

Integration of Digital Competences into a Teacher Education Program: A Sensitive Approach

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Abstract: Future teachers need sound digital competences in order to be able to identify and use the potential of digital technologies for teaching. In the TegoDi project, we are developing and implementing a programme to teach the necessary competences for all teacher education courses at our university. The concept of TegoDi is based on a media literacy competence model adopted from international reference frameworks such as DigCompEdu, TPACK and digi.kompP. The challenge of introducing the programme across the university is met by a change management approach that is participatory and implemented through change agents. The roll-out of the teacher education programme will be further complemented by support structures for students and teachers. Support structures for students draw on learning analytics to realise personalized feedback. Project effectiveness, acceptance and usability of measures as well as the overall impact of the TegoDi project will be evaluated repeatedly involving both formative and summative approaches.

1 INTRODUCTION

The need for digitalisation at schools and appropriate teacher education with regard to digital competences has been brought up in public discussions in the last years on a regular basis (e.g., KMK, 2020). The recent COVID-19 pandemic with its effects on schooling has made the deficits in these areas most visible. According to the Teaching and Learning International Survey (TALIS), only 53 percent of interviewed teachers in 2018 reported a frequent use of computer and information technologies in their teaching practice and 18 percent call for better professional development in the use of information technologies (Schleicher, 2020). McGarr and McDonagh (2019)

argue that there is a special requirement to prepare tomorrow's teachers for the fast-paced change of digital teaching and learning tools.

In this paper we present a comprehensive approach to the sensitive modification of a teacher education program, with mandatory curricular elements related to digital skills and competences required by teachers and the implementation of different support structures. In the center of this approach – called Teacher Education goes Digital (TEgoDi) – are digital media related projects, which have the power to initiate a process of digital transformation for the whole university. In a first step, we will disclose related theoretical and empirical work, which inspired our approach. In a

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second step, we describe the TEgoDi approach, providing a general overview and explanations of important elements. Finally, we summarize and introduce further challenges, based on first experiences with the presented approach.

2 RELATED WORK

The question of how prospective teachers can be better prepared to use digital technologies effectively and productively in their classrooms has been discussed for some time. While early concepts focused on isolated ICT training, more holistic and integrated approaches are being proposed today (see Falloon, 2020). Following this, we designed a project-based approach, which serves the needs of teacher education and keeps the challenges of implementation in teacher education programs in mind. Digital competences of prospective teachers are fostered by a media development project and a media based teaching project allowing students to develop their media-related competencies. Different support structures are implemented encompassing regular feedback based on learning analytics and tutoring.

When talking about media-related competence, terms like digital literacy, media literacy or digital competence are being used. However, these terms are still not clearly defined and often used synonymously (Godhe, 2019). While digital literacy is accused of focusing too strongly on fostering technological skills, the concept of competence is broader and also includes diverse knowledge, capabilities and dispositions needed by future teachers (Falloon, 2020). Thus, our approach for teacher education is mainly based on frameworks for digital competence, as for example the TPACK-model (Mishra & Koheler, 2006), the European Digital Competence Framework 2.1 (DigComp, Carretero et al., 2017), the UNESCO Global Framework on Digital Literacy Skills (Law et al., 2018) and the European Framework for Teachers' Digital Literacy *DigCompEdu*. The latter incorporates a cross-context reference framework which has been tested internationally at all levels of education from primary to higher education and establishes consistent European standards (Cabero-Almanara et al., 2020; Ghomi & Redecker, 2019; Redecker, 2017). In addition, a number of national frameworks encompassing digital competences of teachers, typically with a more restricted scope, such as the Norwegian *digital Bildung* model (Krumsvik & Jones, 2013), which refers primarily to teaching staff in upper secondary schools encourage our

competence model. Digi.kompP (Brandhofer & Wiesner, 2018) also falls into this category, providing a detailed competence grid, allowing an easier adoption in curricula and instructional design.

During their competence development students receive regular feedback based on online self-assessments and learning analytics. Our approach is inspired by the LASSI (Broos et al., 2017b) and LADA (Gutiérrez et al., 2018) dashboards. The first one provides targeted feedback to students with the close involvement of tutors. In contrast, the dashboard LISSA (Millecamp et al., 2018), maps the learning process on the university's learning management system (LMS).

