Where change begins: Teacher-students' professional development during internships in media and computer science education

Judit Martínez-Moreno[a,b]

[a] Zurich University of Teacher Education, Lagerstrasse 2, 8090 Zurich, Switzerland
[b] University of Zurich, Institute of Education, Kantonsschulstrasse 3, 8001 Zurich, Switzerland

Abstract

New curricula are being introduced to foster the integration of media and computer science in education. Therefore, it is of high importance to understand how to train teachers to adapt their teaching practices to these new curricula. In this direction, three models are of high importance: COACTIV, TPACK, and the SQD Model. The COACTIV model gives insights into the competences that teachers need to acquire to teach effectively. The TPACK model poses the types of knowledge needed to teach effectively with technology. The SQD Model presents the key strategies to teach teacher-students on the effective integration of technology. However, these models still present some limitations. First, the expression of TPACK in action and the relevance of its components is not clear. Second, the transversal development of these models has not been sufficiently studied. And third, the relationship between these three models is also under-researched. The present doctorate will address these three limitations by studying the professional development of primary education teacher-students during internships in media and computer science. Three main aspects will be analysed: teacher-student-related variables, internship projects, and training settings. A mixed-method approach will be followed, embracing content and thematic analysis, as well as correlation and predictive analysis.

Keywords[1]

Teacher education, teacher-students, internships, media and computer science education, TPACK, COACTIV, SQD Model

1. Introduction

Specific educational frameworks have been developed to collect the competencies and skills that children need to learn to succeed in the 21st century [1, 2]. In Switzerland, the new Curriculum 21 has been introduced in the German-speaking cantons to foster the development of these competences, including a media and computer science module to be taught in elementary education. However, introducing new curricula is not enough. Teachers should be prepared to adapt their teaching practices to provide students with the best opportunities to acquire the competencies needed and set by the curriculum. To do so, it is of high importance to offer teacher training opportunities that aim at acquiring the required knowledge and competencies.[2]

1.1. Teacher competence

Teacher competence is a difficult topic to treat since it is challenging to define what competences are, as well as to identify the competences that teachers have and need to develop, to successfully perform their practice.

Proceedings of the Doctoral Consortium of Sixteenth European Conference on Technology Enhanced Learning, September 20–21, 2021, Bolzano, Italy (online).
EMAIL: judit.martinezmoreno@phzh.ch
ORCID: 0000-0001-9234-8220
© 2021 Copyright for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).
CEUR Workshop Proceedings (CEUR-WS.org)

CEUR-WS.org/Vol-3076/ECTEL2021_DC_paper04.pdf

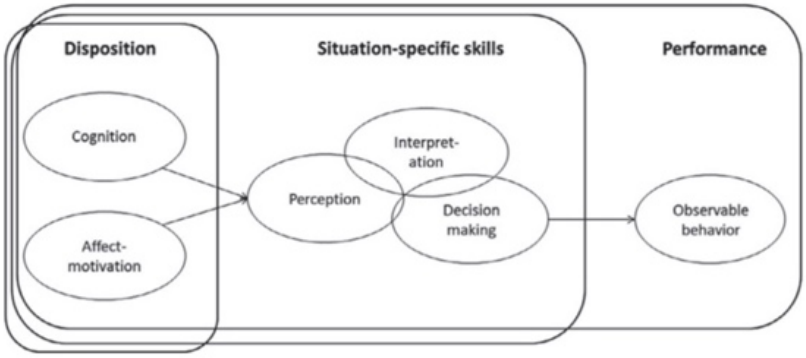

Figure 1: Competence as a continuum taken from Blömeke et al. [3]

After analysing several conceptual frameworks and definitions of "competence" in higher education, the "Competence as a continuum model" was developed [3] (see Figure 1). This model is constituted of 3 parts: the left side includes cognitive, affective, and motivational competences for specific contexts; the right side is the behaviour that can be observed; and this is mediated by the part in the middle, which includes the processes done by the actor, such as perception, interpretation, and decision-making processes.

