ANALYZING DIGITAL TECHNOLOGY USAGE IN SCHOOLS EMPLOYING A SCHOOL-WIDE APPROACH TO PERSONALIZED LEARNING

Sri N.G.Jayanna,
Assistant Professor
Kotturswamy College of Teacher Education,BALLARI

Abstract:
In recent years, several institutions have placed a growing emphasis on personalized learning in their teaching and learning environments. Our study examines the utilization of digital technology in schools to facilitate and promote personalized instruction. We selected the three examples with the greatest frequency of digital technology utilization in the classroom from a pool of 31 lower-secondary Swiss schools that have implemented individualized learning policies. This selection was based on the students' replies to a questionnaire. We conducted an analysis to examine the variations and commonalities in how digital technology contributes to the promotion of personalized learning. We utilized significant categories of digital technology implementation to structure our inquiry. Our investigations resulted in the identification of three distinct methods to integrating digital tools into classroom practices: 1. The deliberate utilization of digital technology based on the teacher's preference; 2. The deliberate utilization of digital technology based on the student's preference; and 3. The systematic utilization of digital technology in accordance with a school-wide strategy. The findings indicate potential avenues for future research and practical implementation in the field of personalized education that maximizes the use of digital technologies.

Key words Utilizing digital technologies, integrating technology, and doing several case studies.
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I. Introduction

Personalized learning as a student-centered approach to education has aroused growing interest in the educational system because it raises the hope of fnding a better way of coping with the students' heterogeneity at school. Private initiatives and initiatives at national level in mainly Anglo-American countries encourage schools to change their teaching towards personalized learning (e.g., Miliband, 2006; Pane et al., 2017; Waldripet al., 2014). These initiatives and international research literature picture personalizedlearning as a multilayered construct that has been defned and implemented in various ways (Keefe, 2007; Zhang et al., 2020a). Despite this conceptual variety, many defnitions consider digital technology to be crucial to implement personalized learning (Bingham et al., 2018; ESSA, 2015; Walkington&Bernacki, 2020). Research on the use of digital technology in the area of personalized learning has predominantly examined technological innovations as an enabler of personalized learning environments (Gierl et al., 2018; Huang et al., 2012; Lee et al., 2018; mcloughlin& Lee, 2010). For example, one study developed and investigated a mobile adaptive learning system to enable personalized learning on mobile devices (Nedungadi& Raman, 2012). Other studies examined the use of an interactive e-book or media wiki to create a personalized learning environment (Huang et al., 2012; Kim et al., 2014). However, many schools have implemented a form of personalized learning as a whole-school approach and using diferent technological tools to tailor teaching and learning to the individual needs of students and to increase student choice, especially in Europe (Petko et al., 2017; Schmid&Petko, 2019). At the same time, it is largely unexplored how these schools use digital technology to facilitate and promote their school-wide approach of personalized learning (Bingham et al., 2018; Schmid&Petko, 2019; Zhang et al., 2020a). Therefore, empirical research on how digital technology is generally used in schools with an explicitly personalized learning approach is needed but still limited. Our paper addresses this desideratum and pursues the question how digital technology is used in schools with a school-wide approach to personalized learning. For this purpose, we specifcally focus on two dimensions that we consider crucial in defning the concept of personalized learning: student-centered teaching methods and students' voice and choice. Student-centered teaching methods put the student with her or his individual needs in the center so that he or she can achieve an optimal learning progress. The implementation of student-centered teaching methods includes higher degrees of student self-direction compared to traditional teacher-centered instruction. Due to this active role of the learner, the student receives a say in the content, time, place, and social form of learning, which also gives him or her more responsibility in the learning process. In order to grant students' voice and choice, a certain degree of student-centered teaching methods is needed. While student-centered teaching methods and students' voice and choice seem to be two sides of the same coin, both aspects (i.e., teacher activities and student activities) need to be closely aligned to result in successful personalized learning. A detailed description of the concept of personalized learning, focusing on the two characteristic dimensions and how technology can support the implementation are following in the next section.

