USING FLIPPED CLASSROOM WITH DIGITAL MEDIA FOR PRE-SERVICE PRIMARY SCIENCE TEACHER EDUCATION

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Based on various reasons, it is demanded to use digital media in higher education. For the present study, a flipped classroom module for pre-service primary science teachers at the Ludwigsburg University of Education (Germany) was developed. Following the approach of a flipped classroom, information about the content on the specific topic are provided by online education resource before the lecture. After this preparation, the students work learner-centred during an in-class meeting, discuss and reflect on their gained knowledge and actively used it in, e.g. problem-solving tasks. Finally, after the in-class meeting, students deepen their knowledge on the topic. Most of the methods – especially the first phase – are based on digital media, which are used in the learning management software. The evaluation focuses on the students' feedback on the used flipped classroom concept and the development of pre-service teachers' TPACK and beliefs regarding the use of digital media in education. The results of the evaluation will be used for the improvement of the concept and the development of open educational resource.

Keywords: ICT Enhanced Teaching and Learning, Higher Education, Computer Supported Learning Environments

INTRODUCTION

With the digitalization of the every-day life, demands are placed on education and especially in higher education. Students and politicians expect that lecturers in higher education exploit the great predicted potential of digital media in teaching. The Ministers of Education of Germany call in various strategy papers for the digitisation of education in Germany, which could contribute to addressing several challenges in higher education (e.g. KMK 2017; 2019). Furthermore, several studies have shown positive effects on teaching and learning with digital media (e.g. Hattie, 2008; Hillmayr, Reinhold, Ziernwald, & Reiss, 2017).

Teaching with digital media can make higher education more attractive, more individual, more practical and more flexible, enabling it to partly respond to qualitative and quantitative changes in the student population. (Dittler & Kreidl, 2018). However, Dittler and Kreidl (2018) and Schmid, Goertz, Radomski, Thom, and Behrens (2017) show that the possibilities of digitization in higher education have so far been insufficiently and only selectively realized. Germany-wide student surveys show that only 50% of courses at universities use audiovisual media (Bargel, Müßig-Trapp, & Willige, 2008). Students would like to see more digital media in teaching (Bargel, Multrus, Ramm, & Bargel, 2009; Kreidl & Dittler, 2018) and expect digital media to enrich university courses and offer new and meaningful opportunities (Kreidl & Dittler, 2018). University lecturers also wish to use digital media and concepts in their seminars and lectures (Alvarez, 2012; Bergmann & Sams, 2012), but mostly only use presentation

software (e.g. Microsoft Powerpoint) and learning management platforms (e.g. Moodle) to provide digital text documents. Lecturers state, that they face multiple challenges, e.g. legal issues, high technological innovation dynamics, higher teaching load, high costs and lack of IT- and didactical-support. Related to students, they see the risk of student' distraction, disruption and fraud (Schmid et al., 2017).

THEORETICAL BACKGROUND

Flipped-classroom-concept

One of the most used concepts to reach the goal of digital learning in higher education is the blended learning approach with the focus on flipped classroom. The flipped classroom is an instructional model, which uses the advantages of learning at home and in-class. Students learn basic contents self-controlled at home asynchronously and independent of location. The selected learning materials can have different formats, such as online videos, texts, podcasts, interviews and illustrations (Bergmann & Sams, 2012; Strayer, 2012). In the lecture, the learning activities are student-centred, collaborative and interactive (Strayer, 2012). These two phases of the lecture are - in contrast to the traditional and teacher-centred lecture concept - flipped or inverted (Bergmann & Sams, 2012). The implementation of a flipped classroom in higher education is used to promote students' engagement, perceptions and attitude, different forms of metacognition, performance, understanding, achievement, and self-efficacy (Al-Samarraie, Shamsuddin, & Alzahrani, 2019). The development of students' deep understanding of the materials by providing them with more control over what and how they learn, is one offered opportunity. Another goal is to facilitate students' acquisition of information, ideas, and reflection on their self-learning experiences (Al-Samarraie et al., 2019).

