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ORIGINAL RESEARCH

Fostering Digital Media-Realted Competences of Student Teachers

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Abstract
Beyond controversy, identifying and using the potential of digital media for teaching requires media-related skills of future teachers. The paper presents in a first step a framework for digital media-related competencies. Within this framework, different areas are identified in which teachers need media pedagogical (didactical), subject-specific and technological competencies related to the instructional design of digital media. In a second step, an educational approach to support student teachers to develop these competencies is presented. This approach is based on project learning and encompasses a media-based teaching project and a media development project. Hereby, different support structures are implemented, i.e. blended learning proposals and self-learning materials, personal support, and learning analytics. Finally, the project evaluation with formative and summative elements, which guides the iterative process of implementing the educational approach into the existing teacher education programme, is presented.

Keywords Teacher education · Digital competence framework · Project-based learning · Fostering digital competencies

Introduction

Digital transformation also affects teaching–learning processes. To enable teachers to know the possibilities and limits of digital media and digital teaching and learning tools as well as to be able to use them in a didactically meaningful way, it is necessary to implement the promotion of digital media-related competencies in teacher education [24]. This argument is supported by findings of the Teaching and Learning International Survey (TALIS) from 2018, according to which only 53 percent of the teachers regularly use computers and information technologies in their teaching practice and under one in five would like further education in the use of information technologies [34].

Digital media-related competencies encompass various knowledge, skills and dispositions that teachers need to effectively design teaching–learning processes [12]. But how to promote these competencies in teacher education? According to Falloon [12] more holistic and integrated approaches are considered more appropriate as isolated information and communication technology (ICT) trainings. So, we designed a project-based approach, which is embedded in a teacher educational programme and in which digital media-related competencies of prospective teachers are fostered. Within our TEgoDi approach student teachers are working on two projects: a digital media development project and a digital media-based teaching project. To support students in dealing with both projects as well as fostering their competence development, different support structures are implemented in the teacher education programme including regular feedback based on online learning analytics, self-assessments, and tutoring.

In the following, we present the framework of digital media-related competencies, which is supported by our educational programme. Next, our educational concept is introduced comprising the project learning approach and different support structures (i.e. blended learning proposals, personal support, learning analytics, makerspace and media labs). Subsequently, the concept of the evaluation with formative and summative elements to guide the iterative process of the "Teacher Education goes Digital" (TEgoDi) approach is

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presented. Finally, further challenges, based on first experiences with the presented approach are summarized.

Framework for Digital Media-Related Competencies

Which competencies in relation to digital media do prospective teachers need? There are already numerous publications on this subject, both in the scientific [5, 38, 39] and in the political context [19]. Most of these models are adapted to the context of teacher education but do not address the different levels of digital competencies such as media pedagogical or subject-specific competencies related to the instructional design of media. Furthermore, the models mostly consider media competencies generically and neglect subject-specific features. Therefore, the relevance of developing a differentiated competency model based on a broader understanding of digital competencies is given for teacher education. Thus, we decided to develop a framework for digital media-related competencies for teachers, which provides orientation in developing different learning opportunities and support structures.

The framework for digital media-related competencies within our TEgoDi approach is based on established international reference frameworks such as the "European Framework for the Digital Competence of Educators" (DigComEdu) [32], Blömeke's [5] concept of media pedagogical competence, the "Technological Pedagogical Content Knowledge" (TPACK, [25], and digi.kompP [6]. The DigCompEdu model specifies six areas in which teachers should build competencies [32]: (1) using digital technologies for communication, collaboration and professional development (*professional engagement*), (2) sourcing, creating and sharing digital resources (*digital resources*), (3) managing and orchestrating the use of digital technologies in teaching and learning (*teaching* and *learning*), (4) using digital technologies and strategies to enhance assessment (*assessment*), (5) using digital technologies to enhance inclusion, personalisation and learners' active engagement (*empowering learners*), and (6) enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving (*facilitating learners' digital competence*). These areas are considered to support the development of students' digital media-related competencies. For example, using online-self-assessment students get feedback on their current competencies in these areas, which is helpful for setting new learning goals and learning activities.

