Design for System Change: Developing Digital Competences of Vocational Teachers

Sabine Seufert, Josef Guggemos, and Eric Tarantini(✉)

University of St. Gallen, Guisanstr 1a, 9010 St. Gallen, Switzerland
{sabine.seufert, josef.guggemos,
eric.tarantini}@unisg.ch

Abstract. Digital transformation shapes the educational system in many ways. It has also far-reaching implications for teachers as their job description may fundamentally change in the future. In this light, it is important (1) to identify necessary digital competences of teachers and (2) to find ways to foster those competences in an efficient way. By means of a literature review and expert interviews, we developed a framework of teachers' digital competences. In line with Baumert and Kunter (2006) as well as Koehler and Mishra (2009), it comprises content knowledge, pedagogical content knowledge and pedagogical knowledge. However, these facets have extended meaning in the context of digital transformation. Moreover, our framework considers the official EU competence framework (Carretero et al., 2017) and hence covers instrumental skills and knowledge in handling digital media. We successfully validated our framework by means of structural equation modelling with a sample of 215 Swiss teachers. Utilising an Importance Performance Map Analysis, we identified competence facets that show the highest effects on the (self-reported) use of digital media and content. For efficiently fostering those facets, we established a webinar series in order to provide further education service regarding topics like digital teaching and learning.

Keywords: Digital competence of teachers · Formal learning · Informal learning · Systematic change

1 Introduction

One would be hard pressed to find a topic of current debate in education policy and educational practice that is as exhaustively discussed as the (proper) handling of the digital transformation (e.g. 'standing conference of the ministers of education and cultural Affairs' [KMK], 2016). A widely shared perception is that a more intensive use of digital media in the classroom will improve learning effectiveness, facilitate greater orientation to the future needs of learners, and support accompanied personality development in a digital society. The sweeping pressure to make changes is marked with a high degree of uncertainty regarding the use and benefits of digital media in schools [6].

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Teachers addressing digital skills, such as the competent handling of online information, are often entering uncharted territory in their respective fields (media education). In this context, teachers are increasingly asking for inclusion of media-specific qualification objectives. However, the kind of competences teachers need to acquire remains somewhat vague and is largely limited to the use and operation of computer applications and digital content media [5, 6]. Furthermore, it is obvious that formal seminars, such as one-day training workshops on how to use ICT, are neither sufficient nor effective for developing teachers' digital competences. On the contrary, successful support initiatives to develop teachers' competence will have to be rooted in their particular context and simultaneously embedded in innovation strategies and quality development processes in their respective schools [33]. The conceptualisation and design of suitable training measures for teachers requires a systematic approach to the professional development of teachers at vocational schools. Developing professional communities among teachers to underpin the benefit of learning together and from each other is of central importance [19]. Learning communities that make use of the potential of digital information and communication are becoming increasingly important as a means of continuously fostering teachers' digital competences. However, there is a research gap in the promotion of digital competences for teachers [13, p. 15]. In this light, this paper focuses on three research questions:

(1) How can digital competences of teachers be defined and measured?
(2) How can measures and interventions to be designed and evaluated for developing teachers' digital competences?
(3) How can teachers' professional development be interlinked with school development for a systematic change?

The paper consists of three parts. In the first part, we consolidate relevant theoretical considerations. The second part outlines the research methodology and the results of the research conducted. The third and final section discusses the results of the study and presents a perspective for further research.

2 Review of the Literature

2.1 Digital Competences of Teachers

An important point of reference is a highly regarded model of professional teaching competence, which comprises professional knowledge, convictions in the sense of personally biased basic orientations, values, motivational orientations and self-regulation (for empirical findings on professional knowledge in the commercial sector, cf. [51]) [7, 23, 24]. Professional knowledge consists of content knowledge, pedagogical content knowledge and pedagogical knowledge. This division can be traced back to Shulman (1986, 1987). Koehler and Mishra (2009) added technological aspects to these facets of professional knowledge. They include technological knowledge as a new, disparate type of knowledge.

Current technological developments, such as artificial intelligence and cognitive computing, are flanked by fundamental questions about which digital competences teachers need to possess.