Several studies validate the potential of a flipped classroom in different learning contexts. Overall, the studies show the potential of the flipped classroom concept in support specific learning outcomes, e.g., engagement, attitude, understanding, metacognition, performance (Strayer, 2012), and self-efficacy (Al-Samarraie et al., 2019). Students take responsibility for their learning and are better prepared for in-class meetings (Alvarez, 2012). Flipped classroom encourages the synthesis of material, critical thinking and higher-order thinking skills (Bergmann & Sams, 2012). The potential of a flipped classroom in higher education has gradually increased across disciplines (Al-Samarraie et al., 2019).

In education courses, most of the previous studies found that the flipped classroom concept is used to enable students to process higher level of reflection and inquiry (Vaughan, 2014). In this area, the flipped classroom can also promote students' creativity through fluency, flexibility and novelty (Al-Zahrani, 2015) and foster the development of learners' self-efficacy and knowledge (Hao & Lee, 2016). The concept promotes students' positive perceptions towards the course (Zainuddin & Attaran, 2016). It enables students to develop positive attitudes (Xiu, Moore, Thompson, & French, 2018) and increase satisfaction (Ritzhaupt & Sommer, 2018) toward the learning process. When students are exposed to learning problems using supportive materials that are consistent with their learning styles, they are likely to develop positive attitudes towards the way of instruction they have experienced (Al-Samarraie et al., 2019).

Although the concept offers several positive opportunities, there are also challenges in the implementation. The main obstacles that need to be faced when using the flipped classroom concept are the time spent and technical difficulties. Furthermore, design efforts, limited practical sessions, lack of immediate feedback and course structure have a negative influence on the perception of the teaching (Al-Samarraie et al., 2019; Hotle & Garrow, 2015). In education courses, difficulties related to the requirement for discipline-specific skills and pre-preparation to implement the flipped learning model were stated in the literature (e.g. Al-Zahrani, 2015).

DEVELOPMENT AND DESIGN

To implement a flipped classroom in our university, we developed a new concept for the lecture "Introduction to science teaching". To sum up, the contents of the lecture are principles of science teaching, constructivism, diagnostic in science teaching and inquiry-based learning as well as dealing with students' misconceptions and language-sensitive teaching. One lecture addresses learning with digital media in science teaching as well. The structure of the single meetings is presented in figure 1. Phase 1 is the preparation at home based on online educational materials. Here the students work on educational videos, texts, interactive presentations (e.g. Prezi, www.prezi.com), tests and collaborative tools. The learning media are accompanied by assignments to work on. In phase 2, the students meet for the in-class actions at the university. Here they discuss, repeat and reflect on their preparation and get short theoretical input from the lecturer. They need to implement the gained knowledge in a practical task, such as the development of diagnostic-instruments and language-sensitive working sheets, jigsaw classroom activities, experiments in the lecture and other practical tools for their future teaching. In phase 3, the pre-service teachers reflect and/or deepen on the topic at home with the help of the mentioned digital education materials.

