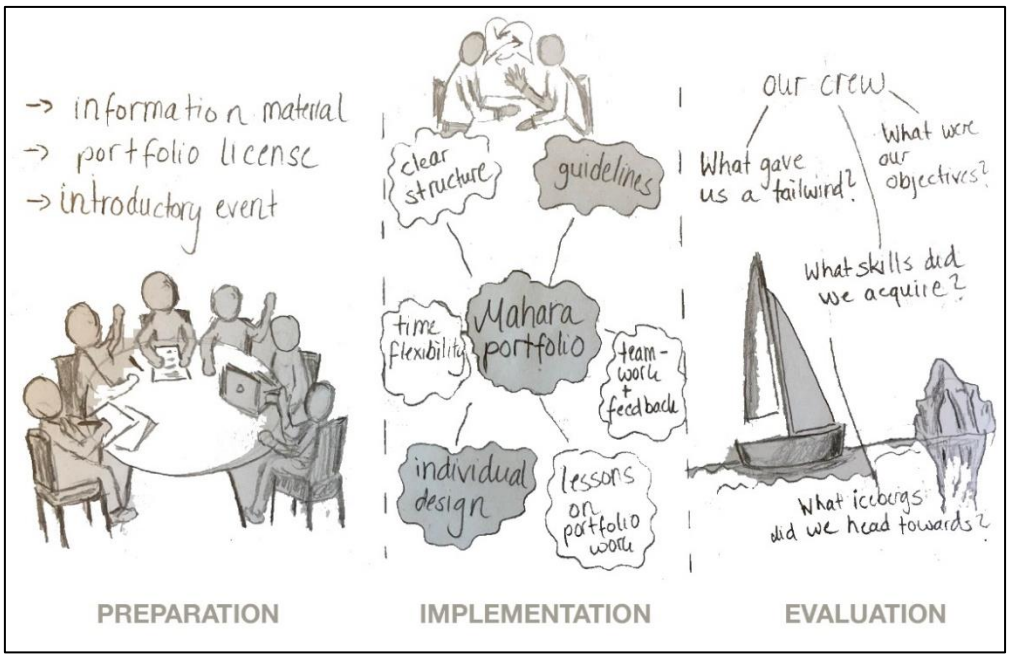

Figure 1. Stages 1–3 of the didactic strategies

3.1 Preparation: Requirements for a starter kit

The analysis of our interviews showed that it is important to create a well-structured introduction to e-portfolios to allow students to use them successfully. All students mentioned that clear expectations in the form of guidelines are very helpful.

Problems and demotivation emerge when the order is not clearly defined, or students have the sensation that they have not been well informed. One of the students interviewed, for example, described the problems he had in developing a workshop for children without being able to judge the target group: 'What was difficult was to really put myself in another head. I might have needed a bit of a framework.' To encourage a high level of motivation in students, it is important to provide comprehensive and well-structured information about a new topic or working tool.

The channels in which the introduction takes place are also relevant. Apart from multimedia information material that students can use while exploring the functions of e-portfolios, there should also be an information event for real interaction with tutors, as well as a Moodle course that students can use by themselves to acquire the skills required for the use of e-portfolios.

3.1.1 Introduction by interaction

As e-portfolios were nearly unknown to most of the interviewees, an ice breaker is needed. Experiences from everyday university life show that using introductory events to present new concepts works. We suggest a two-hour information event during which tutors explain the concept and functions of e-portfolios on Mahara to the students directly. To make it as interactive as possible, the participants should bring their own laptops to try out e-portfolios together with the tutors.

The experiences of the interviewed lecturer who had already worked with e-portfolios suggest that the demonstration of a best-practice portfolio could be a good start; this would show students what a good portfolio should look like. To directly experience e-portfolio work on Mahara, the students then register and create their own profiles. After this, they receive a first invitation to a shared project from the tutors, namely the user manual, which was created for the special needs of our university. By giving the students a user manual in form of a portfolio, the basic functions of Mahara can be explained.

After this, the participants could try to start their own first project on an easily accessible topic, like planning an upcoming weekend trip. Due to the low complexity of this challenge, the students can focus on both the challenge itself and the procedure of integrating their work progress and results in Mahara. As all interviews showed, it is very important for the stakeholders to know what is expected from them. Therefore, they receive guidelines with a description of all requested content and assessment criteria for the project 'weekend trip'. While planning this simple project, they can always access the user manual portfolio when they have questions about Mahara functions.

