

TEACHING INFORMATION LITERACY IN SECONDARY EDUCATION: HOW TO DESIGN PROFESSIONAL DEVELOPMENT FOR TEACHERS?

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Abstract. The networked information and media society provides us increasingly with digital information and knowledge. However, the effective and efficient use of information also requires a high level of information literacy (IL), the competent handling of information and the ability to do that from an early age. Despite this early beginning, the development of IL is considered an important goal of schoolteachers who are required to integrate IL into their daily teaching practice. One reason that IL has only been considered sporadically in education is the lack of a scientifically proven model to operationalize and measure IL. Furthermore, teachers are often uncertain when dealing with digital media pedagogically and need support and clarity in terms of how to evaluate IL in their specific subjects. In the implementation of formal educational efforts, the low practical feasibility in specific working contexts, time and financial aspects are criticized. The current contribution presents a 7i model for the conceptualization and measurement of IL. Furthermore, it provides alternatives to the dominant “training model” to develop the competence of teachers by combining formal and informal learning.

Keywords: information literacy, teachers’ professional development, informal learning

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1 Introduction

One major benefit of the information age is the ubiquitous availability of information and knowledge from various information sources at our fingertips. However, the effective and efficient use of digital media requires information literacy (IL), which is the proficient handling of information [28]. For example, UNESCO considers IL as a major practical competence relevant for the 21st century networked society [32]. Other authors consider it a key competence that facilitates participation in society, a self-determined life and lifelong learning [8]. In general, IL refers to skills necessary to use information effectively and efficiently and is described as the ability to recognize problem-driven information needs, to select information sources, to access, evaluate and use information, and to reflect upon both the applied information searching and processing procedure, and the information resulting from it [2, 8, 28].

In the information age, children and pupils are being exposed to digital media and information and have to deal with them starting from early childhood [9]. Thus, it is becoming increasingly important to promote IL and create awareness of it. This is an important goal for schools [1]. Teachers are faced with the challenge to integrate IL into their learning environments. In order to achieve this goal, a scientifically sound and proven model to operationalize and measure IL is necessary. This would help teachers to define learning outcomes and to evaluate IL by themselves. Furthermore, formal training activities seem to be insufficient to foster teachers' competencies to use digital media pedagogically in their specific working contexts.

The paper at hand first shows the main obstacles preventing IL and digital media from finding their way into the classroom as yet. In a second step, the 7i Framework for measuring IL and the results of the empirical testing are presented and discussed. Finally, alternative approaches to support teachers' media educational skills are shown.

2 Problem and Research Question

In the so-called information age the goal to embed IL in schools has not yet been achieved, as has been outlined above. This can be explained by the inadequate integration of IL as a learning objective into existing curricula. To integrate IL, schools need two models in terms of curriculum development. One type is generic IL model to promote critical thinking, higher-order thinking, reflection and decision making by students for the competent use of digital information (integrated in ICT courses). The other is a discipline specific model to aid in further understanding of a particular school subject.

One reason for this is the lack of a scientifically sound and proven model to operationalize and [28] measure IL. Teachers need support and clarity in terms of how to evaluate IL in their subjects. This seems to be a critical point. The ability of teachers to use digital media pedagogically in the curriculum is still in its infancy [18, p. 159]. Moreover, teachers addressing new 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 demanding the teaching of media-specific qualification goals. However, which skills teachers need to acquire remains rather unclear and these skills are largely limited to the use and operation of the ICT [4, p. 76]. In order to be able to plan and design suitable media education training measures for teachers, a concrete discussion and formulation of the required skills is required [21, p. 157].

The main research question of this paper focuses on this critical issue:

How to design professional development for teachers to develop information literacy skills in Secondary Education?

In order to pursue the leading research question, the following questions are important:

- How can information literacy in high schools be defined and operationalized (Student perspective on learning outcomes)?
- What are the necessary knowledge areas for teachers in terms of the TPACK model (Teacher perspective on instructional practice)?
- How can the competence of teachers be developed by combining formal and informal learning (as emerging alternatives to the dominant “training model”)?

The paper is structured as follows: The next section states the rationale of the research project and composes the leading research question based on the problem identified. The third section explains the applied research methodology. The fourth section provides an overview of the findings: 1) the 7i framework for conceptualization and measurement of IL (student perspective of IL) 2) the required skill-set for teachers based on TPACK model (teacher perspective of IL) and 3) forms of competence development by combining informal and formal learning (emerging alternatives to the dominant “training model” of teachers’ professional development). The last section concludes the paper by discussing the results and providing recommendations for future research.