Furthermore, our framework is referenced to the TPACK-model according to Mishra and Koehler [25]. It extends Shulman's [37] Pedagogical Content Knowledge (PCK) model to include the aspect of technological knowledge, thus representing knowledge related to the instructional design of media as the intersection of a teacher's pedagogical, content, and technological knowledge domains. TPACK has been the subject of several research projects as a framework for designing curricula in teacher education and for evaluating teachers' media-related competencies (e.g., [43]). To use digital media meaningfully in subject teaching, teachers need educational, subject-specific instructional and technological knowledge. Thus, a real added value through digital media in a particular subject only arises if the teacher has such media subject instructional knowledge. In our framework, the media didactic areas of the DigCompEdu model are refined with such media subject didactic content. This is done by a co-working process with colleagues of different subjects and will allow us to describe media subject didactical knowledge more detailed and subject-specific.

Finally, a third model that inspired our framework is the digi.kompP model [6], which was developed by the University College of Teacher Education in Lower Austria (Pädagogische Hochschule Niederösterreich). With this, a grid was developed that is explicitly intended for use in teacher education. In detail, it comprises eight categories (A-H) and three development stages (0–2), covering living, teaching and learning with regard to digitality (i.e. digital life), selecting and designing digital media (i.e. enable teaching and learning with digital media), using and evaluating digital media (i.e. digital teaching and learning), and using digital media in the school community and for professional development (i.e. collaboration and continuing education with digital media). In the TEgoDi approach, we picked up the idea that digital media-related competencies can be arranged by their complexity and that each student has an individual digital media competence profile. To keep it feasible, the level descriptions are based on Anderson and Krathwohl's [2] taxonomy, differentiating understanding, applying, and creating. These levels are adapted for each of the six areas of the developed TEgoDi-model. An example for a developed competency description for the area "Digital Resources" is given in the following Table 1. The competence description focuses on legal (copyright and usage rights) aspects of media-based learning. In addition, there are also competency descriptions in this area that focus more on the design and creation process of various media artifacts.

Table 1 Competence levels of the TEgoDi-model for sourcing, creating and sharing digital resources

Area: Digital resources I can share my digital teaching/learning materials and licensed open educational resources (OER) materials with other teachers		
Level 1: Knowlege	Level 2: Application	Level 3: Creation
I can explain what OER are, how they are licensed (CC), and name different OER platforms *Operators: List, Reproduce*	I can compile (select) digital teaching/learning materials from different OER platforms and use them for my lessons or own teaching concept *Operators: Apply, Translate*	I can produce and license my own OER materials (respecting privacy and copyrights) and make them online available to others *Operators: elaborate*

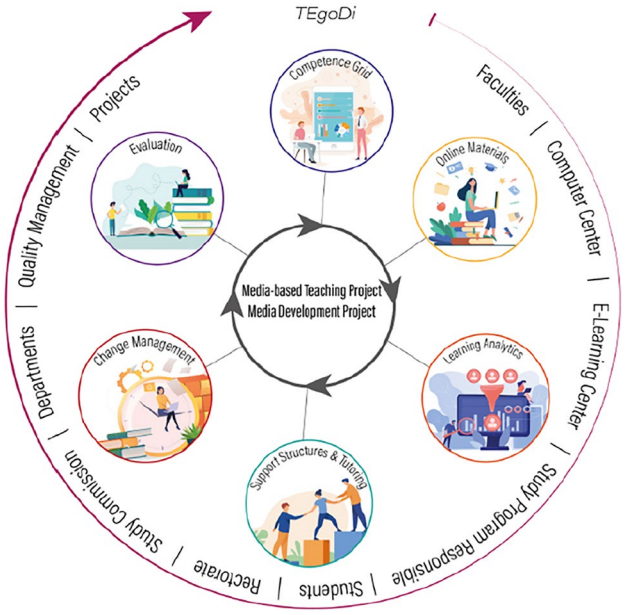

Fig. 1 The TEgoDi concept ([27], p. 234)

