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Contents and Structures of Preservice Teachers' Beliefs about
Technology in School - Before and After Remote Teaching due to
COVID-19

PREPRINT

Abstract:

Teachers' beliefs about ICT play a key role in the integration of ICT in teaching and learning. As findings on the impact of distance learning during the pandemic on teachers' ICT beliefs are inconclusive, a follow-up study to a qualitative study from 2017/18 was conducted in spring 2022. It reveals changes and continuities in preservice teachers' beliefs about the relevance of ICT for subject teaching, its imagined impact on teaching and the changing role and professional identities of teachers. No major changes in ICT beliefs could be identified. Therefore, we suggest that ICT practices during the pandemic did not change ICT beliefs, but rather that these ICT practices were mainly shaped by pre-existing ICT beliefs. Implications for teacher education and CPD are discussed.

Keywords:

Teachers' Beliefs; COVID-19; Emergency Remote Teaching; Teacher Education; ICT; Digital Technology in Education

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1 Introduction

The forms of teaching and learning and teaching required during the closure of schools and colleges due to the Coronavirus pandemic, and especially their social consequences, have posed an enormous challenge for pedagogy. Research into the causes of these fundamental challenges now extends to all agents and structures of the education system. And although a massive learning shortfall was diagnosed and social inequalities and discriminations were massively reinforced even in the privileged industrial countries (Avsar Erumit et al., 2021; Garrote et al., 2021; Reintjes et al., 2021; Engzell et al., 2020; Hughes 2020), the crisis raised hopes for a breakthrough in questions of the renewal of schools and teaching with regard to digital transformation. The exceptional situation was seen as possibly the "most effective CPD measure of the century" (Schratz, 2020) or as a breakthrough for ICT integration in school, which had already fundamentally changed the professional identity of preservice teachers (Gündoğdu & Alkayalar, 2021). On the other hand, it became evident that teachers now fundamentally doubt their own digital competences (Porsch et al., 2021) and it was argued that the pandemic was at most able to provide "certain impulses for change" for teacher education but without producing new insights (Döbeli Honegger, 2021, p. 421). What influence the experiences during the pandemic will have in the long term, whether they will have been a "game changer" (Wright, 2020) or whether de-professionalising effects will possibly prevail (Schmidt, 2021), is currently still difficult to assess.

But it seems reasonable to assume that the forms of teaching and learning implemented during the closure of schools and colleges were interventions that could have a significant impact on teachers' beliefs about ICT (Digital Information and Communication Technologies). And given the fact that teachers' ICT beliefs play a key role in the quality and quantity of technology integration, changes in these beliefs could make a huge difference to future efforts in this field.

2 Background

The supporting and limiting influence of teachers' beliefs on the introduction of innovations and reforms in education is well documented. In this respect they are seen as perhaps the "single most important construct in educational research" (Pajares, 1992, p. 329), as they form the eye of the needle for any improvement of learning based on research. They form an interface between the past (the teacher's previous experiences, training, and development) and the future (changes to teaching practice in the future). Regarding pedagogical innovations, it is therefore important to know which beliefs filter, frame and guide new pedagogical approaches and reforms (Fives & Buehl, 2012, p. 488).

ICT-related beliefs became an important topic of research in light of the poor results of the laptop programmes of the 2000s – the devices were hardly used, and the learning effects were marginal (Schmidt, 2020). ICT-beliefs were considered as the "barrier" or "final frontier" to successful ICT integration (Ertmer, 2005). It was the goal to find strategies to effect a change in these beliefs so that ICT would be used more often and suitably in the classroom. Since then, the study of teachers' beliefs about ICT and other dispositional factors has formed a whole area of research (Ertmer et al., 2015; Ottenbreit-Leftwich et al., 2018), showing the far-reaching influence of ICT beliefs on school practice. Teachers choose ICT uses that fit their existing teaching strategies and, in particular, align with their beliefs about 'good' pedagogy (Tondeur et al., 2016). The more appropriate and valuable an ICT practice is perceived to be to meet the demands of an age group, the content of instruction, and support the achievement of specific learning goals, the more likely it is to be integrated into instruction (Sadaf et al., 2016), with self-assessed rather than factual ICT competencies being crucial (Hämäläinen et al., 2021; Ottenbreit-Leftwich et al., 2018, p. 325). It has also become evident, that attempting to mutually change digital classroom practice and beliefs is a more promising strategy than trying to instrumentally change beliefs to reach intended forms of teaching with ICT (Ertmer et al., 2015; Prestridge, 2012; Ertmer & Ottenbreit-Leftwich,