3 Research Methodology

The main goal of the research presented in the paper at hand is to develop a conceptual framework for teachers’ professional development focused on IL in secondary schools. In order to achieve this goal a two-year research project has been established in cooperation with a secondary school in the German-speaking part of Switzerland. The project is based on a methodological combination of literature analysis, model development and empirical model testing. The following are important:

1. To get an overview of existing IL research, a systematic literature analysis has been performed by focusing on the following research questions (see also [28]): Which terms associated with IL exist and how is IL defined in the literature? What are the salient conceptualizations and measurement models of IL? Which methods are applied in order to examine IL?
2. Based on the findings of the literature research, and by combining and extending existing models, the 7i Framework for measuring IL has been created.

3. The 7i Framework for measuring IL has been tested in five classes at a Swiss secondary school.

The results of the literature analysis and model development are presented in detail in [28, 29]. The most important results are presented in this paper to answer the first research question in order to operationalize IL as learning outcomes.

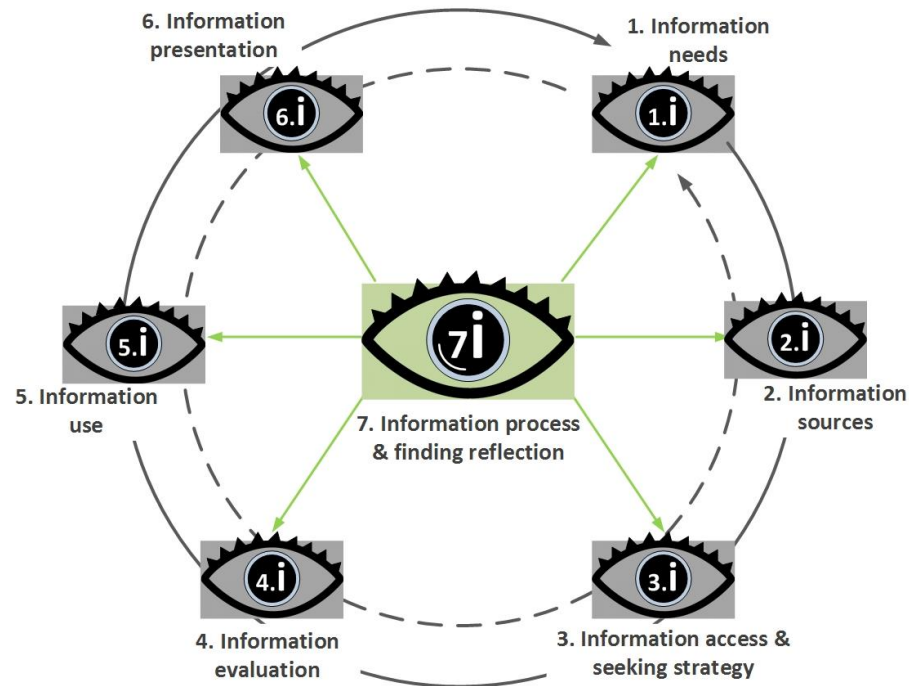
Further literature analysis has been conducted in the field of teacher education with a focus on digital competencies. One main model to develop the digital media skills of teachers is the TPACK model developed by Koehler and Mishara [15]. This model offers a framework to specify further the required skills to integrate IL into teaching practice. Empirical practice reflection within the research project mentioned and a thorough literature analysis are the main research methods for the design of teachers' professional development.

4 Results

4.1 Teaching Information Literacy Skills in Secondary Education based on the 7i – Framework – the Learner Perspective

The starting point for teachers' professional development in the field of information literacy (IL) must be to clarify the required learning outcomes. The learner perspective defines what an information literate student needs to know and to do. Therefore, an IL framework has been developed to provide a basis for teachers to answer questions such as how students' learning processes can be scaffolded, how feedback can be given and how the IL performance can be evaluated and graded (for more detail see [32],[33]).

The proposed 7i Framework is shown in Figure 1. It contains seven sub-competencies comprising knowledge, skills and attitudes: (1) Information needs; (2) Information sources; (3) Information access and seeking strategy; (4) Information evaluation; (5) Information use; (6) Information presentation; (7) Information process & finding reflection.