II. Literature review: personalized learning and digital technology

Personalized learning

The idea of tailoring teaching to the individual needs of students has a long tradition in Europe and the Anglo-American countries, and it is discussed in connection with several educational approaches, for example individualization, diferentiation, student-centered education, constructivist teaching practices, self-regulated learning, or adaptive learning (Keefe, 2007; Stebler et al., 2018). The relatively new and popular term "personalized learning" links up with this idea. Several English-speaking countries have initiated educational reforms that are aimed at personalized learning and rely, among other things, on the help of digital technology. For example, the most recent US Education legislation—Every Examining the use of digital technology in schools with a… 369 1 3 Student Succeed Act (ESSA) of, 2015—intends to enhance personalized learning by digital technology and fnancially supports programs in this area in the hope of improving the quality of instruction and thus the learning success of all students. However, it remains an open question what defnition of personalized learning the ESSA uses as a guideline (Zhang et al., 2020b). In the year, 2010, the US Department of Education already described personalization in the "Education Technology Plan" as an extension of individualization (adaptation of the pace of learning to the individual learner) and diferentiation (adaptation of teaching methods to learning preferences). Not only the pace and the method can vary, but also the learning goals and the contents. The UK Department for Education and Skills initiated one of the frst educational reforms that explicitly referred to the term "personalization". In the report "Schooling for Tomorrow—Personalising Education," personalized learning was defned according to fve dimensions: 1. Assessment for learning: giving students individual feedback and setting suitable learning objectives; 2. Teaching and learning strategies based on the individual needs; 3. Curriculum choices; 4. A student-centered approach to school organization; 5. Strong partnerships beyond the school (Miliband, 2006). The document does not explicitly mention the role of digital technology, but in the research report by Sebba et al. (2007) it was analyzed within the second dimension “teaching and learning”, In sum, they located the potential of digital technology in the provision of learning resources and in the evaluation of student performance.

III. Empirical research on the use of digital technology in personalized learning settings

In spite of the conceptual fuzziness of personalized learning, several empirical studies have evaluated digital technology-enhanced personalized learning and meta-studies have emerged (e.g., Xie et al., 2019; Zhang et al., 2020a). Most research has investigated 370 R. Schmid et al. 1 3 adaptive learning technology that tailors education to an individual student’s needs. This means that students are provided with a specifc software that monitors and assesses their learning process and adapts the learning tasks accordingly (Lee et al., 2018; Zhang et al., 2020a). Comparatively little research has examined how digital tools are generally used in schools with personalized learning settings (e.g., Bingham et al., 2018). A systematic review of empirical research shows that more than two thirds of the studies that had been conducted between 2006 and 2019 examined specifc digital systems or tools that aim to enhance personalized learning in a specifc course or group of students (Zhang et al., 2020a). Given that many schools have been gradually changing their teaching and learning towards personalized learning without integrating a specifc digital system or tool, it seems, that research should more often focus on the diferent ways in which digital technology is used within the implemented educational practices of personalized learning (Bingham et al., 2018; Lee et al., 2018).