Further, our tutoring concept highly relies on known success factors, like pre-qualification of the learning facilitators (e.g., Bierema & Merriam, 2002; Shrestha et al., 2009). Tutors also work with students' feedback based on students' online self-assessments and learning analytics. Beyond this, students will also be enabled to help each other in joint planning of media-based teaching-learning settings. As Schnebel and Kreis (2014) indicate, this co-working process is very useful.

Since digitalisation is a driver of change and does not spare higher education institutions, we rely on a professional change management embedded into our project. Taking into account the organisational characteristics of higher education systems according to Weick (1976) and Mintzberg (1983), the TEgoDi concept refers to the model of collective and participatory change readiness according to Graf-Schlattmann et al. (2020). Current findings concerning the importance of participation and self-determination (e.g., Akins et al., 2019; Falloon, 2020) are considered in the implementation process. Examples are the use of change agents and e-learning experts at faculty level, or the creation of internal boards allowing different stakeholders of the university to participate in diverse ways.

Finally, ongoing evaluation is considered a cornerstone for designing and implementing professional development approaches for teachers (Hobbs and Marks, 2020). So the effect of TEgoDi will be evaluated on two levels: on student level, i.e. the development of digital competences, and on the level of the change management process. On both levels the evaluation incorporates a comprehensive mixed-methods evaluation approach incorporating formative and summative elements (Maderick et al., 2016; Pettersson, 2018).

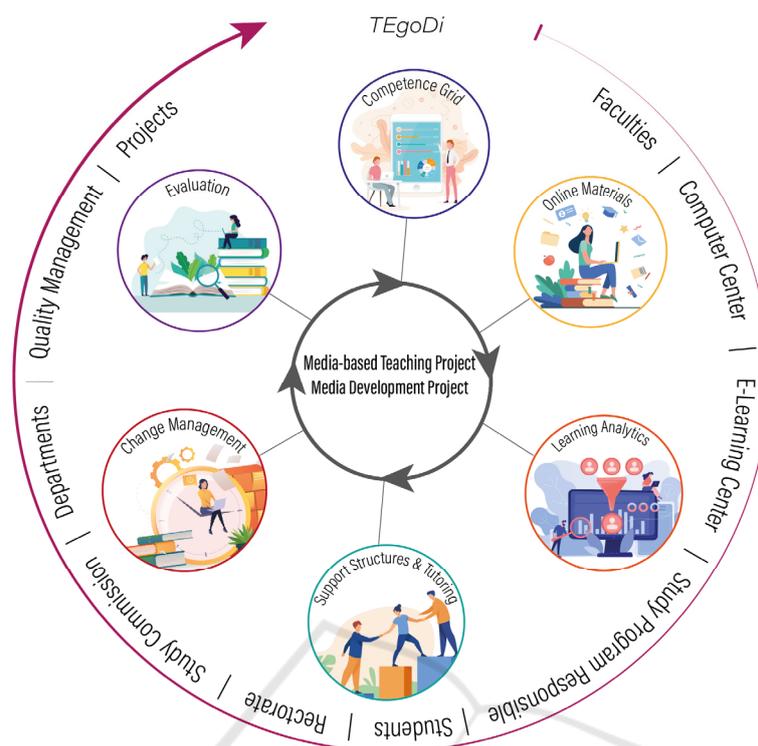


Figure 1: The TEgoDi concept.

3 CONCEPT

Fundamental elements and specifics of our concept are presented in more detail in the following section. First, the overall approach of the competence model of TEgoDi will be introduced, followed by sections on self-guided learning and support structures. Finally, the evaluation concept and the change management process will be presented.

3.1 Overall Approach

Many approaches to professional development for teachers follow a *one-size-fits-all* concept to technology integration that is intended to fit various subjects and skill areas. In practice, this leads to only partially satisfactory media education. It is much more important to understand the interaction of components in order to adequately prepare and rethink teaching and learning (Koehler & Mishra, 2009). At the end of their studies many students do not feel sufficiently and adequately prepared for the effective use of digital media in their own teaching (Kaplon-Schilis & Lyublinskaya, 2019). This circumstance will be addressed by the present approach.