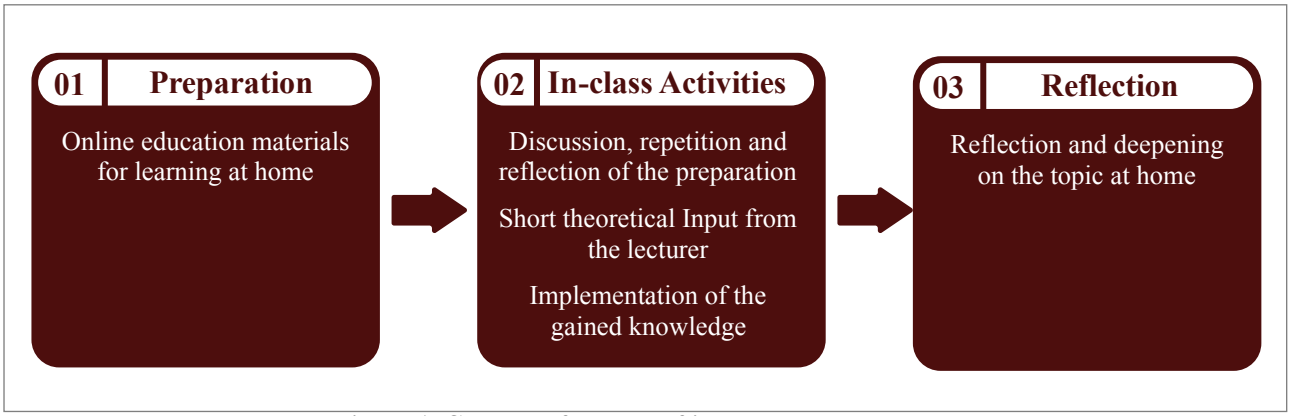

Figure 1. Concept of the used flipped classroom

Impact on pre-service teachers' media knowledge and beliefs

Pre-service teachers observe how lecturers in higher education behave when using media, how they use it, and how they evaluate social change and the changes it brings to their future

schools. Because of that, we tried to design a lecture with didactically appropriate use of digital media in all learning phases and that way to introduce various forms of digital learning to the pre-service students. The lecturer and the lecture itself can be seen as a model, as defined by the social learning theory by Bandura (1977), which influence the student's knowledge, behaviour and beliefs. Thus, they could gain active experience as a learner and see how digital media can be successfully deployed in education. This way, they can learn about application scenarios, characteristics, advantages and disadvantages of digital learning concepts. This knowledge can be used in their future teaching with digital media. In conclusion, we suppose that the successful use of digital media in higher education for pre-service teachers could lead to the learning of media knowledge (e.g. TPACK) and the change of beliefs regarding digital media in teaching.

The term TPACK stands for *Technological Pedagogical and Content Knowledge* and describes the knowledge about the selection and use of technologies to support learning processes in a subject area (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2009). Koehler and Mishra (2008) have provided this framework for the knowledge that a teacher needs in order to use digital media successfully in class. They refer to Schulman's concept of professional knowledge (1986) and expand it to include technological knowledge, that is the knowledge about technology, tools and resources as well as productive use in work and everyday life. *TPACK* describes complex relationships between pedagogical knowledge (PK), content knowledge (CK) and technological knowledge (TK).

Teachers beliefs regarding the use of digital media in learning scenarios are essential if they ought to use them. These beliefs depend on various internal variables of the teacher. The Social Cognitive Career Theory (SCCT) by Lent, Brown and Hackett (2002) attempts to capture the complex interdependencies of these intrapersonal variables and to find out how these variables influence decision-making processes in the context of a profession. These variables, such as self-efficacy, outcome expectations, and interest are interdependent and influence the formation of personal goals as well as the selection, practice, and execution of behaviours, such as the use of digital media (Lent et al., 2002; Niederhauser & Perkman, 2008).

RESEARCH QUESTIONS

Starting from the theory, we raised three main research questions for the evaluation:

(i) How do pre-service primary science teachers experience the developed lecture, and what are the wishes and ideas for the improvement of it?

(ii) How does the concept of the newly developed lecture change TPACK of pre-service primary science teachers regarding the usage of digital media in their future classes?

(iii) How does the concept of the newly developed seminar change the beliefs of pre-service primary science teachers regarding the usage of digital media in their future classes?

METHODS AND SAMPLES

Regarding the first research question, students evaluate the concept following open and closed questions in an online survey after the lecture. In the closed-ended questions, the students respond to the statements, if they liked the interaction and the structure of the lecture as well as the variety of used methods. Furthermore, they rate their effort and learning outcome. In the open-ended questions, we asked for comments on the methodical concept of the lecture and opinion on the used digital media. The pre-service teachers are requested to give ideas for improvement of the lecture and name, which topic they liked the most.

For answering the second research question, the evaluation of pre-service teachers` perceived *TPACK* bases on a quantitative questionnaire (Schmidt et al., 2009; translated by Mahler & Arnold). For answering the third research question, a Likert-type questionnaire about pre-service teachers' beliefs about the usage of digital media was employed (Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman & Harackiewicz, 2009; Davis, 1989; Lent, Brown, Sheu, Schmidt, Brenner, & Gloster 2005; translated and slightly modified).