In the field of teaching, one model that systematically identifies the competencies that teachers need to have to perform a good professional practice is the COACTIV (or *Co*gnitive *Activ*ation in the Classroom) model of teachers' professional competence [4] (see Figure 2, which presents the COACTIV model specified for the context of mathematics teaching). From this perspective, professional teaching practice is an interplay between cognitive and motivational/self-regulatory characteristics. Concretely, it contemplates the following aspects: knowledge; values, beliefs and goals; motivational orientations; and professional self-regulation skills. In the case of knowledge, the COACTIV model adopts Shulman's construct of pedagogical content knowledge or PCK and broadens this definition adding organizational and counselling knowledge.

Other personal variables of teacher-students have been seen to be related to the decision of using technology in their teaching practice, such as positive attitudes toward technology and personal control over the decision to use technology [5]; or to the real use of technology, such as perceived competence using ICT for teaching, availability of computers, beliefs

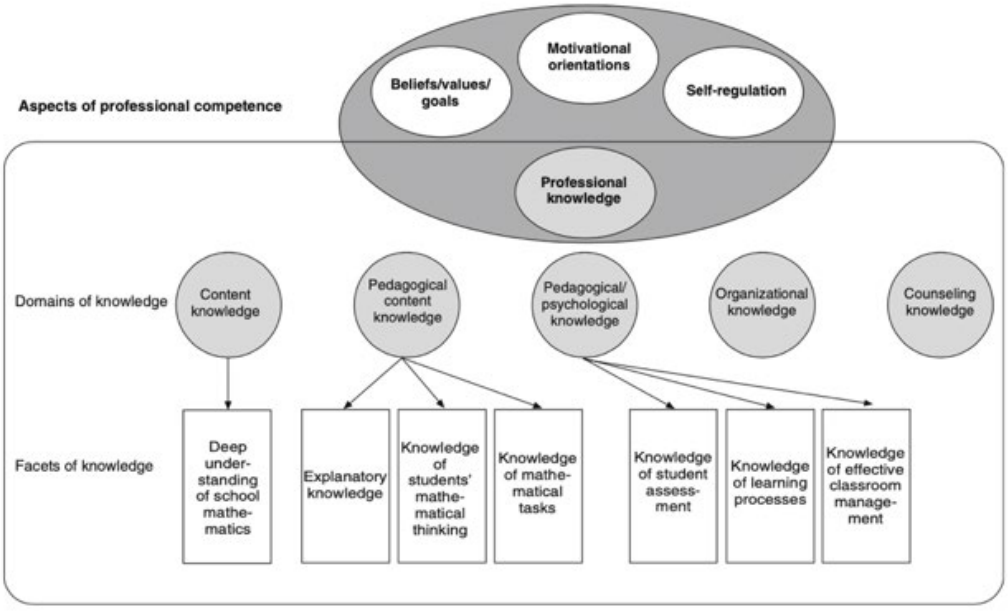

Figure 2: COACTIV model taken from Baumert and Kunter [4]

about the effect of computers, constructivist forms of teaching and learning [6], self-efficacy and value beliefs [7, 8], or intentions to use Meaningful Learning approaches [9].

About the knowledge that teacher-students should have for teaching with technology, one of the most cited models is the technological, pedagogical and content knowledge, or TPACK, developed by Koehler and Mishra [10]. The TPACK model was built also from Shulman's construct of pedagogical content knowledge or PCK. Their authors aimed to explain the three key components of teacher knowledge that teachers need to develop and consider when integrating technology in their practice to produce effective teaching with technology. According to this model, the types of knowledge that need to be considered are technology, pedagogy, and content knowledge, as well as the interactions between all types of knowledge, and knowledge about the context (see Figure 3). The TPACK model has shown to be useful to increase teacher-students' confidence and understanding of digital pedagogies [11]. Furthermore, it has been seen that it can be developed through active involvement in teaching using technology [12].