Figure 1 7i Framework – Students' Information Literacy

The Student who is information literate knows:

1. *Information needs:*
How to determine information needs in the context of a given problem, i.e. to determine information needs in a problem-driven manner
2. *Information sources:*
Identification of relevant information sources and of which information sources apply best to the information needs identified
3. *Information access & seeking strategy:*
Identification of search strategy of information sources identified, and of which methods and search strategies suit best to access the selected information sources
4. *Information evaluation:*
Evaluation of information sources and resulting information. Strategy for evaluating whether the sources and information are valid and reliable
5. *Information use:*
Appropriate and problem-oriented use of the information found. This might also include a general understanding of ethical, legal and socio-political issues related to the information, or a subject- or problem-specific understanding of information and of how to use the information appropriately in order to solve the problem
6. *Information presentation:*
Present the information geared to defined target groups
7. *Information process & finding reflection:*

Reflect upon the information search and processing procedure and upon the information resulting from it and learn how to reflect the information search and processing procedure and the information resulting from it and to learn for future information search processes.

Based on this 7i framework a questionnaire was developed. The 7i measurement model results in two different scores in terms of IL. There is one objective score based on generic assignments, and one rather subjective score, based on self-assessment. Overall, the 7i Framework enables different approaches to measure IL: 1) the objective and self-assessed IL, 2) the separate measurement of the competence level in terms of each of the seven sub-competencies, 3) the interrelationship between the objective and self-assessed IL.

In cooperation with a Swiss high school the model presented has been empirically validated. To achieve this, data from 145 students from eight high school classes were collected using an online-based survey and the data was subsequently analyzed. The results demonstrate on the one hand, the students' objective IL (evaluated by using standardized criteria), and, on the other hand, the subjective IL (self-assessed by the students). The objective IL with a mean score of 29.12 (maximum possible score of 70 points) shows that the vast majority of students have a low level of IL. In the sample, the score ranged from 18 to 42 points and the maximum score measured is only slightly above 50% of the maximum score possible. The highest score was achieved for sub-competence 5 (information use), while sub-competence 6 (information presentation) received the lowest score. Other results are detected in connection with the self-assessed IL of the students with a mean of 42.69 points - significantly higher than the objective IL.

Finally, the results show a discrepancy between the self-assessed IL score and the objective IL. While most of the students evaluated themselves as competent, the objective literacy is considerably lower. Furthermore, in the self-assessed test, the students on average gave themselves high scores for all of the seven sub-competences, whereas the objective test unveils substantial differences among the seven sub-competences [29]. Consequently, a main challenge for teachers will be to sensitize and support students in their handling of online based information.

The 7i model allows teachers to assess their students' level of IL at different times and to support the process of IL development continuously. Furthermore, the measurement instrument provides a measure of the students' IL level in terms of the seven proposed sub-competences. On this basis teachers are able to identify learning needs for each phase and decide on further intervention.

Because of this, in the next section the teachers' perspective on how to integrate IL into their own teaching practice and subject areas will be analyzed.

4.2 Teaching Information Literacy Skills in Secondary Education based on the TPACK Model – the Teacher Perspective

Schools face the challenge of how to ensure the permanent upskilling of teachers in the use of digital media and in particular to support information literacy in high school. In terms of the promotion of the digital media skills of teachers, one example is the TPACK model developed by Koehler and Mishara [15]. The model offers a

framework for concretizing a required knowledge base for teachers if they want to use technologies meaningfully for teaching and learning. In the light of the observations in Shulman's pedagogical content knowledge (PCK) model [26, 27], the authors assume that the development of both technological pedagogical knowledge (TPK) and technological content knowledge (TCK) (together TPACK) is a prerequisite for successful technology-based teaching. The knowledge base (content, pedagogy and technology) form the core of the "technological, pedagogical and content knowledge" (TPACK), whereby the focus is particularly on the interaction and interfaces between the areas. The authors extend Shulman's model by the requisite technological knowledge and defined the following seven knowledge areas (Table 2):

Table 1 Areas of the TPACK-Model with focus on Information Literacy (IL)