The core of TEgoDi is to supplement teacher education curricula with compulsory additional coursework elements in terms of both, a media-based teaching project and a media development project (see figure 1). This project-oriented approach is based on two theories. The first one is situated learning (Lave & Wenger, 2008), which describes learning as a socially active process. The second is authentic learning (Herrington & Herrington, 2006), learning taking place in scenarios that are as realistic as possible or case-oriented. Based on the latter, teacher students may implement the projects within a university course, school internships, or in service learning scenarios. Corresponding project-based approaches did prove their effectiveness in various scenarios for teaching media competence (e.g., Banister et al., 2010) and TPACK (e.g., Papanikolaou et al., 2017).

In their project work, teacher students become practically acquainted with various framework models of media didactics (Kerres, 2013), as well as with various instructional design models of the first and second generation (Niegemann, 2008; Reigeluth & Carr-Chellman, 2009), enabling them to design and analyse media-supported learning situations. Further, they document their reflections and their

development of media (subject) didactic competences in an e-portfolio (Stratmann et al., 2009) based on the competence grid developed in the project (Stratmann & Müller, 2018).

First, the media-based teaching project addresses practical experiences in teaching with media and designing instructional embeddings, also fostering subject-specific competences and TPACK. Then, within the media development project, teacher students cooperatively design a media-based learning offer. This way they deal with corresponding approaches of instructional design or media didactic models as well as with subject-related content. An important element of TEgoDi is the certificate that will be issued to the students. This will document and attest the additional media-related competence they have achieved.

In order to better understand the needs of learners and lecturers, to design transparently the learning processes around the two media projects, and to orchestrate the different measures of TEgoDi in this context, we applied a scenario-based design approach and developed customer journey maps. Figure 2 shows an example of a student's journey through their studies, emphasizing the media projects and involved TEgoDi elements. Nine main steps were defined, that vary slightly depending on the selected project type.

After 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-Assessment (3) provides orientation about media competences and appropriate learning material to acquire necessary skills (4). Content and learning objects 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. A certificate confirms achieved skills and gained experience.

3.2 Digital Competences for Teachers

TEgoDi concept is based on a media literacy competence model adopted from international reference frameworks such as DigComEdu, TPACK, and digi.kompP. The TEgoDi model supports students in assessing the development of their competences. In addition, it serves to integrate ICT-related content systematically into the structure of the study programme and provides a reference framework for the development of an automated feedback system for students based on learning analytics.

During the course of the three-year project, the TEgoDi competence model will be further developed in iterative cycles. Also, it will be progressively operationalised by working out an interdisciplinary competence grid, which will be evaluated and concretized iteratively.