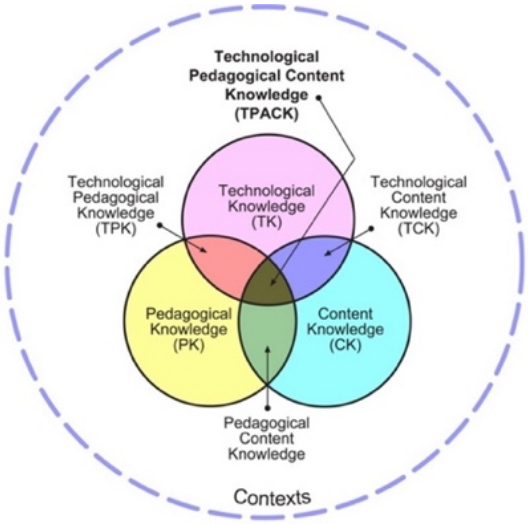

Figure 4: TPACK model taken from Koehler and Mishra [10]

In an attempt to unite the Competence Viewed as a Continuum model, COACTIV and TPACK, [13] developed the Developmental Model of Teacher Professional Competence (DevTPC). Although the author developed it as a framework for teaching foreign language online, it still offers potential uses in other fields (see Figure 4).

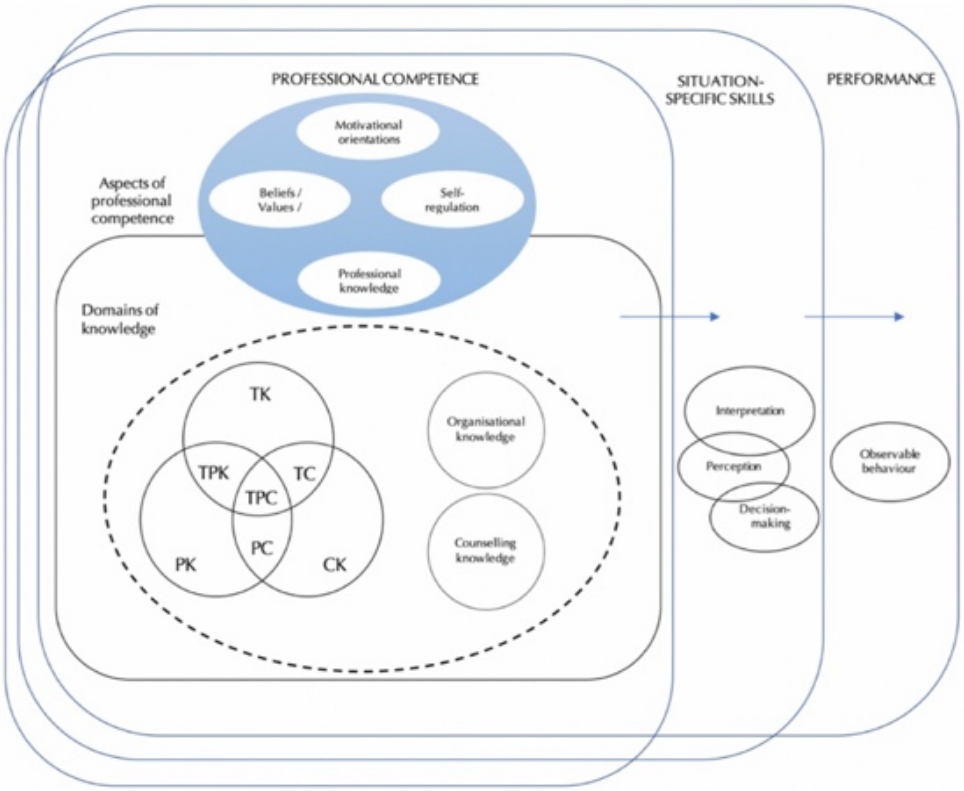

Figure 3: DevTPC model taken from Stadler-Heer [13]