2010). Qualitative studies can show which contents and structures significantly shape these beliefs and thus practice, and to what extent they may change through interventions (Schmidt, 2020; Knüsel Schäfer, 2020; Tondeur et al., 2016). It also becomes clear that these beliefs do not necessarily stand in the way of professional teaching but can serve as valuable starting points for professional development.

Considering this situation, the key role of teachers' ICT beliefs is apparent: it can be assumed that teachers' ICT beliefs shape school practice to a far-reaching extent – this may range from enthusiastic continuous use to the complete rejection of ICT in the classroom – often without didactic, pedagogical, or subject didactic standards being the primary guiding principles (Eickelmann & Vennemann, 2017).

So far, the findings to date on the change in teachers' ICT beliefs as a result of distance learning during the pandemic are inconsistent. On the one hand, fundamental changes in beliefs have been identified as a breakthrough for school ICT integration. For example, one study finds that teachers have changed their beliefs about both their identity and their role as a teacher, as well as now experiencing the integration of ICT in the classroom as an essential part of the development of their professional identity (Gündoğdu & Alkayalar, 2021). On the other hand, the MEDAL study (Porsch et al., 2021) could not identify significant changes in teachers' ICT beliefs at all. It was also shown that teachers did not change their predominantly negative beliefs about online teaching during the pandemic (Avsar Erumit et al., 2021). Evidence has also been provided that shows that it is teachers' stable pedagogical beliefs in particular that shaped ICT practices before, during and after distance learning in the pandemic but also that these stable beliefs do allow for changes in teaching – provided that these changes fit the beliefs (Gao & Cui, 2022).

This controversial starting point has prompted the decision to conduct a follow-up study to the #LPiDW qualitative study of 2017/18 (Schmidt, 2020) to gain more detailed

insights into the content and structures of teachers' ICT Beliefs after distance learning during the pandemic.

3 Methods

The qualitative-explorative study presented here focuses on topics and arguments through which preservice teachers express their ICT beliefs.

The main research questions were:

1. How do preservice teachers express their ICT beliefs? What terms, topics and forms of argumentation can be identified?
2. What significance do preservice teachers ascribe to ICT in relation to teaching and school?
3. What beliefs do preservice teachers express about their own role in relation to ICT use in school?

In the main study of 2017/2018, preservice teachers of social science subjects were surveyed in subject didactics courses at the School of Education FHNW in the end of 2017 and beginning of 2018. Inspired by ethnographic methods in education research (Thole 2010), the intention was to create an intervention that on the one hand is close to a 'normal' university course with inputs by tutors and students as well as group discussions and that on the other hand allows to create a replicable process structure. The multi-phase survey procedure included initial round-robin individual student statements followed by a group discussion stimulated by a scenario (Lamnek 2005, Bullough Jr. 2015). One week later, in the same group, students were asked to design and present a future scenario that expresses their beliefs about the significance of ICT in teaching and learning in groups of two or three. The whole sequence was carried out by the respective tutor of the course in 8 different groups with

a total of n=102 participants with the conductor of the study only observing and (voice-) recording.

Of the 102 participants in the survey, 33 were preservice teachers targeting lower secondary level with the subjects Geography/History or Ethics/Religions and 69 targeting upper secondary level with the subjects: Geography, History or Philosophy. 39% of the participants were female and 61% male.

The analysed data included the transcripts of 102 individual student statements, 8 group discussions and 41 scenarios. These parts were analysed using methods of qualitative content analysis and structured content analysis (Mayring 2015). The identified codes included Topoi (Tools, Teaching and learning activities with ICT, Innovations through ICT, Forms of school and classroom presence), Discourses (Optimisation, Subject Didactics, Competencies, the Inconceivable), Agency (attributed to teacher vs. to ICT), and others. The whole procedure is documented in detail in the main study (Schmidt, 2020).