Knowledge Area	Description	Guiding Questions	Mastery Information Literacy
Content Knowledge (CK)	Knowledge about the teaching subject and topic (theories, concepts, ideas etc.) of the respective subject area.	What content is relevant to understand the topic and should be covered in this lesson? Content for IL as interdisciplinary competences, specific content in the subject area.	Mastery of the IL content in the specific subject area, for example: Integration of IL into subject area "economics and law": google, amazon, apple, facebook as quasi-monopolists in a digitalized society.
Pedagogical Knowledge (PK)	Knowledge about processes and methods of learning and teaching. This means an understanding of processes students use to gain new insights and how students could be stimulated or motivated.	What kind of pedagogical principles should be used in this lesson? Developing a personal learning environment to enable deep learning including IL.	Mastery of classroom strategies (inductive learning strategies), use of learning theories, different types of methods (active search as well as reflection methods), evaluation methods for IL, e.g. self-assessment tools, grading rubric
Technological Knowledge (TK)	Knowledge, which is more than a pure application of knowledge. Rather it means a broad understanding of the opportunities for technology-based communication, information processing and problem solving.	Which technologies should be used in this lesson? Platform technology for classroom management, tools for specific learning phases along the IL competence model	Mastery of different kinds of technologies and ability to provide useful technologies for learning processes: e.g. using search engines, subject-related databases, tools for information use, reflection tools such as blogs
Technological Content Knowledge (TCK)	Knowledge about the way technologies and content interact with each other. Furthermore, teachers need to know which specific tool is best for conveying the content.	Does the use of technologies support representing the content in multiple ways and will these technologies help to ensure a better understanding?	Use of technologies supports the understanding of content, for example to understand google as a quasi-monopolist using expert knowledge about the search engine.
Pedagogical Content Knowledge (PCK)	Knowledge about different opportunities to teach a specific content taking into account the students' prior	Does the underlying pedagogical principles foster an understanding of the topic or stimulate	Challenging problems as the starting point for deep internet research (knowledge not facts);

	knowledge, education guidelines on curricula and requirements.	a deeper learning?	adequate learning strategies (inductive learning strategies and reflection methods)
Technological Pedagogical Knowledge (TPK)	It needs an understanding of the drawbacks of technologies as well as the resulting pedagogic-didactic consequences within a disciplinary context.	Are the pedagogical principles and selected technologies well matched?	Focused on using technologies for learning and helping learners to use them in different ways. But the learning activities (IL integration in lessons) could take them away from actually learning content.
Technology, Pedagogy, and Content Knowledge (TPACK)	Knowledge of the interaction and interfaces between content, technology and pedagogy in terms of the specific context. It needs an understanding of how these domains interact.	Do the selected technologies foster the underlying pedagogical principles and can the interaction between technologies and principles contribute to a better understanding of the content?	A masterful 21 st Century classroom, which considers the learning content, based on good learning theories provided by digital media and using digital information.

In the light of the defined areas of knowledge in the TPACK model, the corresponding educational goals can be derived for describing a skills profile for teachers' professional development. The respective knowledge must be put in an application-specific context. The advantage of such an approach lies in the exact definition of the necessary knowledge base, skills and attitudes. This enables overlaps in the basic knowledge base to be avoided. The disadvantages include in particular the fact that teachers may not be able to derive any practical relevance for their lessons. Thus, for example, courses are often not geared towards the integration of technical knowledge into specific teaching situations. This therefore makes it difficult for teachers to apply a hands-on approach.

For this reason, teachers' professional development with a focus on digital skills and integrating IL into teaching practice has to be considered in new ways. The dominant "training model" focused primarily on expanding an individual repertoire of well-defined and skillful classroom practice is not adequate to achieve the ambitious visions of teaching and schooling embedding technology-based learning and integrating new learning outcomes such as IL. Therefore, the next section will highlight this issue.

4.3 Forms of competence development: combining informal and formal learning

Common teacher training practices are in themselves a major barrier to why the digital media teaching skills of teachers are only developing to a limited extent. Like their students, most teachers learn how to use digital media not so much in formal learning situations, but more informally, in practice. Teachers often simply lack the time to attend a course or to work on a self-learning program regularly [31, p. 3]. As numerous studies show, teachers generally seem to develop their skills predominantly informally in the context of their teaching practice, in an exchange with colleagues and through critical, individual reflection [12, 19]. Learning in informal contexts