Regarding teaching quality, three basic dimensions have been defined to analyse teaching quality: instructional, organizational and emotional support [14, 15]. These three dimensions are linked to variables that are involved in the learning process. The instructional dimension refers to the instructional support given by the teacher to cognitively activate and engage students; the organizational dimension is related to the classroom management and organizational support provided by the teacher to promote academic and social-emotional learning; and the emotional dimension refers to the support that the teacher gives to his/her students to provide a supporting and positive interactions and learning climate.

1.2. Teacher education

Regarding the way that teachers should be trained, different strategies have been implemented to prepare pre-service teachers to integrate technology into their teaching practice. Tondeur et al. [16] carried out a synthesis of qualitative evidence and extracted the key strategies that have been explicitly related to the preparation of pre-service teachers as well as the necessary conditions at the institutional level. With these aspects, the authors built the SQD Model which includes the aspects that should be provided at the micro and institutional level to prepare pre-service teachers (see Figure 5).

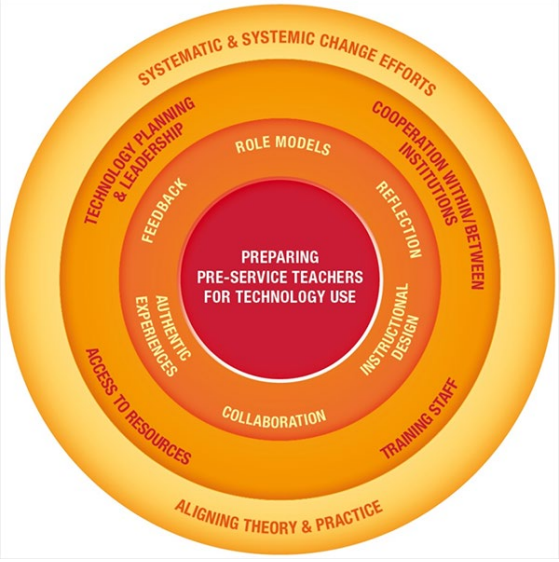

Figure 5: SQD Model taken from Tondeur et al. [16]

These are role models, reflection, instructional design, collaboration, authentic experiences, and feedback at the micro-level; and technology planning and leadership, cooperation within/between institutions, training staff and access to resources at the institutional level. Systematic and systemic change efforts, and aligning theory and practice, are related to both levels. Furthermore, in the field of teacher education, it has been seen that field experiences have positive impact on beliefs and intentions to use technology, especially when teacher-students see technology being used by skilled teachers [9, 17].

1.3. Challenges

Many attempts are being done to set good theoretical backgrounds that foster effective teacher higher education in the field of technology-enabled learning. However, most of the proposed models lack a solid scientific basis, as it is challenging to develop scientific studies whose findings are generalizable and consistent with previous research.

In the case of TPACK, despite it is already one of the most used models in research, it is currently entering a new phase of development as an empirical theory. As indicated by Petko [18] this could be a consolidation phase before a new invigoration, or a period of stagnation and decline. In any case, there are still some open questions about this model that would be interesting to investigate.

In the first place, there is no clear agreement whether the three circles of knowledge contribute equally to TPACK or if these types of knowledge can be different in different situations or levels of technology integration [18]. The specific definition of the different factors is not clear, nor is it the relationship between them. As Brantley-Dias and Ertmer note [19], we are also still missing a detailed description of how does TPACK or its components look like in action. Furthermore, an ongoing debate is whether the TPACK model should be considered an integrative or a transformative model. The integrative vision assumes that all components directly contribute to the final TPACK, whereas the transformative vision assumes that only TCK, TPK and PCK contribute to the final TPACK. It is highly important to understand how the components

interact between them to provide learning opportunities in teacher training that foster the acquisition of TPACK, meaning that if the model is transformative, activities that focus solely on TK will not contribute to improving TPACK, but TCK and TPK will need to be fostered [20].