Two further studies on personalized approaches from the United Kingdom show that digital technology plays a signifcant role in enabling individual learning pathways, monitoring individual progress, and allowing the students to work at their own pace (Sebba et al., 2007; Underwood et al., 2007). However, the efective use of technological tools requires an adequate infrastructure and IT concept. A collective case study in the US concluded that certain infrastructural conditions, for instance sufcient internet bandwidth for high-level use of digital technology, must be ensured prior to the school-wide implementation of personalized learning if this approach is to be successful (Bingham et al., 2018). In accordance with this fnding, US data show that since the beginning of the, 2000s, external barriers to the integration of digital technology such as insufcient equipment with hardware and software have been signifcantly reduced (Ertmeret al., 2012). Infrastructure is an important basic condition indeed, but the integration of digital technology into classroom learning is a complex process with several interacting factors at the level of both the individual school and the teacher, which is why even a high standard of hardware and software does not necessarily lead to a more frequent and more efective integration of digital tools (Niederhauser& Lindstrom, 2018; Petko et al., 2018). This assumption can be supported by studies that have identifed the individual beliefs of teachers about the use of digitaltechnology as one of the most important factors with respect to whether they use digital technology in the classroom on a regular basis (Ertmer et al., 2012). Furthermore, several studies indicate that teachers and students use computers more frequently in student-centered and individualized learning settings than in traditional whole-class settings (Law et al., 2008; OECD, 2015; Tondeur et al., 2017). Even though the approach of personalized learning is less established in the German-speaking part of Europe than in English-speaking countries, a Swiss study on personalized learning and digital technology supports this result. More than twice as many students who were taught in personalized learning settings reported to use digital technology at least once a week compared to students who were taught in traditional learning settings (Schmid&Petko, 2019). Nevertheless, it is still unclear how digital technology is concretely used in practice to facilitate personalized learning settings.

Purpose of the study and research question

As the overview of the current state of research shows, there are several empirical studies on personalized learning that demonstrate the potential of digital tools or systems to enable personalized learning environments (Lee et al., 2018; Zhang et al., 2020a). Further, international fndings indicate a higher use of digital technology within personalized learning settings compared to traditional classroom settings (Law et al., 2008; OECD, 2015; Schmid&Petko, 2019). However, empirical research on how digital technology is actually used in schools that have implemented personalized learning school-wide is largely lacking. In order to gain insights into the current practice, the multiple-case study was designed with the aim of investigating the use of digital technology in schools with an implemented personalized learning concept. Accordingly, our research question is: How is digital technology in general used in schools with a school-wide approach to personalized learning?

IV. Research design and methodology

In order to identify and describe the similarities and diferences regarding the purposes of the use of digital technology across and within schools with personalized learning concepts and thus to address the research question, we opted for a multiple-case study (Yin, 2014). Based on a student questionnaire that had already been completed within a major research project on Swiss schools with personalized learning concepts, we selected three schools for data collection. The next section outlines the wider context of our study in more detail.

Contextualization of the study

A growing number of Swiss schools have been changing their culture of teaching and learning by implementing some form of personalized learning. The Swiss research project perlen("Personalized Learning Concepts in Heterogeneous Learning Groups") investigated such schools in the German-speaking part of Switzerland over the course of 3 years (2013–2015). Our in-depth study on digital technology use formed part of the perlenproject. Although the participating schools inevitably difer in the details of how they have implemented personalized learning, there are evident commonalities. In a bottom-up initiative, all schools have developed their teaching in terms of student-centered teaching methods, self-directed learning, and adaptive learner support. For this purpose, they have integrated regular time slots in the schedule in which the students learn autonomously according to a personal learning plan. In particular during such self-directed learning phases, students have more choice and voice concerning what, how, and when they learn than in traditional classroom settings. As a consequence, the function of the teachers primarily consists in providing adaptive support during the self-directed learning phases.

Selection of the three case-study schools

All schools of the study participated voluntarily. They had either responded to an open call for schools with personalized learning concepts, or they had been explicitly invited on recommendation from municipal and cantonal education departments. The overall sample of the study on digital technology use consisted of 31 lower-secondary schools with a total of 1017 8th-grade students. They completed an online questionnaire that included the question of how often they use digital technology for diferent classroom activities. Based on the students' answers, we identifed the three schools with the most frequent use of digital technology and invited them to take part in our multiple-case study. We frst contacted the principals via e-mail and called them a few days later, asking for permission for a school visit with diferent interviews and observation sequences. After having consulted the teachers, all principals agreed to participate. The Swiss education system assigns post-primary students to three diferent tracks in lower secondary education: "Gymnasium" (advanced level), Track A (challenging level) and Track B (basic level). The three schools of our subsample all ofer education for Track-A and Track-B students and in contrast to traditional schools, the instruction takes place partly in mixed groups and partly in diferent ability groups per subject. They varied in terms of funding, number of students, and demographics and as regards time and reason for implementing personalized learning concepts (see Table 1).