Educational Concept for Promoting Digital Media-Related Competencies

Media Based Teaching Project and Media Development Project as Learning Opportunities

Educational concepts to promote teachers' digital media-related competencies follow mostly a *one-size-fits-all* approach, which is characterized by the integration of technology in teaching–learning processes. Hereby it is assumed that technology integration fits various subjects and skill areas. Kaplon-Schilis and Lyublinskaya [17] argue that this approach leads to only partially satisfactory media education. Thus, at the end of their studies, many students do not feel sufficiently prepared for the effective use of digital media in their own teaching. Accordingly, it seems to be much more important to take the requirements of subject-specific teaching–learning processes into account [20]. This circumstance will be addressed by a project-oriented approach within TEgoDi, based on theories of situated learning [22] and authentic learning [15]. The first one describes learning as a socially active process and is based on the idea that learning is an individual constructive process. The second one highlights that scenarios—that are as realistic as possible or case-oriented—are most suitable to promote learning processes and to avoid dull knowledge. There is evidence that such project-based approaches can be effective in promoting teaching media competencies (e.g., [3] and TPACK, e.g., [30]).

Figure 1 shows the core of our educational program to support student teachers' development of digital

media-related competencies: The supplementation of teacher education curricula with compulsory additional coursework elements in terms of both, a *digital media-based teaching project* and a *digital media development project*. The first one addresses practical experiences in teaching with media and designing instructional embeddings, considering TPACK and subject-specific competencies. Within the second project student teachers cooperatively design a media-based learning activity/session [27]. By doing this they deal with media didactic models [18] or corresponding approaches to instructional design [29, 33] as well as with subject-related content. As an important—also motivational—element of TEgoDi, students will receive a certificate for the additional digital media-related competencies they acquire.

To better understand the project work and how it can be embedded into the curriculum, we applied a scenario-based design approach and developed customer journey maps. As can be seen in Fig. 2, which shows an example of a student teachers' journey through his/her studies, emphasizing the media projects and involved TEgoDi support structures, nine main steps were defined: "After the check-in and orientation phase (1) students are informed about options and requirements. This supports their selection of project type (2) (teaching or development project). Self-Assessments (3) provide orientation about digital media-related competencies and appropriate learning material to acquire the necessary skills (4). Content and learning objectives are defined together with lecturers, resulting in a project concept (5). Teaching materials and tools are gathered or produced (6). Project design is tested involving the target group (7), feedback is provided by tutors and lecturers (8). Final evaluation (9) is conducted using e-portfolio method" [27], p. 235). Hereby they document their reflections and their development of media (subject) didactic competencies in an e-portfolio [40] based on the competence model developed in the TEgoDi project [39].

With a focus on the media development project, students require a specific technical infrastructure. With the CoLiLab (Cooperative Liberal Laboratory) as a pedagogical makerspace, students can use existing learning labs to develop and design digital teaching and learning materials (see Fig. 3). There they receive the necessary equipment and also assistance from tutors who are part of the TEgoDi support structures [23, 27].

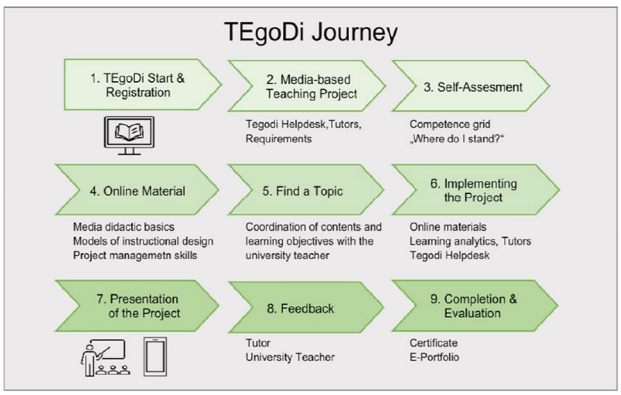

Fig. 2 Example of a student's journey through his/her studies, emphasizing the media projects and involved TEgoDi elements ([27], p. 235)