Moreover, approaches for developing media skills [3, 5, 6, 27, 34, 40] might be taken into account. In this vein, Blömeke's (2003) model is an approach that refers to teacher training. It distinguishes five areas of competence: 'didactic media competence', 'educational media competence', 'socialisation-related competence', 'school development competence', and 'personal media competence'. The demands faced by a vocational school in the light of ever-increasing digitalisation cannot be tackled through the efforts of single individuals. In such a case, the individual teachers would quickly feel overworked [36]. In the light of digital transformation, appropriate advisory and organisational knowledge regarding cooperation in teams and networks can thus be regarded as a relevant facet of competence for the joint development of teaching and schools.

For vocational education and training, the official EU competence framework [9] is leading the way because it defines cross-vocational digital competences (in the sense of "digital literacies"), which can be specified in the Europass European Skills Passport[1] in the form of self-evaluations. The KMK Strategy 2016 follows a similar path, identifying six areas of competence for education in the digital world – comparable to the EU competence framework [22]. However, the implications for professional teaching skills have remained (as yet) ambiguous.

Empirical findings on technology-mediated learning (TML) indicate that affective-motivational characteristics of the instructor are a decisive factor influencing the educationally effective use of digital media in the classroom [14]. Teachers have widely divergent views regarding the extent to which the lessons themselves should undergo digital change [32].

2.2 Professional Development of Teachers

Teacher training and its effectiveness is a field of research that has great untapped potential [39]. Currently, there are virtually no studies that demonstrate the effectiveness of measures for digital competence development [25] [26, p. 228]. According to Terhart et al. (2014, p. 517ff.), the efficacy of training measures must be considered on a case-by-case basis. Since this can be influenced by countless variables and contextual factors (class, teacher, setting, quality of training content, diverse and challenging learning opportunities for teachers, etc.), Terhart (2014) proposes that it is practically impossible to distinguish generally applicable quality standards.

Multiple studies have shown that teachers develop their skills mainly in the informal context of their professional practice, i.e. in exchange with colleagues or through individual, critical reflection [17, 21, 28]. As a result, international research literature on teacher education and training is especially focused on "integrated learning at the workplace", which is increasingly aimed at informal learning and reflective

[1] The Europass aims to provide a way to present qualifications and competences in a way that is transparent and understandable throughout Europe, cf. https://europass.cedefop.europa.eu/de.

dialogue among the teaching staff [28]. For this reason, strong learning environments are based on design principles from a socio-constructivist perspective in the context of informal learning theories. Team and community-based learning may be considered one of the most effective and predominant learning methods in this context and it is against this backdrop that the construct of the professional learning community should be mentioned. According to Hord (1997), PLCs involve groups of teachers or the entire teaching staff at a school that are jointly and constantly seeking ways to increase the effectiveness of their teaching, sharing what they have learned, attempting to put new ideas into actual practice, systematically testing these ideas and reflecting on them [18]. New competence requirements in the wake of increasing digitalisation necessitate ongoing (further) education that is marked by a high degree of speed and innovation dynamic. Teachers can no longer implement these changes individually and in isolation from one another in their day-to-day school routine. Bonsen and Rolff (2006, p. 170) therefore propose "the combination of community and professionalism" in times of turbulent change. In general, experimental testing of new approaches is risky. Hence, it requires continuity and a stable framework for developing common value patterns [7]. Effectiveness studies on PLCs have produced key success factors: Shared practice [19], reflective dialogue, deprivatisation of teaching (teaching is a personal, but not a private matter), common focus on students' learning (shifting the focus from teaching to learning), and fundamentally reinforced cooperation [29].

3 Method

3.1 Design

First, it is necessary to delineate professional competences of teachers in the context of the digital transformation. The resulting framework concept must then be systematically differentiated. For the subsequent test development phase, it is imperative to take into account the purpose of the measurement and the intended use of the results [1, p. 75f.]. The purpose of the measurement is to assess teachers' digital skills for formative purposes. The results should serve to identify potential for improvements and to design appropriate support measures. With this in mind, we have designed a self-assessment tool that has been validated using confirmatory factor analyses. Since the aim of our research is to identify adequate professional development measures, which is within teachers' own interest, we regard a self-assessment instrument as suitable. Finally, the research shall lead to measures in order to develop professional, digital competences of vocational teachers.