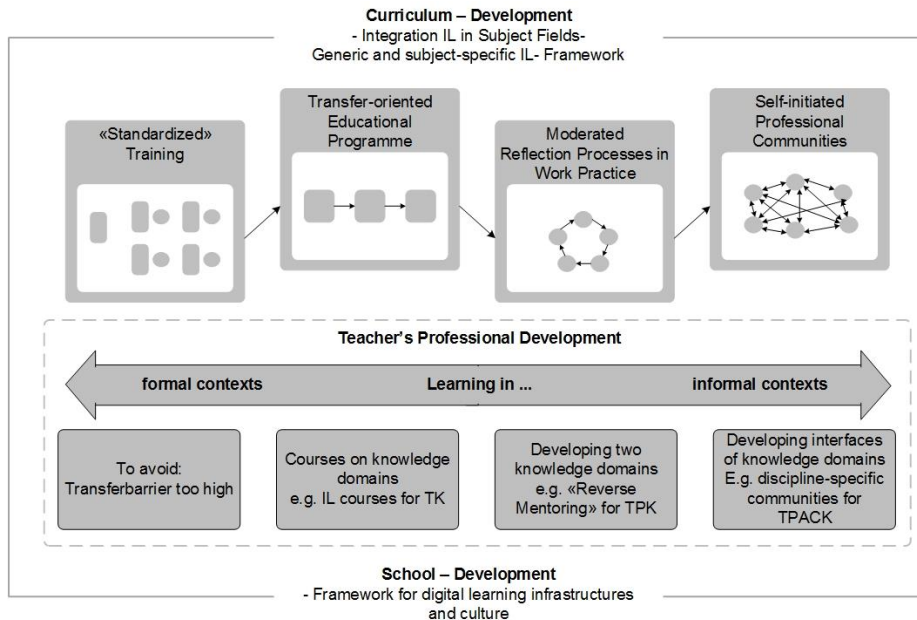
takes place alone or with others outside of institutionalized teaching environments. In contrast, learning under formal conditions takes place in training and further education institutions, where professional teachers endeavor to learn how to teach, assess and if necessary even to certify.

At voluntary further education events for teachers the fact that the individuals who generally attend usually already have a certain level of expertise is often criticized, and attendees often return to school disappointed because what they learned is difficult to put into practice because of a lack of time and money. In addition, school-based training courses (SBT) that are tailored to the needs of a school are very widespread. However, some research studies show that even formally organized school-based events also have a limited impact [14, 22]. Therefore, the international research literature on the education and training of teachers increasingly focuses on workplace-integrated learning, which takes informal learning into account more [12, 35]. One key finding is that formal and informal learning should be more closely interlinked to develop the skills of teachers. A promising approach would in particular appear to be the search for interfaces between learning in formal and informal contexts [7].

The following section focuses on the importance of the skills development of teachers in this context. Heise [10] particularly emphasizes the importance of largely self-directed further education in this professional field. To support and strengthen these desired informal learning activities, it would appear absolutely essential to create an environment conducive to communication within the school organization. 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 [10]. 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. This might make a different kind of support necessary than would be required for teachers that already cooperate or collaborate with one another [12]. A concept to promote informal learning tailored individually to the aims and objectives of teachers could therefore generate added value for curriculum and school development. In the field of information literacy, for example, the pressure on teachers to seek further education has increased immensely because of constant and rapidly advancing technological development.

A main question for schools to address is how skill development measures for teachers which integrate learning in informal contexts be structured in practice. Some examples are outlined below (see following illustration):

Figure 2 Teacher's Professional Development in formal and informal learning settings and based on TPACK-model.



Transfer-oriented training. School-based training (SBT) is basically 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 Engeström's Change Laboratory® [7]. In such a framework it would be possible to re-design courses at a professional association and hence combine the skills development of teachers with innovative strategies for curriculum development in schools [7, p. 12]. Whether or not the transfer of training or further education into the everyday life of teachers succeeds largely depends on individual factors [12]. An open mind towards new ideas and the willingness to adopt and implement innovative proposals are prerequisites for initiating and implementing change processes in school routine. How teachers learn informally differs from one individual to the next [12]. This aspect should be borne in mind 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's needs. One significant advantage provided by the required openness is the ability to obtain feedback on the progress of learning. For example Zwart et al. [35], suggest providing teachers with a "peer coach", who can help them reflect upon what has been learned [12].

