AN EMPIRICAL PILOT IN ASSESSING STUDENT TEACHERS' BIOGRAPHY AND INSTRUCTIONAL BELIEFS

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Switzerland is undergoing a curricular change. Curriculum 21 has been ratified by all 21 German-speaking and is currently being implemented. With this innovation, German-speaking Switzerland will move toward a more technology-oriented education. What has been Manual Training or Wood/ Metalwork Classes is now replaced by composite subjects such as Nature and Technology. These subjects now structurally anchor technology-oriented content at the compulsory school level (Stuber, Heitzmann, & Käser, 2013) and are supposed to be implemented in the sense of the Anglo-Saxon concept of Science – Technology – Society – Environment (Labudde, 2012, p. 86). The technology orientation includes an instructional orientation toward a technical understanding or understanding technology, which, eo ipso, needs to be part of teacher education programs (Keller, 2017). To put things bluntly: Who else than technology/ technics-oriented teachers should teach technology and technics? Yet, technics or technology is not explicitly part of their initial studies, perhaps because in "the mandatory school, i.e. K-12, there is no specific subject 'Technology', but there is a subject called 'Textile and Technical Design'" (Kruse & Labudde, 2016, p. 62). Therefore, student teachers may at the most specialize in textile and technical design or in information technology/ computer science and teach technics and technology in an integrated way. But what are factors they would consider to impede tech instruction? In other words: What are factors that hinder high quality technology instruction by means of teacher beliefs? In this presentation we will give insights to a quantitative exploratory study.

Keywords: Science & technology education, pre-service teacher education, technology instruction

INTRODUCTION

Currently, Switzerland is moving toward a more technology/ engineering-oriented education. What has been *Manual Training* or *Wood/ Metalwork Classes* is replaced by composite subjects such as *Nature, Man, Society*, *Nature and Technology* or T*extile and Technical Design*. These subjects now structurally anchor technology at the compulsory school level (Stuber et al., 2013) and are supposed to be implemented in the sense of *Science – Technology – Society – Environment* (Labudde, 2012, p. 86). Also the subject area of media & information technology education touches the general technology branch, especially when informatics is extended to computer programming, digitalization of work routines and robotics. All this includes an instructional orientation toward a *technical understanding* or *understanding technology* (National Research Council, 2002), which, eo ipso, needs to be part of teacher education programs (Keller, 2017). Current cohorts of student teachers at the Swiss universities of teacher education are supposed to be educated toward these contents. But in praxis, who else than technology-affine teachers should teach technology? Technology was not explicitly part of their initial studies, and even current students do not receive a uniform technology-oriented education. Perhaps because in "the mandatory school, i.e. K-9, there is no specific subject

'Technology', but there is a subject called 'Textile and Technical Design'" (Kruse & Labudde, 2016, p. 62). Also, *Textile Design* is not pure technology and technology is not solely design-oriented. The same is true for media and information technology, digital technology, engineering or any other area.

At the moment, student teachers may – at the most – specialize in textile and technical design or in information technology/ computer science, and consequently teach technology in an integrated way. From the fact that there is no systematic technology education in the course of their university studies, the question arises under which circumstances student teachers individually integrate technology-oriented instruction into their teaching. Thus, we need to know about predictors of technology-oriented instruction. Our question is: What are preconditions that support student teachers pursue technology-oriented instruction in compulsory K-9 school, i.e. primary and lower-secondary school?

THEORETICAL BACKGROUND

It is generally difficult to draw a comprehensive picture of instructional integration processes, especially in terms of a rather opaque field of "technology" education. Thus, in first part of the theoretical section, we want to clarify our conception of technology. In the second theoretical part – because we ask the question "What are preconditions that support student teachers pursue technology-oriented instruction in compulsory K-9 school, i.e. primary and lower-secondary school?" – we want to focus on holistic theories of behavior prediction and integrate them into a framework of technology education.

The term technology

The most debatable term in this study is *technology*. Looking at a large body of research in technology integration in instruction, we see that the term *technology* is mainly used to refer to computer-like systems, digital devices or applications that are programed to substitute analog antecedents. For example the use of computers in classrooms, the implementation of tablets or apps, or having online examinations (e.g. Lumpe et al., 1998; Palak & Walls, 2009; Ottenbreit-Leftwich et al., 2010; Ertmer et al., 2012; Kim et al., 2013; Hutchison & Woodward, 2014; Beschorner et al., 2018). In sum, most studies find teacher beliefs, values, pedagogical self-concept, reflected, goal-oriented intentions, and value for learning outcomes as main factors for technology implementation.