In collaboration with five partner schools from German-speaking Switzerland, we have developed items that capture the constructs described in Sect. 2.1, cf. Table 1. The items are measured on a 7-point rating scale. We have validated the instrument by means of 12 expert interviews. The experts show a diverse background: Training representatives of companies, researcher in the field of digitalization, school principals, educational policy makers and federation representatives. Moreover, we carried out five focus group discussions with teachers at every partner school.

We utilised an importance-performance map analysis (IPMA) [31] to assess teachers' competences and promising fields for improvement. This method, though not yet widely used in the PLS-SEM context, enables a clear and theoretically justified presentation of the results for a baseline evaluation. The first dimension (Importance [I]) of the importance-performance map depicts for each construct, cf. Table 1, or item its impact on a previously specified construct. In our case, we utilize frequency of use (measured on a 5-point rating scale) as the target construct, cf. Table 2. For instance, a value of 0.1 for "pedagogical knowledge" would indicate that an increase in this construct by one unit on the rating scale increases the expected frequency of digital media use by 0.1 units. IPMA also considers indirect effects. This enables us to identify measures that are potentially most beneficial in terms of increasing the frequency of use of digital media. The second dimension (Performance [P]) places each construct or item on a scale from 1 to 100, indicating how pronounced the construct or item is among the teachers studied. A value that is low compared to other constructs or in absolute terms may indicate a potential for improvement. When selecting interventions, the focus should be on constructs that have a comparatively strong impact on the target construct and are not (yet) close to the maximum. We discuss IPMA-results in focus group interviews with school administrations and specialist representatives from pilot schools.

3.2 Instruments and Data Analysis

The final instrument for capturing teachers' digital competence consists of 86 items covering 11 constructs (10 facets of digital competences, cf. Table 1 and frequency of use, cf. Table 2). 215 teachers at nine Swiss vocational schools act as a sample. 50% of them are female. On average, they are aged 45 (SD = 6) and have 18 (SD = 10) years of teaching experience. The lack of normal distribution for all items is noteworthy (Shapiro-Wilk test: $p < .05$). Overall, 3.9% missing values occurred. The absence of values does not follow any specific pattern. A Little's MCAR test performed taking into account all context variables was not significant ($\chi^2 = 3616$, df = 3297, $p = 1$). We also checked for outliers using Mahalanobis distances. However, we did not exclude any observation.

Table 1 provides an overview of the 10 competence facets measured by a seven-point rating scale: From "very low" to "very high" (content knowledge, pedagogical content knowledge) and from "does not apply at all" to "applies very strongly" for all other facets (see Table 1).

Table 2 shows the three elements of the target construct "frequency of use". They are measured on a 5-point rating scale: Never, infrequently (1–2 times per semester), occasionally (3–5 times per semester), frequently (every month), very frequently (every week).

Overall, we consider our instrument suitable for a comprehensive and valid formative assessment of digital competences as well as for competence development among teachers.

Table 1. Facets of teachers' digital competences including sample questions.

Professional knowledge (classroom level, school level) with respect to digitalisation	Instrumental skills and knowledge in handling digital media	Affective-motivational characteristics related to digitalisation
Classroom-oriented professional knowledge *Content knowledge:* (1) General knowledge about digitalisation (e.g. "My basic knowledge about decisive principles of digitalization is…") (2) Business knowledge about digitalisation (e.g. "My knowledge about digital value chains is…") *Pedagogical Content knowledge:* (3) Knowledge about digitalisation as a school subject, (e.g. "My knowledge about teaching digital value chains is…") *Pedagogical knowledge:* (4) General knowledge of digital media (e.g. "I am able to use digital assessment tools for students' summative assessment") (5) Promoting students' interdisciplinary digital skills (e.g. "I am able to foster my students' digital skills to use online information") (6) Media didactics (e.g. "I am able to select adequate learning videos for students' knowledge creation") Professional knowledge at the school level: (7) Advisory and organisational knowledge (e.g. "I am able to support my colleagues to improve professional practice in terms of digital content and digital media use")	(8) Digital skills: – handling digital information (e.g. "I can efficiently use search strategies to find online information"); – creating digital content (e.g. "I can create learning videos"); – digital collaboration (e.g. "I can efficiently use digital communication tools"); – ensuring digital security (e.g. "I regularly check my security settings of my digital devices and/or applications"), – digital problem solving (e.g. "I can regularly keep up-to-date my skills in handling digital media/tools); – specific applications (e.g. "I can use profession-specific applications (e.g. Office applications)"	(9) Positive attitudes (e.g. "I like using digital media/tools in my instruction") (10) Negative attitudes (e.g. "I am afraid of making mistakes when using digital media/tools in my instruction")