TEgoDi Support Structure

Previous comparable projects have shown that prospective teachers have a wide range of support needs when carrying out media projects [23]. On the one hand, they need professional support in media pedagogical, media didactic and media subject didactical questions. On the other hand, there is a need for interdisciplinary support to help students organize their project work and their own teaching and learning processes. Since digital media are an elementary component of TEgoDi, students also need technical support, whether in terms of access to the required equipment, the needed software or in terms of specific technical questions. Thus, corresponding support structures are being established within TEgoDi: Blended learning proposals and self-learning materials, personal support (tutoring), and learning analytics.

Blended Learning Proposals and Self-Learning Materials

The goal of self-guided learning proposals and learning materials is to enable students to independently design

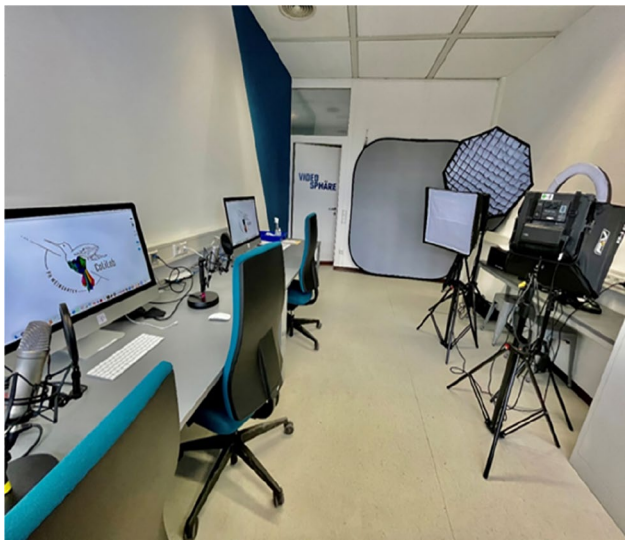

Fig. 3 Video lab as a part of the pedagogical makerspace [27], p. 236)

digital learning materials for teaching–learning processes, e.g., learning apps or explanatory videos. For this, students are requested to define their learning objectives, then deepen these areas and finally practice and consolidate the acquired knowledge by using concrete examples [18]. The idea is to provide students with all didactic, technical, and content-related tools they need to develop open content learning materials or explanatory videos of high quality. To achieve these goals a blended learning seminar in the field of media competence and media pedagogic competence is developed and media-supported self-learning materials accompanying the two media projects are researched and presented.

Based on findings that explanatory videos can have positive effects on knowledge acquisition and that their quality has increased significantly in the last years [10] the learning materials covers primarily explanatory videos on e.g. media didactic basics, procedural models of instructional design, motivational basics, and project management skills. Beyond explanatory videos, tutorials, interactive videos, recorded presentations, further literature, and links to platforms for Open Educational Resources (OERs) are provided as learning materials. Further, student-created materials with high quality ("good practice examples") will in turn be published as OERs to support re-use in the field.

Personal Support

A partially standardised tutoring process is implemented for both, the media-based teaching project, and the media development project. Qualified tutors are available to support student teachers in (a) identifying potentials and added value of digital media based on domain-specific and didactical objectives, (b) making appropriate use of possibilities, and (c) developing digital learning materials [27]. Since an adequate qualification of the tutors is an important success factor in the effectiveness of tutoring programmes (e.g. [4, 36], TEgoDi tutors are prepared for this demanding task by appropriate training). This training is designed as an accompanied self-study course/training programme using online materials as well as regular group meetings. It comprises the following five modules: (1) (media-)didactic basics, (2) tutorial basics, (3) communication and moderation, (4) media technology basics, and (5) project management [27].

In addition to the standardised tutoring process it is promoted that students help each other in the joint planning of media-based teaching–learning settings [21, 35]. This peer coaching approach targets mutual support and is supported by a corresponding workshop, considering the media-didactic orientation of the TEgoDi project. Furthermore, there is personal support by students' lectures to ensure the quality of using digital media to support teaching–learning processes. These lectures in turn are assisted by adequate support materials, discussion guidelines, observation forms or reflection instruments [16].