Data sources and data collection

Data collection was guided by our interest in examining the use of digital technology in classes with personalized learning settings from a qualitative point of view. Before visiting the three schools, we collected relevant curriculum documents from their websites. During the 1-day visit in the fall of, 2016, two researchers carried out semi-structured interviews with the principal(s), two teachers and the person or the persons who were in charge of the IT-infrastructure (see Table 1). Throughout the semi-structured interviews, which were the main data collection tool, the researchers focused on the following areas: characteristics of the school, development towards personalized learning environments, role of digital technology in the school, practical use of digital technology in class, assessment of teaching development through digital technology use, role of participants in the use of digital technology and next steps/further development. For example, we asked each participant what role digital technology plays in his or her school. In total, we conducted 11 interviews with a duration of 22 to 65 min. All interviews were audio-taped and transcribed. At the beginning of each interview, we had asked for

Table 1 Characteristics of the three selected schools

	School A	School B	School C
Funding	Public	Private	Public
Location	Rural, wealthy village	City border, wealthy town	Rural, average village
School size	Medium approx., 200 students	Small approx. 100 students	Large approx. 300 students
Implementation of personalized learning	2011/2012	1998 (founding year)	2009/2010–2013/2014 (grade-by-grade introduction; one grade per school yea
Number of interviews (anonymized label for the participants)	Four interviews: principal (A1), teacher (A2), teacher (A3), computer scientist (A4)	Three interviews: principal (B1), teacher (B2), ICT supporter who works as a teacher as well (B3)	Four interviews: co-principals (C1/C2), teacher (C3), teacher (C4), co-ICT sup porters (C5/C6)

Permission to record it. In addition, we observed and logged open teaching sequences in which the students worked according to individual learning plans. Furthermore, we photographed the learning situations and were allowed to ask the students a few questions which we documented in the feld notes.

V. Data analysis

After the transcription of the interviews, we conducted a qualitative content analysis (Mayring, 2010) in which we consulted our observations as recorded in the feld notes and the curriculum documents from the websites (Yin, 2014). To identify the purposes of the school-specifc use of digital technology, we frst condensed each transcript to extract the main statements. Based on these extracts, we wrote a preliminary case report of each school

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that included the multiple data sources and was structured by three dimensions: 1. School-related factors (e.g., general context and IT equipment), 2. Teachers' skills and beliefs about the use of digital technology, and 3. Teaching and learning with digital technology. We chose this analysis structure based on various research fndings indicating that the use of digital technology in the classroom is highly dependent on school factors (e.g., a good technical infrastructure and a supportive principal) as well as teachers' beliefs and skills regarding the use of digital technology (Ertmer et al., 2012; Niederhauser& Lindstrom, 2018; Petko et al., 2018; Tondeur et al., 2017). After this preparatory work, we conducted the analysis with key categories such as quality of the infrastructure, support, and teachers' beliefs and skills (Petko et al., 2018). In a recursive process of moving back and forth in the interviews, we continuously adjusted the key categories to the data material, which are also structured according to the three dimensions (see Appendix Table 2). This fnal analysis was added to the case reports in which concrete quotes served to substantiate the fndings.

Credibility and trustworthiness

Reliability and validity as criteria for scientifcally solid measurements are common in quantitative research but problematic in qualitative research. Therefore, qualitative approaches often replace them by alternative criteria such as credibility and trustworthiness (Twining et al., 2017). In our study, we tried to ensure credibility through the triangulation of multiple data sources (inter alia, student questionnaire, interviews with principals, teachers and IT support, and curriculum documents from the websites). A further measure to increase the trustworthiness of the fndings was to involve co-researchers in data collection and data analysis. Moreover, we presented the results to the schools to confrm our conclusions from the perspective of the participants themselves.