Table 2. Target construct 'frequency of use' including sample items.

Frequency of use	Sample items
Digitalisation as a class subject (professional, interdisciplinary) Use of digital media for individualisation General use of digital media	How often do you consider digital related topics in your instruction? How often do you foster students' competences when dealing with digital media (e.g. dealing with online information)? How often do you practice individualisation of your teaching according to the learning progress supported by digital media? How often do you practice individualisation of your teaching according to learning preferences supported by digital media? How often do you use blended learning scenarios (e.g. flipped classroom)? How often do you use digital learning arrangements in your instruction?

4 Results

4.1 Competence Facets and Data Analysis

Test validations by means of confirmatory factor analyses generally yielded good values for all eleven constructs (CFI > .974, TLI > .966, RMSEA < .093, SRMR < .036). Measurement invariance analyses demonstrate the instrument's suitability for assessing competence development as well as group comparisons in terms of gender, age and teaching expertise. Frequency of use can be adequately explained using the facets of digital competence ($.36 > R^2 > .26$).

It is important to view the facets of competence in context, and to systematically foster all of them. However, developing all facets of competence at the same time would likely overtax the teaching personnel. Therefore, the next step will be to concentrate on selected competence facets within the framework of an online PLC. In line with the IPMA (baseline evaluation), these would primarily encompass the following:

- **Media didactics** (CFI = .979, TLI = .970, RMSEA = .059, SRMR = .030). This facet of competence exhibits both a low self-assessment and a high level of effect on the frequency of use of digitalisation and on teaching with digital media; the findings show that digital media is primarily used for instructional knowledge acquisition (e.g. use of learning videos), but less for constructivist and cognitive processes, such as for discussion, reflection or for forms of action-oriented teaching and learning (e.g. simulations, multimedia applications).
- **Pedagogical knowledge** (CFI = 1.000, TLI = 1.000, RMSEA = .000, SRMR = .003): General, interdisciplinary knowledge of digital media also shows a rather high importance and a moderate performance. In this area, competence diagnostics with digital media in particular constitutes a knowledge gap for many teachers (this is accompanied by the relatively low values for formative and summative

self-assessments in the competence facet of media didactics, which basically represents the concrete implementation level);

- **Fostering students' digital skills** (CFI = .990, TLI = .982, RMSEA = .058, SRMR = .024). Teachers give the lowest rating to their ability to promote their students' knowledge acquisition of digital media. Against the requirements in vocational education and training, this finding is alarming and illustrates how pressing the need for action to develop the skills of teachers in this area is.
- **Instrumental skills and knowledge in handling digital media** (CFI = .974, TLI = .966, RMSEA = .069, SRMR = .036). This competence facet also has a relatively strong effect on the use of digital content and digital media. The importance of the inclusion of digitalisation related topics in the classroom is even higher than that of the use of digital media in the classroom. A teacher who seems to be more active in the 'digital world' is more likely to recognise the necessity and become familiar with concrete application possibilities in order to integrate digitalisation topics into the classroom in a didactic manner.

In sum, media didactics has a particularly positive influence on the use of digital learning arrangements. There is potential for improvement, particularly in the digital assessment of learners' competences (summative and formative).

The results show, that the average teacher is never or casually (Median = 1 and 3, respectively) actively working with digital media within his lecture (Blended Learning). This is an illustration for the trend that schools are at the very beginning of digital transformation (Fig. 1).