The follow-up study in the spring term of 2022 was conducted with the same target group and the same survey procedure. Here there were 2 groups with n=32 preservice teachers. The analysis included 32 individual student statements, 2 group discussions and 10 teaching scenarios.

The follows-up study of 2022 allows for the comparison of the identified beliefs with the findings of 2017/18 and thus indicates possible changes and continuities in the contents and structures of teachers' ICT beliefs. The focus of the analysis for this comparison was directed at three areas of ICT beliefs:

- Beliefs about changes in school through ICT
- Beliefs about the relevance of ICT in school and subject teaching
- Beliefs about the changed role and professional identity of the teacher through digital transformation.

In the following, the results for these three areas are presented.

4 Findings

4.1 Beliefs about changes in school through ICT

In the main study in 2017/18 as well as in the follow-up-study in 2022, preservice teachers express differentiated beliefs about the changes in school teaching practice brought about by ICT, in particular by naming (1) which digital tools they consider to make decisive changes in school, (2) which teaching activities that use ICT they consider to be central and (3) which innovations they hope for through the use of ICT.

(1) Regarding the digital tools preservice teachers consider to make decisive changes in school, in 2017/18 a wide range of different devices, applications and teaching media, visualisation tools and administrative tools are discussed: tablet computers are mentioned most frequently, followed by laptops, virtual reality applications, learning platforms and smartboards. Overall, hardware in the form of computers and visualisation devices commonly used today dominate the statements. References to software applications for learning, administration, or communication, on the other hand, make up a smaller proportion of statements. An interesting exception is the smartphone and social media with messenger services: their omnipresence in everyday life is only marginally reflected in the statements.

In the follow-up study, the mentioning of digital tools is significantly rarer than in 2017/18. In contrast, the mention of hybrid, synchronous and asynchronous settings – obviously similar to the settings of distance learning in the pandemic – now take a central position. It is remarkable that the technical requirements of these settings are rarely addressed. In addition, virtual reality (VR) simulations are now mentioned second most frequently, together with tablets. Smartphone and social media applications are no longer discussed at all. So, while digital devices and their functions were still a central subject of statements in

2017/18 and their presence was a subject of discussion, now their presence in schools seems to be taken for granted in the form of a technical infrastructure to enable remote learning.

(2) Looking at teaching activities with ICT that are considered central in 2017/18, the teachers' most frequently mentioned activity is the presentation of lesson content with projectors and VR, as well as the transmission of worksheets or tasks to the students' devices. Checking tasks or the status of learning on a learning platform and displaying or implementing a (partly automated) prefabricated lesson are the second most frequently mentioned teacher activities. Interactive learning with and between students is discussed only occasionally. Thus, activities that serve the transmission of predefined learning content dominate the statements, while constructive or co-constructive activities are hardly described. Nevertheless, the activity of the teacher is often described using the term 'coach', which expresses the belief that teachers are now less concerned with the teaching of content than the technical processes of transmitting the material and accompanying the learning process.

In the follow-up study, there are very few noticeable differences in the activities described. Compared to 2017/18, the creation and provision of learning materials on learning platforms for asynchronous learning settings is somewhat more prominent and the image of the teacher as a coach who accompanies learning (of mostly predefined content) is now consistently present.

(3) Also central, are teachers' beliefs about what innovations ICT bring to schools. In the main study, innovations were seen above all in the simplified delivery of learning material, in the automated monitoring of learning progress or in VR visualisations. ICT is also seen as a tool newly enabling personalised and self-directed learning. Other innovations are seen in connection with VR simulations, e.g., for history or geography lessons. Overall, in 2017/18 ICT use appears mostly as part of a traditionally organised classroom, equipped with tools perceived as new (mostly tablets, laptops, projectors, VR) and with the teacher 'in front'. But alongside this, there is also a widespread belief that the traditional classroom

should increasingly be supplemented by new forms of learning such as open learning spaces or individual e-learning, or project work with and without ICT.