Results

In this section, we present the results of the three case studies separately and structure our portraits according to the three dimensions that constituted the basic framework of our analysis (see "Data analysis" section): (1) school-related factors, (2) teachers' skills**.**

School A: selective use of digital technology according to individual teacher preference—"it depends largely on the assignments" and "it's a matter of taste"

School A is a public lower-secondary school and located in a large canton in Switzerland. Approximately 300 students are taught by about 30 teachers. The village on a hill with a view of the lake has a higher tax income than the average Swiss village, which can have an advantageous efect on local education policy (e.g., better equipment of schools with infrastructure)

School-related factors

As the number of students had decreased over the last few years through a lower birth rate in the school district, the school was faced with the necessity to adapt its structures. At present, it runs only three classes per grade instead of the formerly four classes. This cut resulted in a structural problem because the school was no longer able to run two Track-A classes (challenging level) and two Track-B classes (basic level) every year. Consequently, the opportunity for students to join a Track-A class varied from school year to school year. According to the principal, the school was motivated to improve this inadequate ("bad") system. In order to provide high-quality education in spite of the student decline, the school decided personalized learning as its new system and thus abolished separated Track-A and Track-B classes. The school changed its teaching to personalized learning in partly mixed classes and partly ability groups per subject within eight months. The local school authorities agreed to the new teaching principle but on condition that the percentage of students passing to the "Gymnasium" at least remains the same or increases. This has been achieved with a slight increase in student performance. Today, the students spend one third of their time in self-directed learning phases in mixed classes while input lessons in the subjects mathematics, German, French, and English are held in ability groups. During the selfdirected learning phases, each student works on her or his individually designed desk in a large room—the so-called learning landscape, which looks like an open-plan ofce. In contrast to the classroom for input lessons, the learning landscape accommodates all 50 to 60 students of the same grade. The IT infrastructure in the classrooms for input lessons presents itself as heterogeneous. Although each classroom is equipped with a projector and cable internet access— "that's a must, anyway" (Principal A1), all rooms lack a "standard" equipment and open wireless internet access. However, the main problem was stated by Teacher A2 as follows: "We have a great infrastructure for instructional teaching [during the input lessons], but not a good one for group work or individual practice". Moreover, Principal A1 expressed the wish to have some mobile devices in every classroom whereas at present, each learning landscape is equipped with 15 to 20 computers as standing workstations that can be used during the self-directed learning phases. These computers are suitable for individual work, but as speaking is not allowed in the learning landscape, they cannot be used for group work. 376 R. Schmid et al. 1 3 The school fnds itself in the comparatively privileged situation that an inhouse computer scientist maintains all 260 school devices. Even though Principal I perceives the IT infrastructure as quite outdated and is determined to improve it, the interviewed teachers regard it as generally good. The use of educational digital technology and the diverging opinions concerning this issue are an often-discussed topic, but the inclusion of digital tools is "defnitively no element of the school profle" (Teacher A2). This statement corresponds with the stance of Principal A1 who does not push the teachers in terms of digital technology integration. Rather, he is confdent that digital technology integration in class will evolve naturally, driven by the younger teachers. The development of an IT concept for the school has recently been initiated but at present there are no school-internal general rules for the (student) use of digital technology. Probably due to the few specifcations at the level of the whole school, there is a remarkably pronounced informal exchange among the teachers to which they refer as "open-door policy and discussions", especially within the individual teams who are jointly in charge of all of the students in one grade (see also "Teaching and learning with digital technology" section).