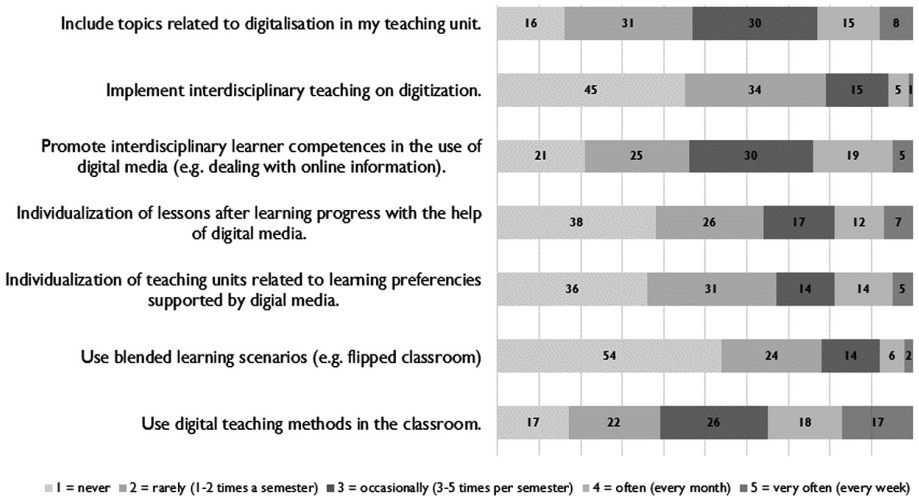

Fig. 1. Frequency of use (percentages).

4.2 Teacher's Professional Development in Formal and Informal Learning Settings

The following section focuses on the importance of the skills development of teachers in this context. Heise (2007) particularly emphasises the importance of largely self-directed further education in this professional field. To support and strengthen these desired informal learning activities, it might be vital to create an environment conducive to communication within the school organisation. The targeted encouragement of professional discussions before classes begin or during breaks and the use of free periods for detailed reflection, for example on critical practical situations, can make an important contribution to triggering and promoting informal learning among teaching staff [15]. However, not all teachers will be willing or able to collaborate with their colleagues on the preparation and follow-up of the classes. On the contrary, a certain proportion of teachers usually work alone, which might make a different kind of support necessary than would be required for teachers that already cooperate or collaborate with one another [17]. A concept to promote informal learning tailored individually to the aims and objectives of teachers could therefore generate benefit for curriculum and school development.

In the field of information literacy, for example, the pressure on teachers to seek further education has increased immensely due to the constant and rapidly advancing technological development (Fig. 2).

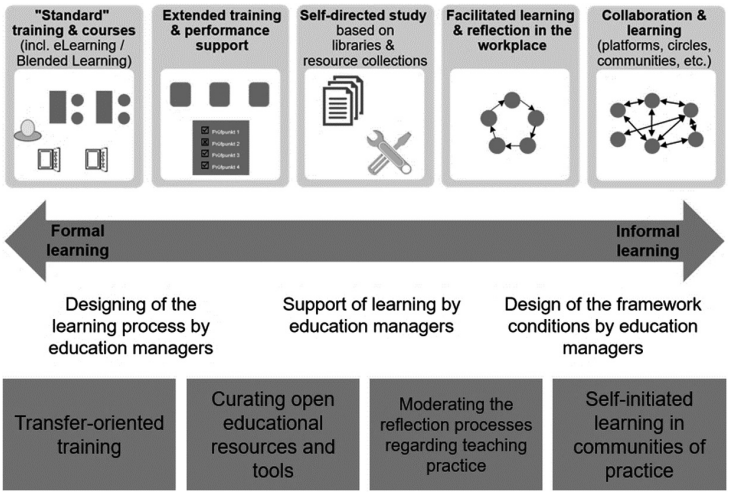

Fig. 2. Teacher's Professional Development in formal and informal learning settings.