Many extensions and combinations of the model have been done, such as ICT-TPCK [21], TPACK-XL [22], or GPACK [23], increasing its complexity while remaining unclear whether they offer better theoretical ground. For this, the DevTPC model [13] offers a new approach for combining different complementary models rather than extensions of TPACK, including personal variables originally part of the COACTIV model [4], and an explanation of how to evaluate competences originally from the Competence as a continuum model [3].

About measuring TPACK, there aren't many valid and reliable tools for doing so, since most of them are self-reports that don't evaluate factual knowledge but self-efficacy beliefs and can be easily biased. Another method that has been used are rubric-based ratings based on lesson plans. Furthermore, TPACK has not been studied in international large-scale, longitudinal nor experimental settings [18]. Furthermore, while it has been stated that TPACK is constituted by what teachers know, what teachers do and their reasons for doing so, in the field of education and technology, very little research has investigated the instructional decisions that teacher-students make, focusing on *how* and *why* [24].

A part of knowledge, it is difficult to conclude what other teacher-student-related variables are important to teaching competence. This is why the COACTIV model [4] refers to an interplay between cognitive and motivational/self-regulatory characteristics. And not only personal aspects are needed, but also those at an institutional level for teacher training. Here is where the SQD Model [16] poses several variables, but further research into these aspects is still needed to know the role that these variables play as a mediator of teacher competence.

2. Current research

2.1. Research aim

As it has been presented in the previous section, there are some challenges in the field of teacher education for media and computer science teaching, especially regarding the theoretical grounds that support specific didactic actions. Therefore, the main aim of this research will be to contribute to the development of theoretical models using teacher-students' internships on media and computer science education as the object of study, proving the validity of these theories. The theoretical models that will be used for research purposes will be TPACK and the COACTIV model for teacher competence, and SQD Model for teaching settings.

2.2. Research objectives and research questions

The objectives that are expected to be achieved during this research and the specific research questions that will be addressed are:

1. Objective 1: To describe the expression of teacher-students' TPACK in action and analyse the relevance of its components.
   - 1.1. Is self-reported teacher-students' TPACK coherent with observed TPACK?
   - 1.2. Do all TPACK components relate to the general TPACK?
   - 1.3. Are all TPACK components related to a good internship project for media and computer science education?
2. Objective 2: To analyse the professional development of teacher-students during an internship in media and computer science.
   - 2.1. Do teacher-student-related variables change after participating in an internship on media and computer science?
   - 2.2. Is there any factor (latent variable) that moderates professional development?
3. Objective 3: Investigate the relationships between models (COACTIV, TPACK, SQD Model) and their influence on teaching quality (Three Basic Dimensions model).
   - 3.1. Is there any relationship between teacher-student-related variables based on the COACTIV and TPACK models?

3.2. Is there any relationship between teacher-student-related variables, internship projects, teaching quality, and training settings?

3. Research methodology

3.1. Research settings

This research will follow a mixed-methods approach, since qualitative and quantitative data will be collected throughout the study in an embedded manner. Confirmatory and exploratory correlation analysis will be followed depending on the research question.

This research will be conducted in the context of the module "Media and IT education" at the University of Teacher Education of Zurich (PHZH – Pädagogische Höchschule Zürich). The students that participate in this module are teacher-students being trained for teaching in the primary education level. The module includes a practical part of 1 ECTS (30 working hours) where students participate in an internship. For this internship, students conceptualize a media or computer science project based on the Lehrplan 21 [25] and implement it in a school. They do this internship in pairs, and work in a class where they have already been doing internships in the past, therefore, they already know the students and the teacher. After the internship, students submit the project documentation and written observations, and they make a presentation. They are graded based on their performance.