131 pre-service primary science teachers participated in the study. They were aged 19 - 38 (M = 23). The pre-service teachers were at the beginning of their teacher training, visiting the second or third semester in a bachelor's program. Approximately 80 % of the pre-service teachers were female, which is typical for universities of education in Germany.

RESULTS

In the following, the results will be presented to answer the research questions.

RQ1

The quantitative results (figure 2) show that the participants like the used variety of methods (M = 4,08 on a 1-5 Likert-scale) and that the lecture was designed with interaction (M = 3,79). They pointed out the better structure of the lecturer (M = 3,88) and that they took a lot of the lecture (M = 3,66). They had an average effort (M = 3,23) in this lecture.

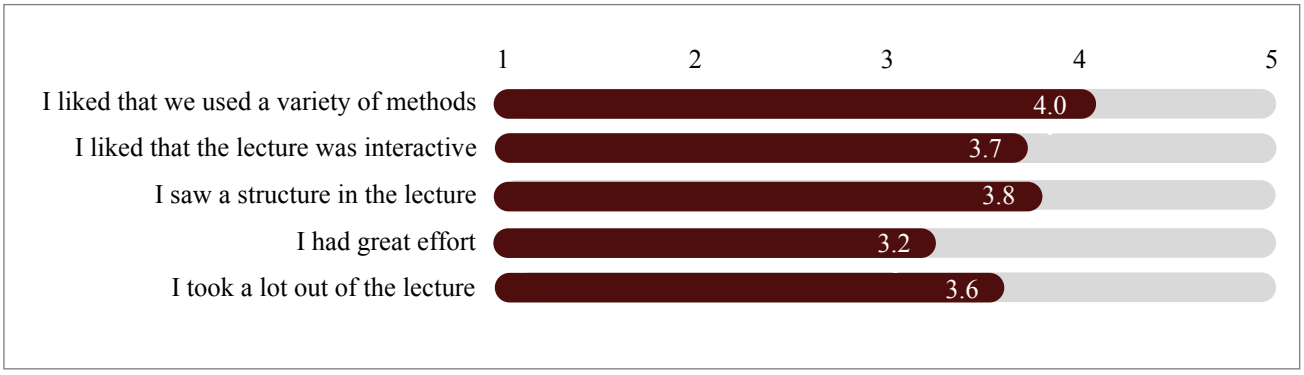

Figure 2. Closed-ended questions (N=131)

The qualitative data supported these results and put them into context. For most of the pre-service primary science teachers in this study, this was the first touch with a flipped classroom. About 20 % stated that they worked more comparing to a traditional lecture. However, the vast majority pointed out that they learn more compared to the traditional lecturer by the combination of theory in preparation at home and practical application in the lecture. Only some of the pre-service teachers in this study felt overstrained and wished for a traditional lecture with theoretical input from the university educator and only a few digital learning settings. The great majority of the pre-service teachers highlighted the work with a variety of digital media in this lecture was new and attractive, and they stated that this primarily facilitated their learning. They mentioned that they got a good overview as well as inspiration and knowledge for their future digital teaching.

Furthermore, for a majority, the cooperative group activities facilitated their learning. These active learning opportunities with the development of practical tools were labelled as useful for their future profession. Overall, they evaluate the flipped classroom concept positive and got a good overview as well as inspiration and knowledge for their future teaching.

RQ2 and RQ3

The results regarding the third research question are presented in figure 3.