Yet, the term technology not solely refers to digitalization. Although there may be various understandings around the world and particularly within European countries, and also differences between US and Europe, we want to employ a definition that, to our knowledge, addresses most conceptions: "Technology comprises the entire system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves." (National Research Council, 2002, p. 3). Thus, *technology* and *technics* are defined as a construct of informatics & digital literacy as well as technical & engineering knowledge and any innovative combination of any of these fields. Within this broad conception of technology one needs to consider engineering school education, too. Yet, this has been hardly explored. Van Haneghan et al. (2015) find that teachers' experience with engineering is of advantage when it comes to teaching engineering topics. Also, the value teachers see in teaching engineering has an effect on the implementation of engineering topics (Park et al., 2016). Similarly to technology integration, engineering instruction is also related to how well prepared (content-wise and pedagogically) the teachers feel themselves (Wang et al., 2011; Rich et al., 2017)

Pedagogical knowledge, beliefs, socialization, and motivation as instructional predictors

Teachers work within a context of not-well-structured problems and infinite variability of outcomes. By definition, "well-structured problems are constrained problems with convergent solutions that engage the application of a limited number of rules and principles within well-defined parameters. Ill-structured problems possess multiple solutions, solution paths, fewer parameters which are less manipulable, and contain uncertainty about which concepts, rules, and principles are necessary for the solution or how they are organized and which solution is best" (Jonassen, 1997, p. 65). To solve ill-structured problems teachers need a broad spectrum of reactions, competence, and experience. Jonassen (1997) argues that ill-structured problems are solved best if one can a) articulate the problem space and contextual constraints, b) identify and clarify alternative opinions, c) assess the viability of alternative solutions by argumentation and beliefs, and d) apply, monitor and adapt the solution. Taking into account that this whole process is situational, the most relevant predictors of solving an ill-structured interaction may be the teachers' mindset and their ability to consider the contextual/ interactional constraints (i.e. pedagogical knowledge). A prominent model of teacher resources for instructional practice has been proposed by Kunter et al. (2013). It integrates professional cognitive competences (e.g. pedagogical content knowledge), beliefs and motivational variables as the most valuable predictors of instruction:

a) *Pedagogical (content) knowledge* represents what the teacher knows about teaching content matter to students in a particular stage of development. Thus, pedagogical content knowledge includes knowledge about the content area, knowledge about instructional methods, and knowledge about the developmental stage of the students.
b) *Teacher beliefs* of instruction can be seen an interactive process guided by individual norms, one needs to understand the beliefs of the involved individuals (Raymond, 1997; Pane, 2010). Beliefs are often formed by prior teaching experiences, e.g. how they were taught to teach in their teacher education program or even how they were taught themselves during their schooling. Especially the latter reaches out into the wide field of socialization and biographical backgrounds.
c) Hurrelmann (1986, 2002) draws on socialized cognition, knowledge, biography and social contexts in order to explain purposeful behavior and decision-making. General, but also family and school socialization develops motivation and interest in any domain, also in technology (Deci & Ryan, 2000; Renn et al., 2009; Ardies et al., 2015; Adenstedt, 2016).

Therefore, we want to emphasize home, school and hobby/ interest as major predictors of technology socialization.

d) *Motivation* can be defined as the result of situation-belief interaction (J. Heckhausen & Heckhausen, 2018). Motivation results in action. In the motivational process intention plays a central role: The Rubicon model of action phases (H. Heckhausen & Gollwitzer, 1987; Gollwitzer & Oettingen, 2001; Achtziger & Gollwitzer, 2007) – a sequential, psychological model – predicts a person's behavior. In the model, the intention-building is central as it activates planned behavior. Based on van Hooft, Born, Taris, van der Flier, and Blonk (2005), who articulate that planning is essential and can be assessed in a questionnaire. This methodological idea is in line with Fishbein and Ajzen (2010) who argue that asking a person is a good proxy for the person's true intentions.

Based on the above mentioned, we developed a research framework that includes the major dimensions of instruction and their relevance in general educational contexts. In our case we focus teacher prerequisites related to their instruction in compulsory school (see Figure 1).