The data will be collected on the Autumn Semester 2022 and Autumn Semester 2023. About the sample, 300 students participate in this module each semester, although not all of them are expected to participate in the study.

It is still to be confirmed whether it would be possible to create an experimental condition where a group of students goes through an intervention different than those in the control group. It is also pending of confirmation whether it would be possible to have access to a control group consisting of teacher-students who take part in an internship that is not related to media and computer science education.

3.2. Measurements

The main aspects that will be evaluated are:

a. Teacher-student-related variables
b. Internship projects
c. Training settings

For the evaluation of teacher-student-related variables (a), self-reported questionnaires will be distributed before and after the internships. These self-reports will evaluate their professional competence based on the COACTIV model, which includes knowledge; professional values, beliefs, and goals; motivational orientations and rationales; and professional self-regulation skills. The specific questionnaire to be used for this aim is still to be confirmed. For evaluating knowledge, the TPACK.xs questionnaire [20] will be distributed before and after the participation in the internship. It consists of 28 items, four per each subscale, and has shown a good validity and reliability for assessing teacher-students' TPACK. However, since self-reports involve certain limitations such as biases due to social desirability and Dunning-Kruger effects, or measuring teachers' self-efficacy beliefs instead of factual knowledge [18], performance-based measures to collect more factual knowledge will also be used. Concretely, teacher-students' internship reports, grades, and reports from teachers from the PHZH and the school where the teacher-students did the internship. Other variables such as beliefs about technology or previous experience with technology will also be analysed to allow further exploration.

Regarding the evaluation of their internship projects (b), the related documentation will be treated as qualitative data and will be analysed making use of categories and codes following content and thematic analysis [26]. From this documentation, their knowledge will be analysed using the TPACK model, and teaching quality using the framework of Three Basic Dimensions. To evaluate the level of competency that students acquire, the evaluation grid that teachers already use may be considered. This grid is KoRa (Kompetenzraster) and it measures 12 competence standards required for an optimal teaching competence [27]. Finally, other variables such as technology used, or topics treated will also be analysed to allow further exploration.

For the evaluation of training settings (c), the SQD Model [16] will be used to analyse the conditions provided to pre-service teachers to

prepare them for technology use. This will be done asking teacher-students through a self-reported questionnaire. Furthermore, the TPACK.xs questionnaire will be distributed among their teachers to evaluate the level of TPACK among teacher-student's role models.

3.3. Data analyses

Qualitative and quantitative methods will be used to analyse the data indicated above. For the qualitative analysis, thematic and content analysis will be performed. These analysis will be used to identify the different TPACK categories in students' projects, similar to [24], and to analyse their teaching quality.

For the quantitative analysis, correlational and predictive relationship analysis will be used depending on the specific research question being addressed.

The correlational analysis will be:

- Analysis of Variance, ANOVA (qualitative and quantitative variables) for RQ 1.1 and RQ 1.3.
- Independent t-test (quantitative variables, independent measures) for RQ 1.2 and RQ 3.1.
- Dependent t-test (quantitative variables, repeated measures) for RQ 2.1.
- Factor analysis (latent variables) for RQ 2.2.
- (optional) Chi-square independence test (qualitative variables)

On the other hand, the predictive relationship analysis will be:

- Structural equation modelling (multiple regression analysis) for RQ 3.2.

4. Ethical considerations

Since this research involves the collection and evaluation of personal data, an informed consent form will be created to be signed by all participants. The consent form will include information about the research and about the participant's rights, such as opting-out or eliminating their data. The data collected will be coded and pseudonymously treated during the whole research process.

5. Planning

This thesis will be conducted during September 2021 and September 2025. A general overview of the project schedule is as follows.