In 2022, the focus is more on innovations through hybrid, synchronous or asynchronous teaching settings. But here also, the structure of a digitally enhanced ‘teaching from the front’ is dominant, where the central question now seems to be when, how and which external participants should be included. Also, the belief that open learning spaces or individual project work with and without ICT are an important innovation remains common in 2022.

4.2 *Beliefs about the relevance of ICT in school and subject teaching*

These beliefs about changes in school and teaching through ICT are reasoned by the preservice teachers in different ways. The qualitative content analysis allows us to determine in detail which arguments preservice teachers use to express their beliefs. This allows a glimpse into the structure of the beliefs: into what they believe ‘what it is all about’ when ICT is used in school. Three main patterns of argumentations (‘discourses’) could be identified: a discourse on effectiveness and efficiency, a discourse on improving didactics and a discourse on learning objectives.

(1) In terms of length and frequency, a discourse around optimisation is predominant, in which ICT is presented on the one hand as a means to make routine tasks easier and thus save time and resources (efficiency), with the focus on the possibility of simplified visualisation and distribution of learning content. On the other hand, ICT is seen as a means to achieve better learning outcomes (effectiveness). A higher effectiveness in terms of better learning outcomes is hoped for through more intensive visual experiences in VR environments or through learning software that automatically adapts to the students. Both in 2017/18 and 2022, efficiency and effectiveness are the main reasons for the use of ICT.

(2) Less frequent, but nevertheless consistently present, is the belief that learning can be didactically improved by ICT. In the group surveyed there is the belief that the use of VR simulations in the form of a 'visit' to the past in history lessons or an 'excursion' to landscapes in geography lessons will improve subject learning. In addition, ICT is seen as an opportunity to enable personalisation or self-directed learning. Almost universally, the social and socialising function of school and the importance of interaction in person are expressed when the acquisition of declarative knowledge is to take place mainly individually and based on ICT. The preservice teachers are also often convinced that students should continue to learn with pen, paper and books and that physical presence and direct social interaction in the classroom are important for successful learning. In this area no significant differences between 2017/18 and 2022 were found.

(3) A third field is the beliefs about learning objectives when teaching with ICT. Most frequently expressed here is the belief that the development of "media literacy" is key, meaning a critical and mature use of ICT is the central goal. Other competences considered important are of a compensatory nature: understanding and mastering the analogue and physical world, learning to read long texts, being able to write with pen and paper, development of gross motor skills through sports, etc., are all named to emphasise that, in the face of extensive use of digital media, the material, sensorial or social dimension is still important for pupils or that a balance should be created in school. Less frequent are arguments that criticise utilitarian or neoliberal views on education that are supported through ICT or that warn against totalitarian structures of surveillance and control and thus encourage a moderate or reflective use of ICT in schools.

Overall, in 2022 the 'discourses' are characterised by the same structures as in 2017/18. In 2022, however, the arguments are exemplified more often in the formats of digital distance learning or hybrid formats. Also, they appear to be thematically narrower than in

2017/18, but generally, effectiveness and efficiency remain the leading reasons for ICT integration while didactics and learning objectives are less apparent.

4.3 *Beliefs about the changed role of teachers and their professional identity*

The presented beliefs about changes through ICT and their relevance for teaching show that preservice teachers are largely convinced that ICT is essentially a practical substitute or an effective supplement to previous teaching tools without fundamentally changing school or teaching and learning. The statements are often accompanied by judgements about what seems unthinkable to them: for example, the replacement of the teacher by robots or the complete shift of teaching into a virtual space. In addition, continuities are often emphasised, or traditional elements of teaching and learning in today's schools are perpetuated without being questioned. Thus, the expression of preservice teachers' ICT-beliefs is characterised by a double figure: the rejection of far-reaching changes and the assertion of continuities when integrating ICT. The preservice teachers declare openness to changes in teaching and learning settings, but they reject a questioning of the teacher him/herself, of the lessons he/she designs or of the school as a place of social learning. Almost without exception, the preservice teachers directly or indirectly express the belief that they will continue to be the central actors in students' learning. They largely assume that they themselves make the decisive contribution to the shaping of lessons or to the successful learning of students (agency) and only attribute a little of the impact to ICT.