3.1.2 Information material

Information material should be available independent of the information event to all interested participants. Weber's research work points to the importance of guidelines that support students by providing them with the terms and functions of Mahara from the beginning [7].

To reach different types of learners, it can be helpful to have a printed version and a digital version. As briefly described before, the material should consist of four parts: a best-practice portfolio demonstration in form of a video/ pictures; a user manual for Mahara with all important functions and terms, which is supplemented by short learning videos/ pictures; guidelines containing the requested contents for the product design course and the contact information of the tutors, as well as the office hours for questions about portfolio work; and a description of the assessment criteria.

3.1.3 Portfolio license

To motivate students to really work with Mahara, a short course (with a workload of 3 hours) on Moodle that they can go through by themselves is a good additional resource. The course contains different tasks that, step by step, enable the users to use Mahara comprehensively. They become familiar with its structure, all possible functions, interactions with users, and how to upload videos, pictures, and documents on Mahara. They demonstrate their acquired skills at the end of the course by completing a multiple-choice test. Experiences from our human resources department show that e-learning courses, which employees can complete independently, make a good contribution to knowledge acquisition. Participation in the Mahara course will be a prerequisite for registering for our product design course.

The instructor of the course could also imagine a more extensively designed Mahara course that could be used to obtain elective credit points (2 ECTS) and a document which could be called a 'portfolio license'. The license, in turn, would offer the students the opportunity to work as portfolio tutors.

3.2 Implementation

After this comprehensive introduction, the instructor can start incorporating e-portfolio work into his project-based product design course. As the e-portfolio is a new working tool, it is very important that e-portfolio work is continuously accompanied by the lecturer and the tutors. The analysis of the interviews with stakeholders produced the following critical points to be considered for good working results: a structure that includes clear instructions and working methods and space for flexibility and creativity, and the promotion of autonomous learning and feedback loops. All of these aspects will be explained below.

3.2.1 Clear instructions and working methods

For product design, the systematic approach of Pahl and Beitz will be used due to its simplicity and effectiveness. Pahl and Beitz define four crucial steps: task classification, conceptual design, embodiment design, and detail design [11]. These steps will also give the basic structure to our portfolio template on Mahara. Every step contains different tasks one can manage using project management methods like writing a project diary, designing a mind map, etc.

The specification of methods on product design and on project management is necessary due to the strong need of all surveyed persons for clearly defined structures, tasks, and time frames. The interviewees found it very helpful to learn classic project management methods and to directly realise them while planning and documenting their own practical work step by step: '[…] write down tasks that you can then work through in a structured way, so I think that's very helpful in a project like that.' A clear framework also helps the teacher to limit the portfolio work so that it does not require any additional work compared to the previous form of examination.

One of the students feared that e-portfolio work could lead to an unauthentic way of working if a method is chosen because of its external effect and not because the learner really prefers to work with it. The danger that there is no real reflection on what has been learned, but that the portfolio work is reduced to self-marketing, is also addressed by Arnold et al. [12]. To avoid this risk, it is very important to clearly communicate that the design of the portfolio will not be assessed and that students can make mistakes. What is important is how they handle these mistakes and if they can reflect on and react to feedback.

3.2.2 Flexibility and room for creativity

Another important aspect that the interviewees pointed to was the ability to work in a creative, flexible way and to show one's own strengths through e-portfolio work. The challenge is to satisfy both needs: the need for safety can be met by a clear structure, but there is also a desire for autonomous, creative, and flexible learning. Gebhard defines this challenge in the following way: 'In general, instructors and learners must find their optimum middle way between a lax laissez-faire attitude and rigid requirements' [13].

One of the interviewed lecturers suggested balancing these opposed needs by providing plenty of structure but communicating simultaneously that students can always leave the given path. Weber recommends in her research work to use an open-adaptive concept to satisfy both the demand for a clear structure and the wish for liberty and creativity. This can, for example, be realised by providing a clear framework and best practices during orientation and then letting students independently develop the topics they want to work on [7].