Year 2021/22:

- Tasks: Literature review and data collection tools selection.
- Output: Paper "The more you know, the more you believe: Examining the influence of self-reported TPACK on teacher's technology-related beliefs" *(data already collected at the University of Zurich)*

Year 2022/23:

- Tasks: Data collection and data analysis.
- Output: Paper "TPACK: reported vs observed; paper COACTIV and TPACK: internal structure of the COACTIV model in media and computer science education"

Year 2023/24:

- Tasks: Data collection and data analysis.
- Output: Paper "Relationships between TPACK and teaching quality; paper Teacher-students' professional development and moderating factors"

Year 2024/25:

- Tasks: Final thesis elaboration.
- Output: Cumulative dissertation.

6. References

[1] European Commission, European framework for the digital competence of educators: DigCompEdu, Publications Office of the European Union, Website, 2017. Accessed: Apr. 21, 2021. [Online]. Available: http://op.europa.eu/en/publication-detail/-/publication/fcc33b68-d581-11e7-a5b9-01aa75ed71a1/language-en

[2] E. van Laar, A. J. A. M. van Deursen, J. A. G. M. van Dijk, and J. de Haan, The relation between 21st-century skills and digital skills: A systematic literature review, *Comput. Hum. Behav.*, vol. 72, pp. 577–588, Jul. 2017, doi: 10.1016/j.chb.2017.03.010.

[3] S. Blömeke, J.-E. Gustafsson, and R. J. Shavelson, Beyond Dichotomies: Competence Viewed as a Continuum, *Z. Für Psychol.*, vol. 223, no. 1, pp. 3–13, 2015.

[4] J. Baumert and M. Kunter, The COACTIV Model of Teachers' Professional Competence, in *Cognitive Activation in the Mathematics Classroom and Professional Competence of Teachers: Results from the COACTIV Project*, M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, and M. Neubrand, Eds. Boston, MA: Springer US, 2013, pp. 25–48. doi: 10.1007/978-1-4614-5149-5_2.

[5] J. H. Watson and A. Rockinson-Szapkiw, Predicting preservice teachers' intention to use technology-enabled learning, *Comput. Educ.*, vol. 168, Jul. 2021, doi: 10.1016/j.compedu.2021.104207.

[6] D. Petko, Teachers' pedagogical beliefs and their use of digital media in classrooms: Sharpening the focus of the 'will, skill, tool' model and integrating teachers' constructivist orientations, *Comput. Educ.*, vol. 58, no. 4, pp. 1351–1359, May 2012, doi: 10.1016/j.compedu.2011.12.013.

[7] I. Backfisch, R. Scherer, F. Siddiq, A. Lachner, and K. Scheiter, Teachers' technology use for teaching: Comparing two explanatory mechanisms, *Teach. Teach. Educ.*, vol. 104, p. 103390, Aug. 2021, doi: 10.1016/j.tate.2021.103390.

[8] S.-L. Cheng, L. Lu, K. Xie, and V. W. Vongkulluksn, Understanding teacher technology integration from expectancy-value perspectives, *Teach. Teach. Educ.*, vol. 91, May 2020, doi: 10.1016/j.tate.2020.103062.

[9] M. J. Nelson and N. A. Hawk, The impact of field experiences on prospective preservice teachers' technology integration beliefs and intentions, *Teach. Teach. Educ.*, vol. 89, Mar. 2020, doi: 10.1016/j.tate.2019.103006.

[10] M. Koehler and P. Mishra, What is Technological Pedagogical Content Knowledge (TPACK)?, *Contemp. Issues Technol. Teach. Educ.*, vol. 9, no. 1, pp. 60–70, Mar. 2009.

[11] D. Maor, Using TPACK to develop digital pedagogues: a higher education experience, *J. Comput. Educ.*, vol. 4, Mar. 2016, doi: 10.1007/s40692-016-0055-4.

[12] J. Voogt, P. Fisser, N. P. Roblin, J. Tondeur, and J. van Braak, Technological pedagogical content knowledge – a review of the literature, *J. Comput. Assist. Learn.*, vol. 29, no. 2, pp. 109–121, 2013, doi: 10.1111/j.1365-2729.2012.00487.x.