A main question for schools to address can be summarized as follows: How might skills development measures for teachers that integrate learning in informal contexts be structured in practice? Some examples are outlined below (see following illustration):

Transfer-Oriented Training. School-based training services (SBT) are nothing new. However, it is now often combined more than was the case in the past with measures that support the transfer of what has been learned (such as preparatory phases and follow-ups). Effective results can for example also be achieved with more open learning environments, such as Engestrøm's Change Laboratory® [13]. In such a framework, it would be possible to re-design courses in a professional association and hence combine the skills development of teachers with innovative strategies for curriculum development in schools [18, p. 12]. Whether or not the transfer of training or further education into the everyday life of teachers succeeds, largely depends on individual factors [17]. An open mind towards new ideas and the willingness to adopt and implement innovative proposals is the prerequisite for initiating and implementing change processes in school routine. How teachers learn informally differs from one individual to the next [17]. This aspect should be considered when developing further education concepts and should lead to a sense of openness with respect to the curriculum, so that it is possible to adapt learning processes to the individual needs. One significant benefit provided by the required openness is the opportunity to obtain feedback on the learning progress. For example, Zwart et al. (2008) suggest providing teachers with a "peer coach", who can help them reflect upon what has been learned [17].

Curating Open Educational Resources and Tools. Open educational resources are defined as teaching, learning and research resources that "reside in the public domain or have been released under an intellectual property license" permitting their free use [3, p. 4]. It is important that educators have access to tools that highlight valuable resources [38, p. 240]. The adequate management of user communities, multiple information sources and online platforms is crucial to gain effective experiences in "digital-rich learning environments". The success of open educational resources lies in four essential components: The convergence toward common metadata, an adequate balance of experts' and community's definitions of quality, community input and interoperability. The last term indicates that it would be more efficient if "a single query could search across multiple online collections". This means that the educator does not have to visit multiple websites.

Moderating the Reflection Processes Regarding Teaching Practice. Critical, individual reflection upon one's own teaching represents a central impetus for the skills development of teachers [28]. A change in thought structures and hence upskilling is possible especially when the teacher experiences cognitive dissonance, i.e. inconsistencies between their own perception and how they actually experience critical teaching phases [38, p. 410]. This raises the question as to what extent such learning options can be promoted in order to initiate appropriate reflection processes. The findings of the group led by Zwart et al. (2008, p. 990) show that informal talks with students from the perspective of an observer offer a valuable learning option. Other examples involve mentoring programmes in which students act as trained mentors and assist the teacher in teaching with notebooks. "Reverse mentoring" is currently enjoying growing popularity even in business. Trainees who are familiar with and able to use digital media critically act as mentors for senior managers and help them find their way in the new digital world. It remains to be seen whether this is merely a short-term fad, or if it will become established as an element of a changing learning and management culture.

Reverse mentoring could also be an approach for the school learning environment to compensate for any lack of media skills on the part of teachers by using the potential of the digital natives. In this way, the students' resources could contribute to the informal skills development of the teachers.

Furthermore, other forms of mentoring, such as near-peer shadowing, are capable of triggering reflection processes among teachers and thereby promoting the informal skills development [28]. Experimenting with new teaching methods (whether adapting a theoretically recognised concept, copying a colleague's method or developing one's own new idea) and even the immediate feedback from a colleague contributes substantially to the informal learning of teachers [17] [28, p. 90]. In this regard, mentoring programmes can be orchestrated in different ways, i.e. the proportion of informal and formal elements of the learning process vary greatly [10]. The degree of refinement of the framework, such as the concrete learning setting, the place of learning or the general process, influences the "predictability of chance" in the further education for teachers and generates an added value for the school organisation and the learners.

Self-initiated Learning in Communities of Practice. The idea of the near-peer mentoring entails a practice-oriented community of people (community of practice according to Wenger [1998]), who are informally linked with each other, are faced with similar tasks and shape the practice in this community through a self-organised exchange. "Professional Learning Communities" in the teaching profession have long been a popular research field [19], but the effects of professional learning communities have yet to be researched in detail [38, p. 408]. The basic consensus in the literature seems to be that community-internal characteristics – such as high motivation for self-development and student focus – are required in order to address a deeper level of reflection in teachers as compared to a conventional training seminar [38, p. 408]. The literature on collegial reflection illustrates the added value of such working relations [17, 28]. Communities of practice increase the circle of possibilities for reflection and provided the aforementioned conducive group characteristics exist, are another instrument of informal skills development of teachers. A beneficial environment for the successful interplay within the community of practice, such as the time window for the professional exchange, must be provided by the school.