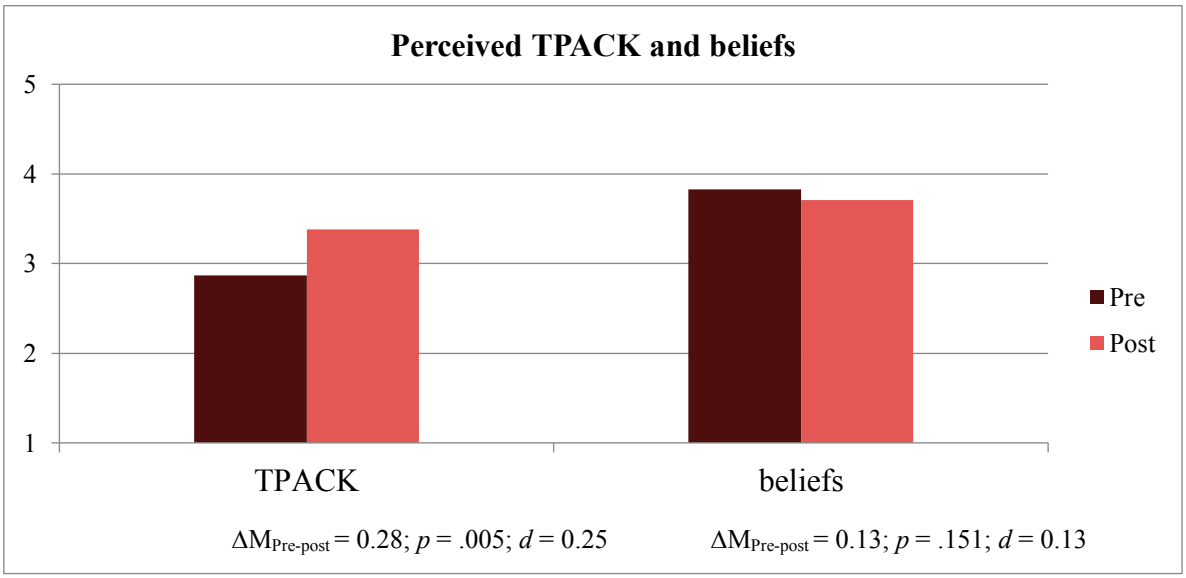

Figure 3. Pre-service teachers' perceived TPACK & beliefs (N=131)

The diagram in figure 3 shows the development of the pre-service teachers' perceived TPACK in the pre- and post-test. The value in the pre-test is 3.1, and it increases to a value of around 3.4 in the post-test. The pre-service teachers` perceived TPACK increased significantly (ΔMPre-post = 0.28; p = .005; d = 0.25). The increase of the perceived TPACK is significant and has a small effect size with a Cohen's d > 0.2 (Cohen, 1988). The development of the pre-

service teachers' beliefs in the pre- and post-tests is also demonstrated in figure 3. In comparison to the TPACK, the pre-service teachers` beliefs regarding the learning with digital media decreased, but not significantly (ΔMPre-post = 0.13; p = .151; d = 0.13). Overall, the beliefs remain on a high level with a value of 3.8 on a Likert scale from 1 to 5.

DISCUSSION

The present study shows the evaluation of a flipped classroom based on digital media in higher education from the perspective of pre-service primary science teachers. For our group of pre-service primary science teachers, a flipped classroom seems to be a fitting opportunity to combine theoretical and practical elements in a lecture and lead the students to work effectively. The pre-service students liked the concept and learning activities in the lecture. Though it was the first experience for them, it was easy to work this way. The participants see the value and the advantages of the flipped classroom for their professional development.

Regarding the perceived TPACK of the students, a significant increase could be observed, with the highest value in the post-study. Thus, we conclude that the lecture leads to an increased perceived TPACK. On the opposite, the pre-service teachers' beliefs slightly decreased insignificantly but remained at a high level. In Germany, the topic of digitalization in trendy because of the overall digitalization of society and a massive governmental campaign for supporting the digitalization in schools is set up. Thus, we assume, that this could explain the high level of beliefs before the lecture, especially because they stated, that they did not come in contact with digital media in an educational scenario before this lecture. The remaining of the beliefs at a high level can be interpreted as a positive result since the lecture did not discourage pre-service teachers with a realistic view on the implementation of digital media and the learning with and in this digital concept.

Interestingly, pre-service teachers can develop perceived TPACK and get a more realistic view, eventually mainly through the frequent use of digital media together with one specific session. In the debate about the responsibility for the education of pre-service students in media knowledge in higher education, frequent usage of digital media could be one practical and influential way for every participating domain. However, this requires further studies.

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