[13] S. Stadler-Heer, Introducing German pre-service teachers to remote teaching: Policy, preparation and perceptions of competence development of future foreign language teachers, *Train. Lang. Cult.*, vol. 5, pp. 68–85, Mar. 2021, doi: 10.22363/2521-442X-2021-5-1-68-85.

[14] D. Holzberger, A.-K. Praetorius, T. Seidel, and M. Kunter, Identifying effective teachers: The relation between teaching profiles and students' development in achievement and enjoyment, *Eur. J. Psychol. Educ.*, no. 34, pp. 801–823, 2019.

[15] A.-K. Praetorius, E. Klieme, B. Herbert, and P. Pinger, Generic dimensions of teaching quality: the German framework of Three Basic Dimensions, *ZDM*, vol. 50, no. 3, pp. 407–426, Jun. 2018, doi: 10.1007/s11858-018-0918-4.

[16] J. Tondeur, J. van Braak, G. Sang, J. Voogt, P. Fisser, and A. Ottenbreit-Leftwich, Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence, *Comput. Educ.*, vol. 59, no. 1, pp. 134–144, Aug. 2012, doi: 10.1016/j.compedu.2011.10.009.

[17] İ. Reisoğlu and A. Çebi, How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu, *Comput. Educ.*, vol. 156, Oct. 2020, doi: 10.1016/j.compedu.2020.103940.

[18] D. Petko, Quo vadis TPACK? Scouting the road ahead, Jun. 2020, pp. 1349–1358. Accessed: Nov. 14, 2020. [Online]. Available: https://www.learntechlib.org/primary/p/217445/

[19] L. Brantley-Dias and P. A. Ertmer, Goldilocks and TPACK: Is the Construct 'Just Right?,' *J. Res. Technol. Educ.*, vol. 46, no. 2, pp. 103–128, Dec. 2013, doi: 10.1080/15391523.2013.10782615.

[20] M. Schmid, E. Brianza, and D. Petko, Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK.xs) and comparing the factor structure of an integrative and a transformative model, *Comput. Educ.*, vol. 157, Nov. 2020, doi: 10.1016/j.compedu.2020.103967.

[21] C. Angeli and N. Valanides, Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK), *Comput. Educ.*, vol. 52, no. 1, pp. 154–168, Jan. 2009, doi: 10.1016/j.compedu.2008.07.006.

[22] M. M. Saad, A. M. Barbar, and S. A. R. Abourjeili, TPACK-XL Framework for Educators and Scholars: A theoretical Grounding for Building Preservice Teachers ICT Knowledge Base, p. 21, 2020.

[23] E. R. Urban, M. Navarro, and A. Borron, TPACK to GPACK? The examination of the technological pedagogical content knowledge framework as a model for global integration into college of agriculture classrooms, *Teach. Teach. Educ.*, vol. 73, pp. 81–89, Jul. 2018, doi: 10.1016/j.tate.2018.03.013.

[24] C. R. Graham, J. Borup, and N. B. Smith, Using TPACK as a framework to understand teacher candidates' technology integration decisions, *J. Comput. Assist. Learn.*, vol. 28, no. 6, pp. 530–546, 2012, doi: 10.1111/j.1365-2729.2011.00472.x.

[25] Lehrplan 21. https://zh.lehrplan.ch/index.php?code=b|10|0&la=yes (accessed Apr. 20, 2021).

[26] M. Vaismoradi, H. Turunen, and T. Bondas, Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study, *Nurs. Health Sci.*, vol. 15, no. 3, pp. 398–405, Sep. 2013, doi: 10.1111/nhs.12048.

[27] S. Biaggi, H. Andreas, and M. Kramer-Länger, Kompetenzraster Berufspraktische Ausbildung PH Zürich: Primar-stufe Quest-3. Version 2.0., Zürich: Pädagogische Hochschule Zürich, 2021.