Not only networking internally within the teaching staff, but also the search for forms of more intensive cooperation between learning locations, is a field that is still relatively young in Switzerland and has yet to be implemented systematically [11]. Schneider and Mahs (2003) provide one example of a concept of continuous self-qualification and cooperative self-organisation for the skills development of teams of trainers (trainers, teachers, professional services). Here, team meetings represent an important measure in the course of which training modules and further education per se can take place in a self-organised way through the multiplier principle [33, p. 300]. More recent examples support learning cooperation using Web 2.0 to bridge the gap between learning locations [4]. However, experience with knowledge forums [33, p. 416] reveals that work within the forum has so far encountered considerable problems; there is often a lack of motivation to cooperate at the various locations. The formation of networks in relation to the outside world thus also has a bearing on the internal relationship between the participating organisations, ("which is why knowledge forums cannot become

bridges between the organisations, yet bridges are built without ensuring the access," [33, p. 416]). Even when using Web 2.0 applications, the critical success factors are therefore not so much technological aspects. Rather, cultural factors determine the extent of participation in the community of practice. The above-mentioned promotion of a climate that is conducive to cooperation within the school influences the informal learning activities of the teachers [24]. The availability of time as well as virtual and real rooms fosters proactive action by the practical community [30].

4.3 Developing Teachers' Digital Competences as a Systematic Change Process

Teachers' professional development in the competent use of digital information therefore requires considerable efforts in the schools. Consequently, it is not enough to organise a new training course as a further education offer for teachers, which is usually held as a one-time event. The new further education course will continue to be out of place in the school. On the contrary, it appears more important that support initiatives for the skills development of teachers are based on this context and are simultaneously embedded in innovation strategies and quality development processes in schools [33, 35]. As a result, curriculum development, staff training and school development measures must be coordinated in order to implement education reforms [19]. The development of a school culture in which students and teachers alike attach great importance to learning together and from each other is of central importance [19].

New competence requirements in the wake of increasing digitalisation necessitate ongoing (further) education that is marked by a high degree of speed and innovation dynamic. Teachers can no longer implement these changes individually and in isolation from one another in their day-to-day school routine. Bonsen and Rolff (2006, p. 170) therefore propose "the combination of community and professionalism" in times of turbulent change. In general, experimental testing of new approaches is risky.

In this regard, the relevance of virtual and online learning communities in a learning organisation has become apparent through learning communities with the objective to enhance teachers` digital competences. The conditions for their success (such as coherence, transparency and quality of moderator performance) have been examined in numerous studies (particularly noteworthy is the meta study [comparison of 64 studies] by Wegener & Leimeister, 2012, cf. also [2, 6, 8, 12, 16, 36, 37]. Similar results have been obtained in studies that investigate professional learning community for the teaching profession supported by digital media [20].

5 Conclusion and Outlook

Our research project has produced a framework for the conceptualisation of digital competences of teachers in the field of business. In terms of professional knowledge, there are two building blocks of digital competences: (1) *Instructional level:* designing classroom situations, and (2) *School level:* shaping school development. Drawing on this framework model, we were able to operationalise the ten facets of digital competence in an instrument that we tested empirically in a pilot study with 215 teachers.

The fit values for the instrument are decent, allowing the results of the pilot study to be used as a baseline evaluation for subsequent research projects.

Furthermore, it was possible to acquire insight into how these digital competences can be continuously and effectively fostered among teachers by means of professional learning communities. The aim is not only to examine the effectiveness of the support models, but also to explore which factors influence teachers' use of digital learning opportunities. The skills development of teachers, in particular in order to test and learn new teaching concepts, is inextricably linked to curriculum and school development. As already stated in the introduction, school routine is currently dominated by traditional forms of teaching, in which innovative educational approaches are almost impossible to realise. Such teaching practices are therefore the central impediment to the integration of digital media in everyday school life [41, p. 38].

The main limitation of our study is the reliance on self-assessments. This could result in two different types of bias: Teachers deliberately give inaccurate answers or are not able to make a valid assessment. We regard the first bias as unlikely because the survey was voluntary and anonymous. Irrespective of this, based on the impressions gained during the qualitative phase of the research project, we can attest that the teachers are highly self-reflective. This indicates that the second type of bias may also be inapplicable.

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