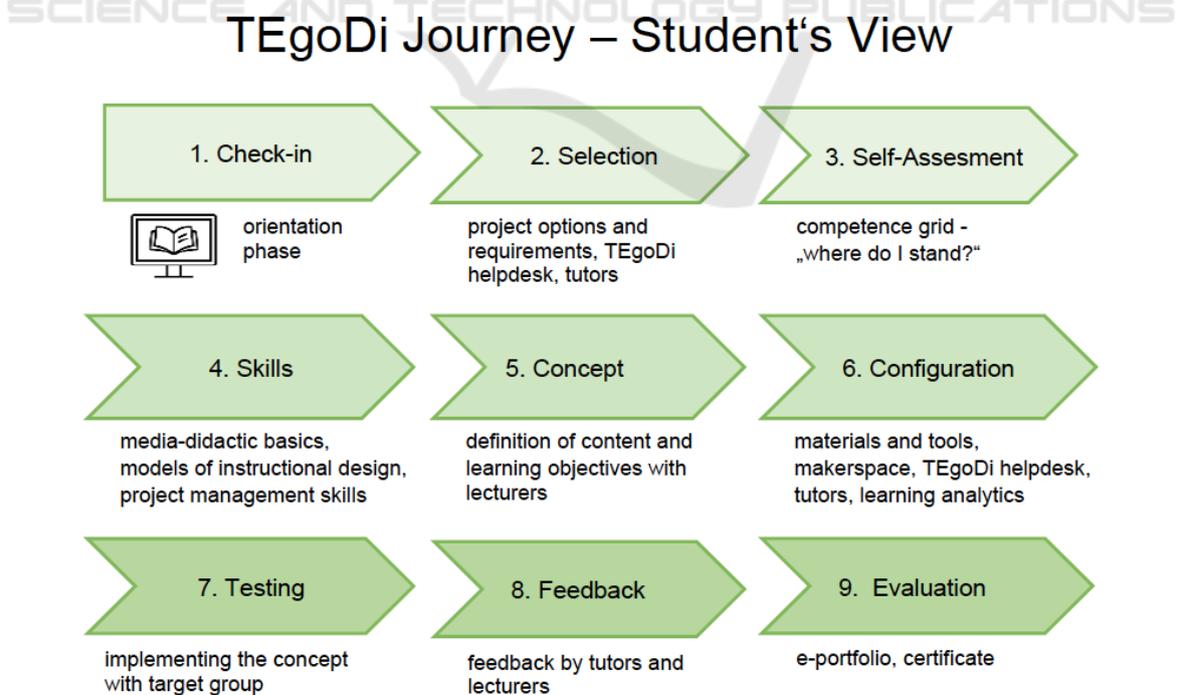


Figure 2: TEgoDi procedure was modelled using the customer journey method.

Professional action competences of teachers are at the core of the TEgoDi competence model. It links content knowledge, pedagogical knowledge and pedagogical content knowledge with a supplementary focus on further development of attitudes regarding media-based learning (Baumert & Kunter, 2011). From a pedagogical content knowledge perspective, the TPACK model according to Mishra and Koehler (2006) has been selected. Content thus plays a relevant role within the context of digitalisation-related competences.

In order to meet the different requirements of the addressed subjects the TEgoDi model is domain-specific. A lively exchange with the diverse departments of the university gives them the possibility to adapt the TEgoDi competence model to their respective subject didactics. Nevertheless, it should be noted that the operationalisation of TPACK competences is subject to pronounced variation within research (Willermark, 2018). For this reason, the inclusion of various established competence structure models from the field of teacher education, such as Baumert and Kunter (2006) or Blömeke (2003), is intended to counteract potential deficits.

3.3 Self-guided Learning

Self-guided learning includes a blended learning seminar in the field of media competence and media pedagogic competence. Furthermore, it also includes media-supported self-learning materials accompanying the two media projects. Online self-assessments indicate which additional learning materials should be provided to students. In formulating the learning objectives, competences from the competence grid were mapped to the learning objectives, divided into rough and fine learning objectives (Kerres, 2013), and the appropriate presentation medium was selected.

The online-based learning materials cover motivational and media didactic basics, procedural models of instructional design and promote basic project management skills. Students are prepared for their media project work and are accompanied in their learning process by tutors and additional support measures. This enables students to independently design learning materials for their lessons, e.g., explanatory videos, learning apps, etc. Learning objects are first presented, then deepened and finally practiced and consolidated using concrete examples (Kerres, 2013). Common formats are used for the distribution of learning materials. The learning units include interactive videos, links to platforms with Open Educational Resources, templates, checklists

and guides, recorded presentations and further literature. Generated materials will in turn be published as Open Educational Resources so that they can be used in the field.

The largest part in the distribution of learning materials are tutorials and explanatory videos. The potential of explanatory videos has always been very high, and in recent years the variety and quality of videos has even increased significantly (Dorgerloh & Wolf, 2020). Explanatory videos are characterized by thematic and creative diversity, an informal communication style and a diversity in authorship. Professionally produced educational videos usually focus only on central topics that address a broad audience. Open accessible explanatory videos also address very specific topics in detail, and thus achieve immense depth (Dorgerloh & Wolf, 2020). The goal is also to provide students with all the technical, didactic and content-related tools they need to develop open content-quality explanatory videos and learning materials themselves and, if necessary, to publish them. Students are able to use existing learning labs to develop and design teaching and learning materials (see figure 3). There they receive necessary equipment and support from tutors who are part of the support structures.