Teachers' skills and beliefs about the use of digital technology

Various statements point to a large discrepancy between the diferent teachers' beliefs about the use of digital technology. Teacher A2 uses digital technology in class regularly and states: "This is the information medium that we all use; they [the students] need to learn how to handle it". This quote illustrates that some teachers see digital devices as an integral part of everyday life so that their routine use in the classroom becomes indispensable if school is to prepare students adequately for the future. Other teachers, by contrast, wish to restrict the students' working time on computers. Older teachers in particular tend to hold more negative beliefs than the younger teachers, which is refected in the frequency of use of digital technology in class and in line with the observations on site. Principal A1 comments on this observation as follows: My school team comprises a lot of older people too. I can imagine that in 10 to 15 years a lot of young people will have arrived who use computers in their everyday school life much more often and consider them useful. While mentioning their beliefs, the teachers hardly ever brought up their skills regarding the use of digital technology. Teacher A3 mentions only in passing that they have a very good IT infrastructure, but that one has to know how to use it. Overall, however, the teachers' digital technology skills appear to be a minor issue.

Teaching and learning with digital technology

As stated in Section "School-related factors", School A has no general teaching concept regarding the use of digital technology. Each teacher is responsible for her or his subject. This includes assigning tasks for the self-directed learning phase, collecting the students' work if necessary and correcting it. The integration of digital technology is subject-specifc. On the one hand, "it depends largely on the assignments" (Teacher A3) and, on the other hand, on the teacher: "It's a matter of taste" (Teacher I.1). Nevertheless, the team members who are jointly responsible for the same grade need to fnd common ground, as Teacher A2 explains: "This [the shared basis] was arranged but has not been written Examining the use of digital technology in schools with a… 377 1 3 down", The common standard of the team of Teacher A3, for example, requires that "the students must be able to justify why they are working on the computer", In joint eforts to defne standards, quality is often an issue. In this connection, the teachers regularly discuss "for which assignments it makes sense to use a computer" (Teacher A3). A few years ago, "everybody used computers" (Teacher A2), which is why the discussion about quality has arisen. At the same time, students receive no education in media and computer sciences during their frst two years. This proves to be a challenge. Depending on the task, Teacher A2 begins with a guided sequence on the computer and explains: … If the learning landscape is free, I can introduce and guide the students on the computer in the learning landscape. For example, when they are preparing a presentation, I tell them not to start simply by designing the PPP [powerpointPresentation]. Otherwise, they design 5 hours and still have no content. In this way, I can point out that research comes frst. In the context of the input lessons, teachers mostly use the projector and the interactive whiteboard. Teacher A2 was "totally stuck" when the projector did not work for 2 months: "You need the computer a lot as a teacher", Teacher A3 points out that the administration is easier to manage: "I can show the worksheet I want to discuss in 2 clicks", Furthermore, newer teaching materials such as the textbooks for English as a foreign language are increasingly interactive in design and integrate computers. As a consequence, several teachers use interactive teaching materials in which tasks have been redesigned through the use of digital technology. A similar example is the learning software "Religiopolis" that allows the students "to immerse in the worlds of religion" (Teacher A2), which would not be possible to the same extent without digital technology. In the context of self-directed learning phases, Teacher A2 describes it as "pretty cool" that she can provide her students with the new option of completing a task with a voice message or a text. Teachers rarely integrate mobile phones in class but "particularly for photos, it is a really simple instrument as well. We no longer have a class-set of cameras [one camera per student]" (Teacher A2). In mathematics, the students have access to all solutions on the server so that they can correct and revise their work themselves. Moreover, they practice regularly with a specifc learning software. Despite the regular use of digital technology, several teachers try to keep a balance between the analog and the digital, which is refected in diferent practices. For example, only certain texts may be written on the computers, and before the online vocabulary training, the students must write down all foreign words by hand at least once.

School B: selective use of digital technology according to individual student preference—"they [the students] are relatively free to decide when they go to the computer"

The small private school is located directly at the bus stop "City Border", which describes the location exactly. The former factory building has diferent entrances that give access to the kindergarten, the primary school, and the lower-secondary school. Of the total of approximately 100 students, 35 attend lower-secondary school.