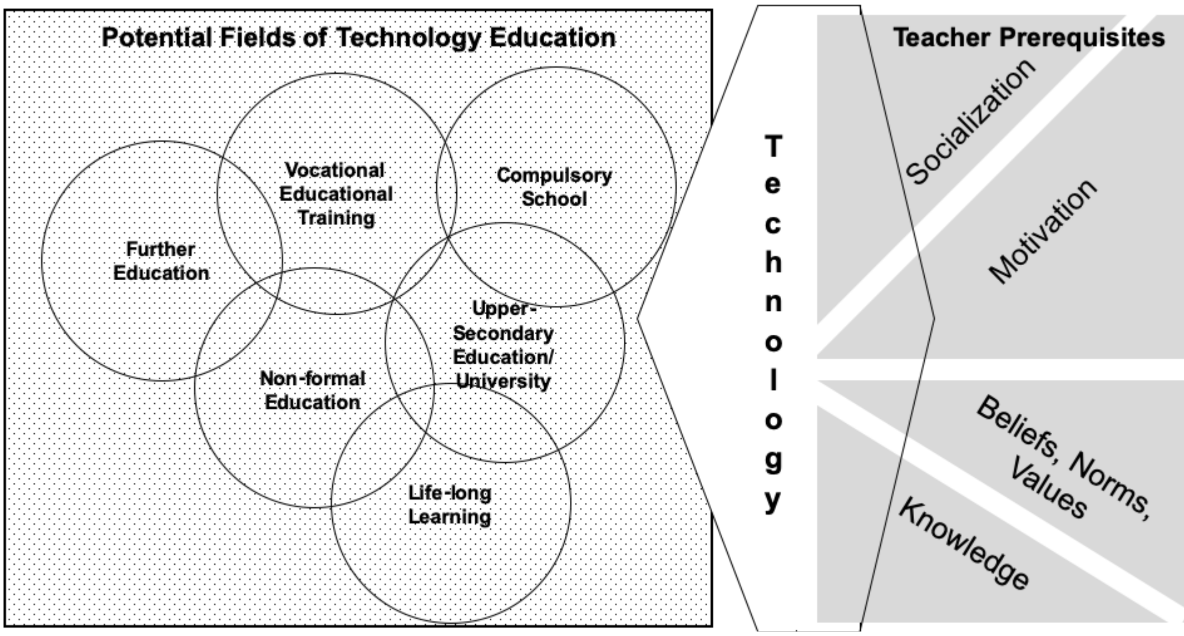

Figure 1: Framework of teacher prerequisites and implementation fields for technology education

In Figure 1 the major variables for successful technology implementation are teacher socialization, motivation, beliefs, and knowledge. These variables combine self-attribution as well as objective evaluation.

METHOD

Instruments

We used a questionnaire to assess the biographical background (socialization) and the intention to implement technology instruction and self-confidence in technology instruction. All items were rated on a 5-point Likert scale (do not agree --- fully agree). The instruction included clarification of the term, i.e. it means digital technology as well as engineering.

Technology socialization was newly developed, has 4 items (e.g. Technology played a role in my family during my childhood"), showed uni-dimensionality in principal component analysis and reliability was α=.78; The intention to implement technology instruction was adapted from van Hooft et al. (2005), included 4 items (e.g. "I know exactly how to implement technology in my instruction"), showed uni-dimensionality in principal component analysis and reliability was α=.78.

In addition to the two theoretical variables above, we assessed a lack professional and instructional self-confidence as hindering elements to implement technology instruction. These single item indicators were "I think my content knowledge is insufficient." and "I think my pedagogical competence does not suffice."

Sample and context of data acquisition

In autumn 2016 we deployed questionnaires to 69 student teachers (66% kindergarten & primary level, 34% lower-secondary level; 2 courses in primary level – 4-4.5% male students; one course in lower-secondary – 64% male students). All participants were enrolled in a class on "quantitative research methods". As the class was compulsory in the education program the backgrounds of the students were manly randomized, i.e. they were neither biased in terms of interest, nor preferred subjects. 77% of the students were female, kindergarten and primary level are dominated by female students (Phi=.66, p.000). On average, they were in their second year of study. Data were analyzed with SPSS 24. Two-tailed Spearman-correlations were computed and Kruskal-Wallis test/ separate Mann-Whitney U tests were used for comparisons between the three groups. Because of the small sample and the exploratory purpose of the study, we give exact p-values that need to be interpreted carefully, but also with tolerance.

RESULTS

The implementation intention correlation was .24, p=.066, the correlation between the single item indicators was .46, p=.000. The pedagogical confidence was not associated to the socialization (r=.20, p=.118), but the confidence in content knowledge was (r=-.27, p=.035). With reference to the implementation intention, both pedagogical confidence (r=-.35, p=.006) and confidence in content knowledge (r=-.50, p=000) showed statistical significance. The the Kruskal-Wallis test for overall comparison resulted in two-sided p-values for technology socialization (p=.006) and the other variables in a range of p=[.366;.515]. Mann-Whitney U tests with corrected alpha level of p=.05/3 tests=.017 showed that the group of lower secondary students scored higher on technology socialization than any of the primary teacher groups (p=.010; p=.004), the two primary teacher groups did not differ (p.=872).

DISCUSSION

This study framed the term "technology" in a content area of informatics & digital literacy as well as technical & engineering knowledge and any innovative combination of any of these fields. We also picked up the issue of technology instruction without a subject named "technology" in Switzerland and investigated the relation of a technology-oriented socialization and the implementation of technology instruction. Furthermore, we explored the association of pedagogical and professional self-confidence with respect to socialization and implementation. The results seem promising and showed that a stronger self-reported technology orientation during childhood is associated with how technology education enters instruction. Confidence in pedagogical and professional knowledge share a stronger association with the implementation than socialization does, but it seems that socialization can play an important role. As this is a pilot study with a small sample size we still need to be careful in interpretation. But if the effect holds true in a large sample we have evidence that school sets itself into a vicious cycle of technology education and its mandate to educate kids toward a good fit into society. The reason is that technology at school is part of the socialization, and if it is left out we will not have teachers with sufficient technology socialization that trust themselves to teach technology. A second exploratory finding is that lower-secondary teacher students rate their technology socialization higher than the primary school peers, but they are not more confident in their abilities. Thus, a "women underrate their abilities" explanation in which the female-dominated primary teachers do not trust their abilities as much as the male students, does not apply. We speculate that this effect may rather appear because students perceive subjects in different way: in lower-secondary education they have separate subjects, in primary/ kindergarten they teach holistically. We hope for more research on this assumption, especially because it is just out of an exploratory approach in a small sample pilot study.

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