Moderating the reflection processes regarding teaching practice. Critical, individual reflection upon one's own teaching basically represents a central impetus for the skills development of teachers [19]. 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 [17, p. 410]. This raises the question of 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. [35, p. 990] show that informal talks with students from the perspective of an observer offer a valuable learning option. Other examples involve mentoring programs 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 digital media and able to use it 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 whether it will become established as an element of a changing learning and management culture. Reverse mentoring could also be an approach for a school’s 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 informal skills development [19]. Experimenting with new teaching methods (whether adapting a theoretically recognized concept, copying a colleague’s method or developing one’s own new idea) and even the immediate feedback from a colleague contribute substantially to the informal learning of teachers [12, 19, p. 90]. In this regard, mentoring programs can be orchestrated in different ways, i.e. the proportion of informal and formal elements of the learning process vary greatly [5]. 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 of teachers and generates an added value for the school organization and the learners.

Self-initiated learning in communities of practice. The idea of near-peer mentoring entails a practice-oriented community of people (community of practice according to Wenger [33], who are informally linked with one another, are faced with similar tasks, and shape the practice in this community through a self-organized exchange. “Professional Learning Communities” in the teaching profession have long been a popular research field [13, 30], but the effects of professional learning communities have yet to be researched in detail [17, 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 obtain a deeper level of reflection on the part of teachers than the level obtained at a conventional training seminar [17, p. 408]. The literature on collegial reflection illustrates the added value of such working relations [12, 19]. Communities of practice increase the circle of possibilities for reflection and, provided the aforementioned conducive group characteristics exist, are another instrument for the 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, are fields that are still relatively young in Switzerland and have yet to be implemented systematically [6]. Schneider and Mahs [24] provide one example of a concept of continuous self-qualification and cooperative self-organization 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-organized way through the multiplier principle [24, p. 300]. More recent examples support learning cooperation using Web 2.0 to bridge the gap between learning locations [3]. However, experience with knowledge forums [16, 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 organizations, (“which is why knowledge forums cannot become bridges between the organizations, yet bridges are built without ensuring the access,” [16, p. 416]. Even when using Web 2.0 applications, the relevant prerequisites for success are therefore not so much technological as cultural factors that represent incentives for 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 [11]. The availability of time and virtual and real rooms fosters proactive action by the practical community [20].

In the light of on the above examples, it is clear that the combination of formal and informal learning is possible, in particular by using two different approaches. “This can be done independently by the learner (e.g. through documentation, checklists, learning diary) and/or with support (e.g. learning process support, group discussions). By means of constructive and critical reflection on one’s own experiences, the mere “gaining of experience becomes an effective learning experience that supports one’s own skills development” [23, p. 77]. Alternatively, however, significance is attached to the structuring of the self-organization of learning processes on the continuum between formal and informal. With this approach, self-organized learning is promoted in daily school routine through staffing, methodological or medial structuring aids. This makes it possible to tap into the experience of organized forms of learning gained in the course of everyday teaching practices for the acquisition of skills (for example through the combining of project and learning tasks or observational tasks to focus the attention of the students).

5 Discussion and future Perspectives on Professional Development for Teachers

This contribution posits a problem of “fit” between new requirements in terms of digital skills such as IL and prevailing configurations of teachers' professional development. It argues that the dominant “training model” of teachers' professional development focused primarily on expanding an individual repertoire of well-defined

and skillful classroom practices is not adequate to realize the ambitious visions of teaching and schooling that embeds digital skills such as IL.

Emerging alternatives to the training model, though small in scale, embody assumptions about teacher learning and the transformation of schooling that appear more fully compatible with the complex demands of teaching digital skills.

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 realize. Such teaching practices are therefore the central impediment to the integration of digital media in everyday school life [34, p. 38].

Teachers' professional development in terms of the competent use of digital information therefore requires considerable efforts in the schools. Consequently, it is certainly not enough to organize a new training course for teachers. Such courses are usually held as one-off events. Hence, a new further education course will continue to be out of place in the school. On the contrary, it appears all the 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 [24, 25]. As a result, curriculum development, staff training and school development measures must be coordinated in order to implement education reforms [30]. The development of a school culture in which students and teachers alike attach great importance to learning together and from one another is of central importance [13, 30].

Developing a learning-conducive school culture can be regarded today as one of the key challenges for the successful implementation of educational innovation and continuous quality improvement processes. To enable technology to become firmly established as a method and a subject in school routine in the long term, appropriate framework conditions are required at the organizational level. In this context, an appropriate learning culture must be established. This would promote learning with and from one another, and would promote the testing of new forms of teaching with digital media.

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