School-related factors The state-approved private school has been pursuing the approach of personalized learning since its founding year in, 1998. The focus on the students' "individual development of potential" through personalized learning and smaller class sizes (10 to 12 students) are central characteristics that distinguish this private school from the average public school. Only a small percentage of all students attend private schools in Switzerland because the federal education system is of high quality. Principal B1 explains that this approach, day care from 7:30 to 18:00 as well as bad experiences at previous schools' cause parents to send their child to this private school. To cover the costs of approximately, 2000 dollars per month excluding meals and schoolbooks, typically both parents have to work. The heart of the school building is constituted by "Wing A", which is a large lightfooded room for the self-directed learning phases, so-called "in-depth learning studies", These in-depth learning studies take place with a frequency of at least one lesson per day. During this time, the students have free access to 12 computer stations. Principal B1 describes them as follows: "The shell of the computers is old, but apart from that they are kept up to date", Nevertheless, the school plans to replace its IT hardware soon. Teacher B2 is very satisfed with both the infrastructure and the IT support: "Digital media are becoming more and more important. 12 computers for 16 students—that is a big deal […] I always receive support when I need help", Furthermore, the students have the possibility to bring their own devices. The students use this possibility chiefy to write their fnal thesis in the last year. During this period, the ICT supporter opens the WI-FI network to the students. For the rest of the year, the students have to use the cable internet. The smaller rooms for the input lessons are arranged around the main wing. Their IT infrastructure difers and meets the preferences of the teachers as Principal B1 explains. The classroom for mathematics is equipped with a smartboard while other classrooms are equipped with a presenter or only with whiteboards. In general, the school has not developed a special concept for the use of digital technology. Principal B1 rather sees them as an integral part everyday teaching and learning: "If you look at how children handle media in everyday life, the school cannot cut itself of from digital media. […] We have computer stations; they are used daily. We don't have ICT lessons once a week; we learn this in the subjects", Every year, one 9th-grade student acts as the contact person for computer problems and helps the others. Usually, this student intends to begin an apprenticeship in the ICT sector after the completion of compulsory education. Principal B1 was a driving force behind the digitalization strategy at his school: "At the organizational, level everything is digital", For example, the documents concerning the team meetings are stored in a cloud and the students' week plans are published on the intranet, which is especially appreciated by parents. Furthermore, the teachers use a specifc platform as a "management tool" to document the discussions with parents. In contrast to the organizational level, the use of digital technology in the classroom varies considerably. There is neither a school-wide discussion nor clarity about the goals of the use of digital technology. The existing exchange among the teachers is limited to applicationrelated knowledge, for example to topics such as "how Apple TV works" (Teacher B2).

Teachers' skills and beliefs about the use of digital technology

As mentioned in "School-related factors" section, the use of digital technology in class varies, and Teacher B2 describes it as "autarkic and type-depended". Overall, the majority of teachers see added value in the use of digital technology. Still, a few older teachers do without the support of digital technology due to their negative beliefs about the use of digital technology: Not everyone works so much with digital media. It depends on the age. One teacher still does everything on paper, and that works greatly because she has such an attitude. […] I hardly write on the blackboard anymore. It really depends on the type. You realize it when Dropbox doesn't work; some are afected, others not, (Teacher B2) The interview with ICT Supporter B3 shows that he expects every teacher to have a certain level of digital skills, although a few older teachers have to acquire these skills frst: “I expect teachers to be skilled in this area [integration of digital technology]. The younger ones fnd it easier”, Principal B1 notices the diferences in terms of skills and beliefs as well. Therefore, he has initiated an efort to increase the integration of digital technology in class “step by step”. For the majority of teachers, digital technology already plays a major role in their daily practice: “[…] we noticed it last week when the Internet went down. It was a disaster”. (Teacher B2).