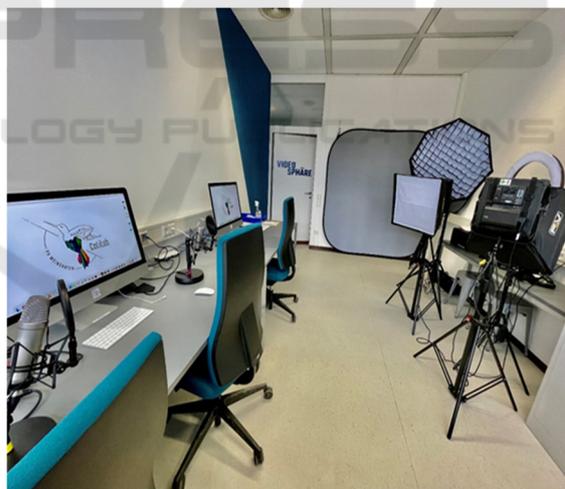


Figure 3: Video lab as a part of the pedagogical makerspace.

3.4 Support Structures

In order to support students in carrying out their projects and working with media, corresponding support structures are being established within TEgoDi. To this end, a wide variety of measures has been conceptualized and will be implemented stepwise, tested, coordinated and ultimately

implemented in a sustainable manner. These measures can be differentiated according to whether support is realised either by persons or with the help of adaptive digital learning material based on online self-assessments and learning analytics. In addition to demand-oriented tutoring, personal support includes peer coaching by other students as well as learning support by lecturers.

3.4.1 Personal Support

During the implementation of their projects, the students are accompanied by a partially standardised tutoring process. Depending on their individual situation, qualified tutors are available to support them in identifying potentials and added value of digital media based on domain-specific and didactical objectives, in making appropriate use of possibilities and in developing digital materials. Here, an important success factor is prior qualification of the learning facilitators (e.g., Bierema & Merriam, 2002; Shrestha et al., 2009). Accordingly, TEgoDi tutors are prepared for this demanding task by appropriate training, which is designed as an accompanied self-study using online materials. It comprises the following five modules: (1) tutorial basics, (2) (media-)didactic basics, (3) communication and moderation, (4) project management, and (5) media technology basics.

In addition to the supervision by tutors, mutual support of students in terms of peer coaching (Kreis et al., 2017) is promoted. For this, a corresponding workshop offer has been designed, taking into account the media-didactic orientation of the TEgoDi project. In this way, students will be enabled to help each other in the joint planning of media-based teaching-learning settings (Schnebel & Kreis, 2014).

In order to ensure quality of teaching students are also supervised by their lecturers. In order to support those lecturers in working together with the students on planning and reflecting media-based learning scenarios in a theory-based manner (Janssen et al., 2013), adequate support materials, for example discussion guidelines, observation forms or reflection instruments are developed and provided within the framework of the project.

Linking these three measures is promoted in TEgoDi, as there will always be overlaps between tutoring, peer coaching and learning support by lecturers when providing demand-oriented support to students. Concepts are also being developed at an early stage to combine these support structures efficiently and purposefully with learning analytics.

3.4.2 Learning Analytics

In addition to the support structures mentioned above, learning analytics represents an important element in TEgoDi, providing personalized feedback to students, especially in the prevailing self-guided learning activities. As such, learning analytics elements and concepts are highly integrated within the foreseen support structures. The immediate consideration of learning analytics as an integrated element in a curriculum modification represents an important innovative approach in this project. Personalized learning analytics dashboards provide students with an overview and insight in their personal development and the effectiveness of their learning processes through visual processing and visualization of their learner-related data (Broos et al., 2017a; Ebner et al., 2015). In relation to the tutoring concept, this data represents an opportunity for personal feedback on the projects already described by a qualified tutor if required. Not only should students be shown certain identifications of potentials and possible stumbling blocks through the use of the learning analytics dashboard, but the tool offers also the possibility to personalize the learning environment based on the data.

Dashboard design is guided by established best-practices (e.g., Charleer et al., 2014, Verbert et al., 2013) as well as analytical process scenarios formed by visual analytics (e.g., Munzner, 2015). In principle, data will be collected from the university's learning management system (LMS) and stored in a learning record store. In this context, learning analytics also guides the conceptualization and implementation of learning material, providing for adequate monitoring of learning processes and allowing for valuable didactic feedback.