Such attributions of 'agency' to ICT or the teacher can be found in four different forms: in most cases, agency is associated with the image of traditional teaching, where ICT is predominantly understood as a supplement or more functional substitute for previous teaching tools and the teacher's agency consists of operating these tools (traditional ICT agency). In a second form, the self-attribution of agency arises from the perceived importance of the teacher's personal presence for learning or social interactions, even when ICT is used

(personal ICT agency). In a third form, the self-attribution of agency is based on the coexistence of traditional and open forms of learning, both of which are shaped by the teacher with the use of ICT (extensive ICT agency). Far less often is agency attributed predominantly to ICT, so that learning software, robots and VR simulations take over central tasks from the teacher. But even then, the teacher is still attributed a crucial role, ranging from being a mere technical supporter to being a learning coach. The teacher himself stays indispensable, but his agency is subordinated (secondary ICT agency).

In 2022, the forms of agency are often articulated around classroom situations of distance learning during the pandemic (traditional agency appears, for example, in the way that teachers upload materials onto learning platforms instead of, as in 2017/18, loading them on to students' tablets) but the general forms of agency remain unchanged from 2017/18 and in similar distribution.

Taking together the elements of the beliefs about their own person, role and task, common characteristics of these beliefs could be identified. A first common feature of almost all statements is that preservice teachers are convinced that they are the central agents of learning processes. At most, due to the changed technical possibilities, they delegate the acquisition of declarative knowledge to ICT and emphasise their own role more in learning support ("coach"). A second common feature of the beliefs is that classroom lessons continue to be the central form of subject learning. They are also largely convinced that classroom instruction centrally led by the teacher should be supplemented by other forms such as open learning spaces or personalised learning, but almost never is instruction itself questioned. These two characteristics also imply the third element, which is not up for discussion: that they are convinced that school will remain as a physical space and continues to be the central place of learning. Hereby the social tasks of school appear reinforced by the digital transformation; a complete replacement by virtual learning spaces is rejected almost completely.

5 Discussion

Comparing 2017/18 with 2022, it can be said that no fundamental changes in the content and structure of ICT beliefs can be discerned. The guiding idea of a digitally enhanced style of ‘teaching from the front’ remains central. In 2017/18 it is equipped with ‘new’ digital tools, namely tablets; in 2022 with the ‘new’ possibility of connecting other participants online.

Also, the belief that open learning spaces or individual or collaborative project work (with and without ICT) play a growing role alongside teaching from the front remains prevalent.

Effectiveness and efficiency remain the leading categories for the justification of ICT use, while didactic considerations or learning goals are secondary. One important change can be noted: while digital tools, their functions and their presence in schools were still a central subject of debate in 2017/18, their presence is now rather taken for granted in the form of an infrastructure to enable distance learning.

In all the statements an unchanged hard core of ICT beliefs can be identified: that teachers are convinced that they remain the central facilitators and designers of learning processes (at most handing over the transmission of declarative knowledge to ICT), that centrally organised lessons remain the form of subject teaching (supplemented by open learning spaces, personalisation and flipped classroom settings with and without ICT) and that the school remains the central place of learning (with a stronger focus on social tasks, balancing the one-sidedness of intensive technology exposure).

According to the findings, the experiences during the pandemic have not changed these fundamental, identity-related ICT beliefs. The identified changes seem to be more related to the superficial elements of teaching with digital tools, for which - equally problematic - it is now no longer the equipment with tablets as in 2017/18, but the emergency remote teaching settings that are paradigmatic.

The results of the quantitative MEDAL study (Porsch et al., 2021) can thus be confirmed where no significant changes in the teachers’ ICT beliefs could be identified. Our

findings also support the results of Gao et al. (2022) identifying both teachers' willingness and resistance to change, but on different levels of practice. It also supports their assumption that it is stable pedagogical beliefs that shape ICT practices both before, during and after distance learning during the pandemic and that these certainly offer space for changes in teaching - provided that these changes fit the beliefs (Gao & Cui, 2022). In contrast, stable, negative beliefs about online teaching (Avsar Erumit et al., 2021) could not be identified, and the finding that pandemic distance learning would have brought new beliefs about teaching and learning and a changed professional identity for preservice teachers (Gündoğdu & Alkayalar, 2021) cannot be confirmed in any way.