For the product design course, we would therefore suggest a clearly structured portfolio template and list of requirements combined with giving the students the freedom to decide which project management tools are used when and in what way material is presented on Mahara. One interviewee, for example, told us about his preference for visual content: 'For example, the one point where I explain how I took the measurements for the tractor. I see the picture and know, ah, this is happening in this paragraph.' Others do not like typing on the computer and would rather take a picture of their handwritten scripts to load them into their e-portfolios. Thus, along with concrete instructions, students concurrently have space to explore their own ideas and strengths.

One of the interviewees objects that some students, especially students of engineering, could feel unsettled if design is made an important element of their portfolios: 'Especially among the technicians,

the visual skills are perhaps not quite as pronounced. Maybe some of them would have a massive advantage. Others, they might not have it at all.' This shows again how important it is not to assess design aspects themselves, but only to assess if the presentation is vivid and understandable. If a student is not a graphic design student, artistic aspects of the portfolio should not be evaluated.
One aspect of the product design course that students also mentioned very positively was the flexibility they had in writing their seminar papers. In contrast to exams, where the 60 minutes of the examination are decisive for the assessment of students' overall performance, students can work on their papers over a long period of time. This same flexibility can be a part of e-portfolio work.
Positive mention was also made of a possible experimental, autocorrective approach to errors: 'So you make a first version of something, then you see how it looks. Does it work at all and then you make another version until it works. And then there's the error analysis, which of course also counts.'
All these aspects coincide with the findings of Gebhard, who found that e-portfolio work is very motivating for students, as it allows them to demonstrate their individual skills in a flexible, creative way and under little pressure [8].

3.2.3 Reflective, autonomous learning and feedback

In accordance with the guiding principle of competence-oriented teaching and self-responsible learning of the European and German Qualifications Framework, e-portfolio work supports the individual acquisition of competences [12]. This is achieved through the independent documentation and reflection of learning processes and the exchange of information with others [12]. In particular, exchanges between fellow learners and teachers concerning the learning content can be implemented very well via Mahara through the group chat and comment functions. In contrast to this, in a classic seminar paper, as one of the interviewees complained, the performance aspect of teamwork is difficult to depict.
To guarantee that all students are motivated to work autonomously with Mahara and to interact with others, e-portfolio work must be learned and practiced by the students together in the compulsory course. One of the interviewed lecturers observed that many students do not learn to work independently and to reflect on their own learning process in high school. Autonomous learning can therefore by no means be taken for granted as an ability; it must be learned by many students at the university level. Furthermore, experts recommend clear guidelines for social interaction so that everyone feels comfortable participating [14].
Our course consists of 14 weeks x 180 minutes of weekly classes. Each week, 120 minutes are reserved for product design itself and the acquisition of the methods. The course mainly takes place as a workshop, and lectures are given on demand. Sixty minutes each week should be spent on the topic of e-portfolio work (weeks 1 to 4). Of these 60 minutes, 30 minutes are used to try out certain functions together and the other 30 minutes are reserved for individual work with the portfolio.
One important function, for example, is sharing projects with others and commenting on each other's content. Teachers should set feedback rules to help learners formulate their feedback in a constructive way. In addition, it must be clearly defined to what extent exchanges among the students are included in the assessment of portfolio performance. More reserved learners should not be disadvantaged compared to extroverts who love to be in constant communication with other students. Rather, the assessment should be about encouraging students to interact with each other in the first place.
The following framework could make this aspect implementable: All students receive a tandem partner by lot, and they and their partner give each other feedback on a work result four times during the seminar via the comment function. In addition, each student attends the tutor's portfolio consultation hour at least once. The assessment is only based on whether the student has completed all five feedback interactions, not on the content of the feedback. For weeks 5–14, we can assume that the Mahara functions have been fundamentally mastered and therefore we can shorten the joint portfolio work during lessons to 30 minutes per week. As there are always lectures on demand, students still have the ability to discuss further questions about Mahara during the course.
Research shows that for portfolio work to be accepted and successful, beginners must be continuously assisted, and they must have the ability to exchange information about questions that arise [7]. To ensure this support, e-portfolio tutors should be available to students on a regular basis during weekly consultation hours, in addition to the portfolio units in the course.