Following best practices in the implementation of learning analytics at an institutional level (e.g., Broos et al., 2017a), another important and valuable source are self-assessments of students, integrated into personal learning processes on a regular basis. Learning analytics is also to be applied to support the assessment of students' achievements in terms of project descriptions and experiences in their e-portfolios. Here, analytical approaches for the analysis of e-portfolios (e.g., Müller et al., 2016) will be applied and extended, to automatically identify missing required elements as well as providing overview depictions, to guide detailed analysis and to highlight exceptional or abnormal elements. In general, privacy issues and ethics in the handling of data are of major importance. In specific, a high level of trust on the part of the students is required. In this

context, all concepts are based on the principle of *trusted learning analytics* (Hansen et al., 2020).

3.5 Evaluation

Project effectiveness, acceptance and usability of measures as well as the overall impact of the TEgoDi project are evaluated repeatedly involving both formative and summative approaches. Following an iterative development procedure based on agile project management (Allen et al., 2012), the entire process is designed with three major development loops. Each loop is evaluated extensively, including feedback from the different target groups (students and lecturers) and additional stakeholders (e.g., tutors, board members), using the results for tailoring and implementation processes. The evaluation will be conducted using mixed methods, e.g., from the fields of usability engineering and user experience design.

The development iterations correspond to the following stages: (1) The first stage involves a comprehensive needs and context analysis to inform the development of measures, the selection and adaptation of validated instruments to measure the designated constructs, e.g. digital competences (Ghomi & Redecker, 2019), digital media self-efficacy (Pumptow, 2020), or acceptance (Venkatesh & Bala, 2008), followed by pre-piloting and revision. (2) The next stage comprises the implementation-focused formative evaluation of measures across two academic years, facilitating any needed refinements. (3) The last stage comprises the university-wide implementation of measures accompanied by a longitudinal summative evaluation study to assess and foster students' digital competence development and ensure suitability of measures. Different cohorts of students (i.e., different semesters) participating in the project are surveyed four times, prior to semester start. Students for teaching degrees (primary and secondary) from other universities serve as a control group.

In addition, the effects of the TEgoDi project on the digitalisation of teaching at the university as a whole will be recorded and analysed periodically as part of the institution-wide monitoring cycles. An overall concern of the evaluation endeavor is to identify the critical success factors for sustainability of the implemented processes and structures. Generalizable findings of efficacy and lessons learned will be published in order to transfer knowledge to upcoming projects that face similar challenges.

With contemporary and interactive evaluation methods the research team strives to promote a positive evaluation culture viewing the university as a

learning organization by incorporating in-depth feedback from important stakeholders, to facilitate and transform its processes and structures continuously. Furthermore, capacity-building activities based on a collaborative self-evaluation approach are employed to enhance internal processes.

3.6 Change Management for Curricular Innovations

The expansion of the curriculum through compulsory coursework is intended to systematically anchor the cross-sectional competence of media literacy in all subjects. Therefore, it represents an innovation and change for study and teaching. Media projects that are successfully integrated into the curriculum contribute to the overall digitalisation of the university. In order to steer and successfully implement project driven changes, a smart and well adjusted change management is needed. A classic approach often used in practice is the stage model by Kotter (1995). However, this approach is often described as inadequate taking little account of the special nature of German higher education system (Stichweh, 2005). In Kotter's stage model, willingness to change is generated by a given vision and strategic leadership. However, university's decision-making processes, especially with regard to changes in the university's teacher education program, are not organised top down, but take their course through the university's faculties and departments (Graf-Schlattmann et al. 2020). In addition, there are other special organisational characteristics, such as resource problems, especially in the IT infrastructure.

Taking all this into account, TEgoDi applies a participatory change management approach, promoting and maintaining collective willingness to change in the entire university. This approach is comparable to the model of collective readiness for change developed by Graf-Schlattmann et al. (2020). Furthermore, change agents attached to the faculties act as experts for e-learning. They promote and mediate communication and cooperation between lecturers, university management, faculties and project staff.