Learning Analytics

Learning analytics has the aim to provide students with personalized feedback on their self-guided learning activities and it is foreseen as a part of the support structures. Best practices [9, 42] as well as analytical process scenarios formed by visual analytics [28] guided us to implement learning analytics as a dashboard design. These dashboards provide students with an overview and insight into their individual development of digital media-related competencies and the effectiveness of their learning processes by visual processing and visualization of learner-related data [7, 8, 11].

Moreover, learning analytics is also used to give feedback on students' e-portfolios. Hereby, analytical approaches by Müller et al. [26] will be applied and extended to automatically identify missing required elements as well as provide overview depictions, to guide detailed analysis and to highlight exceptional or abnormal elements [27]. An important aspect hereby is that privacy issues and ethics in the handling of data are of major importance, so the TEgoDi dashboard using learning analytics is based on the principle of trusted learning analytics [14].

Evaluation

The implementation of two digital media-based projects in teacher education to promote digital media-related competencies of tomorrow' teachers is the goal of the TEgoDi approach. To foster the process formative and summative approaches are used with a focus on e.g. the acceptance, usability of measures, project effectiveness, and the overall impact of the TEgoDi project. The formative evaluation follows the iterative development procedure [1], which encompasses three major development loops. Each loop is evaluated using feedback from students and lecturers (as different target groups) and tutors or board members (as additional stakeholders). The summative evaluation focusses primarily on the effect of the two digital media-based projects on two levels: (1) On students level the central question is the effect on different individual variables, e.g. digital media self-efficacy [31] or digital media-related competencies [13]. (2) On the level of lectures the acceptance of digital media in teaching–learning processes [41] or the increased use of digital media during lectures are of interest. Further, it is intended to identify the critical success factors for sustainability of the implemented processes and structures as well as to publish them to transfer knowledge to upcoming projects with similar challenges [27].

Summary and Outlook

The TEgoDi concept represents an innovative approach to support student teachers' digital media-related competencies. It is characterized by a compulsory integration into an existing teacher education programme, thus addressing all student teachers at the university. Both media projects are an integral part of the teacher education programme and curricular anchored—which is a key factor for the sustainability of the TEgoDi concept [27]. This gives all lecturers the opportunity to integrate media projects into their courses. Nevertheless, they are not obligated to do so. It is however crucial that the students have sufficient offers to carry out both media projects in the course of their studies. The integration of media projects means that both groups have to work on additional content in the limited time available. This presents lecturers with a new challenge, which ultimately also raises the question of changes in the learning culture.

Supporting students and lecturers in dealing with the media projects, a support system is launched encompassing blended learning proposals, personal support, and learning analytics. Due to the TEgoDi approach lecturers also receive the opportunity to "refresh" their courses, the preparation for school practice phases or test new forms of exams. Since schools and universities often have different technical equipment, an essential approach is to give lecturers and student teachers the opportunity to test the provided equipment, to get a feeling for the creation of digital teaching materials. In addition, they shall be made aware of OERs and the possibilities they offer to decide whether they need to create new content or use or adapt existing materials to prepare their lessons (for school and university).

Our aim is to increase the participation of university departments and lecturers by discussing digital media-related competencies as a cross-cutting competence. Thereby, a common competence framework can serve as a basis for practice-oriented discussions and offers student teachers and lecturers' opportunities to reflect on their own teaching. In our point of view, the success factors of the TEgoDi concept are the project-based approach and the innovative strategical involvement of all subjects of the teacher education programme in the implementation strategy. Moreover, it must create an exploring field for students to try and test. Although we developed the TEgoDi approach in German higher education, it can be of relevance in any university for teacher education around the world [27].

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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest. The authors declare that they have no conflict of interest.

Ethical standards Principles of ethical and professional conduct have been followed.

Authors' note Graphics elements in Fig. 1 are from vectorjuice, pikisuperstar, pch.vector / Freepik.

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