4 CONCLUSION AND OUTLOOK

In this paper, we showed approaches to implementing e-portfolios via the Mahara software in a course on project-based product design for engineers. The analysis of our interviews with different stakeholders led to the following five important aspects that should be considered in the development of didactic strategies: First, e-portfolios are an unknown tool for most of the interviewees at this point; therefore, a comprehensive introduction is an important prerequisite of their success. Second, for the realisation of e-portfolio work, students need a clear, well-defined framework and guidelines. Third, to enable students to use Mahara autonomously and creatively at the same time, they have to be instructed in its functions through weekly tutorials as part of a compulsory course. Fourth, design aspects may not be assessed. Fifth, mutual exchange, feedback, and teamwork, as important parts of autonomous learning, should be promoted by tandem partnerships and regular consultation hours.

To continue to keep students' perspectives in mind, we will also conduct interviews with learners during the implementation phase. Finally, a comprehensive evaluation of the project by students and teachers will contribute to the improvement and further development of e-portfolio work in the department of engineering and to the general increase of knowledge in the field of e-learning.

ACKNOWLEDGEMENTS

We thank the *Stiftung Innovation in der Hochschullehre* for funding our research project '3-Klang' (putting e-portfolios into practice – a triad of theory, communication, and utilisation).

REFERENCES

[1] Bailey R. and Szabó Z. Assessing engineering design process knowledge. *International Journal of Engineering Education*, 2006, 22(3), 508–518.

[2] Hilzensauer M.W. and Hornung-Prähauser M.V. *ePortfolio – Methode und Werkzeug für kompetenzbasiertes Lernen* (Salzburg Research). Available: https://eportfoliowick.jimdofree.com/literatur/salzburg-research-forschungsgesellschaft/ [Accessed on 2022, 23 February] (2006).

[3] Eynon B. and Gambino L. M. *High-impact ePortfolio Practice: A Catalyst for Student, Faculty, and Institutional Learning*, 2017 (Stylus, Sterling, Virginia).

[4] Schütz-Pitan J., Seidl T. and Hense J. Wirksamkeit eines fächer- und modulübergreifenden ePortfolio-Einsatzes in der Hochschullehre. Einflussfaktoren auf den Kompetenzerwerb. *Die Hochschullehre Interdisziplinäre Zeitschrift für Studium und Lehre*, 5, 2019, pp. 769–796.

[5] Himpsl-Gutermann K. *E-Portfolios in der universitären Weiterbildung. Studierende im Spannungsfeld von Reflexivem Lernen und Digital Career Identity*, 2012 (VWH Verl. Hülsbusch, Boizenburg).

[6] Rachbauer T. *E-Portfolios als Instrument für Selbstreflexionsprozesse in der Lehrerinnen- und Lehrerbildung. Eine empirische Untersuchung zur Implementierung von E-Portfolios in der universitären Lehrerinnen- und Lehrerbildung*, 2019 (Dissertation: LIT Verlag, Münster).

[7] Weber N. *Reflexionsmedium ePortfolio. Strukturierung von digitaler Portfolioarbeit im Lehramtsstudium*, 2021 (Dissertation: Verlag Julius Klinkhardt, Bad Heilbrunn). Available: https://elibrary.utb.de/doi/book/10.35468/9783781558854 [Accessed on 2022, 1 February].

[8] Gebhard C. Das Lernportfolio als Leistungsnachweis im Chinesischunterricht. *CHUN*, 35, 2020, pp. 86–102.

[9] Mayer H.O. *Interview und schriftliche Befragung. Entwicklung Durchführung und Auswertung*, 4th edition, 2008 (Oldenbourg, München [u.a.]).

[10] Misoch S. *Qualitative Interviews*, 2, pp. 119–128, 2019 (De Gruyter Oldenbourg, Berlin, Boston).

[11] Bender B., Gericke K. and Pahl G. *Pahl/Beitz Konstruktionslehre. Methoden und Anwendung erfolgreicher Produktentwicklung*, 9, 2021 (Springer Vieweg, Berlin).

[12] Arnold P., Kilian L., Thillosen A.M. and Zimmer G.M. *Handbuch E-Learning. Lehren und Lernen mit digitalen Medien*, 5, 2018 (W. Bertelsmann Verlag, Bielefeld).

[13] Gebhard C. Portfolios as performance records in a reflective approach in teaching Chinese as a foreign language. In *Business Meets Technology 2. Proceedings of the 2nd International Conference of the University of Applied Sciences*, Ansbach, July 2020, pp. 22–25.

[14] Spielmann D. *E-Portfolio in der Schreibberatungsausbildung. Cognitive Apprenticeship und reflexive Praxis*, *Volume 2*, 2017 (wbv, Bielefeld).