In a loosely coupled system such as the university (Weick, 1976), it seems to make sense, with the involvement and support of this collective approach, to offer the actors, i.e. the professors, as much freedom as possible, to provide suitable support and incentive structures and to perceive and involve them as experts in their field. The goal for each subject is

to develop its own good practice examples how to foster media and information literacy skills in their specific domain. To this end, change agents are holding talks with all departments to form a common vision and relevance for the topic of media competence in teacher training (Getto et al., 2018). Within the departments, *early adopters* are identified and ideas that have emerged are made transparent and fed back into the community (Rogers, 2003; Reinmann, 2015, 2019). Furthermore, change agents support the systematic expansion of the curricula through individual and group coaching. At the same time, the need for further training is to be assessed in order to offer the teachers suitable further training in the form of bar camps, workshops, online seminars, etc. at a later stage of the project.

This approach is intended to take into account the identified variables for action according to Graf-Schlattmann et al. (2020): professionalism and freedom, recognisable benefits, coordination and networking, transparency and visibility as well as support structures, and to increase the collective willingness to change.

In order to ensure sustainability of the project, regular meetings are held with all stakeholders of the university to reflect on and adapt the approach. At the strategic level, representatives of the computer centre, of the central e-learning institution, the university management, as well as the faculties and deans for studies and teaching are taken into account. Project staff take part in the university's working groups and organise informal coffee rounds and interactive university formats in order to implement the participatory approach throughout the university.

4 SUMMARY AND OUTLOOK

The TEgoDi concept presented in this paper represents an innovative approach in its combination of all elements and its integration into all subjects of teacher training, so that teachers of the future will be digitally competent. However, it is precisely this innovation of the broad and systematic introduction of media projects that also poses the greatest challenges. It implies a change in the culture of teaching and learning. The project-based approach gives student teachers the opportunity to develop and reflect on their media competences, especially their subject related media didactic competences. A comprehensive support system based on a specific and well adapted competence grid, with needs oriented online materials and tutorial support, learning analytics and other feedback structures are

necessary to make the media projects possible and not to burden lecturers and departments with further work effort.

A key factor of sustainability and success of the TEgoDi project is the curricular anchoring of the media projects. In this way, the media projects get the chance to be perceived not just as an add-on, but as integral part of teacher education. Lecturers are open to involve the projects in their lessons their way. Due to the TEgoDi support structures, lecturers get 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 teacher students the opportunity to test the provided equipment in order to get a feeling for the creation of teaching materials. In addition, they shall be made aware of Open Educational Resources and the possibilities they offer in order to decide whether they need to create new content or can use existing material to prepare lessons (for school and university).

A curricular change for the entire teaching profession is a major and complex challenge. In addition, many different stakeholders are involved, who have different previous experiences, needs and fears. Not only personal variables, but also organisational ones, such as the described peculiarities of the German higher education system, determine the discourse and dynamics of change. In addition, there are political requirements as well as challenges in the digital infrastructure. Currently, there is a strong commitment to digitization in schools. However, the question of resources is a central challenge, as there is a personnel and financial dependency on political priorities.

Our aim is to increase participation of university departments and lecturers by discussing media literacy as a cross-cutting competence. Thereby, the competence grid serves as a basis for practice-oriented discussions and offers teachers opportunities to reflect on their own teaching. Furthermore, this will allow for a coordinated adjustment of topics related to the competence grid across all subject fields in the teacher education programs. This process is supported sensitively by change agents, fostering a careful integration of digitalisation-related elements into courses, with iterative improvements and regular evaluations.

The success conditions of the TEgoDi concept are the project-based approach, the inclusion of the European competence frameworks, like DigCompEdu, and the innovative strategical involvement of all sections of teacher training in the

implementation strategy. Moreover, it must create an exploring field for the students to make trials and tests. Even if we developed the TEgoDi model taking into consideration the processes in the German high education, it can be used in any university for teacher education around the world. The competence framework is partially based on DigCompEdu, which is already a standard at the European level. Moreover, our approach is interdisciplinary, which means that the model can be successfully applied in language teaching or biology, for example. Each subject can use and adapt the competences which are more defining in its field. Last but not least, the model can be applied and customized to different technical levels. It is not related to a certain minimum technical requirement.

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