6 Conclusions

From these results it can be concluded that the challenges for teacher education and CPD concerning the impact of beliefs on the integration of ICT remain - systematically seen - unchanged. Also, after the crisis, it can be assumed that teachers' ICT beliefs remain very influential for the way ICT is used in schools and that far more than professional standards shaping their practices, teachers will probably continue to choose those ICT practices that fit their beliefs. In view of the present results, it seems more plausible that teachers' ICT beliefs already present before the crisis became decisive for the perception, assessment, and handling of the crisis situation than to assume that the crisis changed their ICT beliefs. It is precisely in situations of irritation and uncertainty that the impact of beliefs as a filter, frame, and guide (Fives & Buehl, 2012) for teaching practices becomes more apparent. And if one compares the ICT beliefs already identified before the crisis with the practices realised during the pandemic, their similarity is striking. Therefore, we suggest that instructional practices during school closures should be understood as expressions of existing, guiding ICT beliefs that were widely manifested and established during the crisis. This could also be theoretically informative: maybe this can better explain the problems that arose, such as learning dropout,

social isolation and discrimination, rather than attributing the problems to deficient teachers or to the digital formats themselves.

If it is true that even such an intensive intervention (such as distance learning during the pandemic was) is not able to fundamentally change teachers' ICT beliefs, then the question must be asked: which measure of teacher education could do this at all? Presumably, professional development does not succeed against the ICT beliefs of teachers, but rather through and with them. Thus, the findings are a further indication that the framing of ICT beliefs as an eliminable 'barrier' to meaningful school ICT integration is not helpful (Schmitz et al., 2022). For teacher education, it seems more promising to make the contents and structures of ICT beliefs themselves the starting point for designing lessons (Schmidt, 2020; Schmidt & Reintjes, 2021; Fluck & Dowden, 2013) and to develop professional standards from there.

Through the experiences of the last two years, this task has probably not become easier, but rather more difficult. Even if it is true that most research findings in this field are not systematically new, the experiences of teachers were still subjectively new and very memorable for most teachers. And teachers' ICT beliefs, therefore, while not new, may be more firmly anchored, as they have become self-confirmed, so to speak, in the many weeks-long practice required by emergency distance teaching. And for the next generation of teachers, the remote teaching undertaken in teacher education throughout the pandemic months could have worked as a kind of unintended "didactic double-decker" (Wahl, 2002) - where the routines of remote teaching at university are now available as well-practised models for action in school. These beliefs, stabilised through practice, should be a central theme in teacher training and CPD, otherwise normalisation and habituation could perpetuate questionable practices in the long term.

This is why the categorical difference between intentional, professional teaching with ICT and emergency remote teaching (ERT) should be looked at more sharply in the future.

Not only in retrospect is it surprising how the attempts to improvise digital remote teaching in view of the necessary school closures were conflated with planned, professional online teaching or even with a breakthrough in the question of technology integration in schools. ERT is a temporary shift in modes of delivery in crisis situations, such as pandemics or war (Hodges et al., 2020). Its intentions and quality criteria are different (such as maintaining the pedagogical relationships, strong consideration of the social, economic, and institutional contexts, media adequacy) from those of professionally facilitated online learning or standards of teaching in the digital age. Thus, ERT can be neither a role model nor an antagonist of regular, intentional school ICT practices. The fact that both have been confused with each other, measured against each other, or even discursively played off against regular teaching, can maybe be explained by the good fit of the practises used during school closures and the existing ICT beliefs that have been identified here. - In any case, ERT should become a regular part of the curricula of teacher education in the future. But this should rather happen in the theoretical and practical context of other special learning settings, such as learning in out-of-school sites or the design of inclusive teaching, rather than in the context of ICT integration efforts.

None of these tasks can be tackled separately from all other questions of teacher education. They call for integrated approaches to teacher education, where the new possibilities and tasks brought about by digital transformation are no longer focused on separately in the form of "digital" competences but are modelled as an integrated facet of all aspects of professional teacher knowledge and integrated into all aspects of the curriculum (Schmidt, 2020, Schmidt&Reintjes 2021).

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