VI. Discussion

Summary and conclusions

Our study aimed to examine the utilization of digital technology in schools that implement personalized learning on a school-wide level. We sought to acquire insights into the specific practices and strategies employed in these schools. Each of the three scenarios exemplifies a distinct approach to the daily utilization of digital technology in educational settings. Consequently, the organization of the investigations led to the identification of three distinct categories: Type A employs digital technology in a discerning manner based on the personal desire of each teacher. Although each teacher has the autonomy to decide how to use digital technology into their own subjects, it is necessary for the team members responsible for the same grade to reach a basic agreement. The teachers frequently engage in discussions regarding the ways in which digital technology can enhance specific tasks. The conversations reveal that older teachers, in particular, maintain a suspicious attitude towards the adoption of digital technologies. In contrast, other lecturers strive to convey a proficient and significant approach to utilizing both digital and analog media. While the use of digital technology is not an essential part of the school's profile and there are no specific rules defined within the school, selectively using digital technology in personalized learning settings can bring about administrative simplifications, functional improvements, and occasionally introduce new types of assignments. Students have increased opportunities for selecting their own path, particularly during self-directed learning periods when they collaborate with their personalized learning plans. Simultaneously, certain teachers impose limitations on students' ability to utilize digital devices, requiring them to provide a justification for their desire to work digitally. Type B utilizes digital technology in a targeted manner based on the specific preferences of each learner. Particularly in the initial lesson and during the phases of self-directed learning, the students have the autonomy to choose if they choose to utilize the computers for assignments. Most teachers have already used digital technology into their daily practices. 384 R. Schmid et al. 1 3 However, the integration of digital technology in the classroom is not yet consistent, in contrast to the fully digital operations at the school level. The principal expedites the integration of digital technology in the classroom, while taking care to avoid alienating a small number of instructors who hold unfavorable beliefs about ICT. According to the questioned teachers, incorporating digital technology into individualized learning settings allows for increased flexibility in teaching and provides students with more options. The promise of digital technology appears to be effectively utilized in several domains. The inclusion of digital technology is essential for achieving the same level of quality and personalization in teaching the subject of "occupational studies". Type C employs digital technology in a methodical manner, following a comprehensive approach implemented throughout the entire institution. The regular and methodical utilization of the learning platform streamlines the implementation of the new teaching system and is largely perceived as an administrative simplification for the teachers. In general, the teachers view the integration of digital technology as advantageous and helpful. The principals exhibit greater skepticism than the teachers regarding the utilization of digital technology in the classroom and intentionally refrain from advocating for its introduction due to the children' extensive engagement with digital technology in their homes. They prioritize pedagogical progress, viewing the integration of digital technology as a beneficial aid. The customization of the learning process is accomplished by incorporating assignments that allow students to make choices and by giving them more independence throughout the self-directed learning stages. In addition, the predominantly predetermined utilization of digital technology fosters both individualization and interactivity. Furthermore, the teachers employ differentiation by categorizing the students into ability groups during the self-directed learning stages and the input lessons.

Limitations and future research

While our study offers valuable insights into the implementation of digital technology in schools that adopt a school-wide approach to individualized learning, it is important to acknowledge its limits. The analysis of the results is based on the premise that a significant degree of technology alteration to conventional teaching methods is associated with a consistent implementation at the school level. Alternatively, it is plausible that schools which, based on students' responses in the questionnaire, use digital tools less frequently in the classroom have implemented the integration of digital technology in a more organized manner at the school-wide level. To validate or refute this hypothesis, additional research is required using a more extensive sample that encompasses schools varying in the frequency of their utilization of digital technology. In addition, the use of triangulated data does not guarantee accurate findings due to potential distortions. This is because the interviews conducted with only two instructors from different teams may not accurately represent the perspectives of all teachers in the school. Regarding the representativeness of the sample, it is crucial to mention that the sample is restricted to Switzerland. Hence, the findings may only be partially and cautiously extrapolated to other countries. Furthermore, the case studies are conducted in a cross-sectional manner, allowing for the possibility that digital technology-based teaching techniques may have altered or developed further since then. The recent addition of media and computer education to the Swiss K-9 curriculum has probably led to a greater focus on incorporating digital technology in schools, as well as in teacher education and training. Therefore, it would be beneficial for future studies to concentrate on the influence of the emerging field of "Media and Computer Education" on the utilization of digital technology in schools that employ individualized learning approaches.

REFERENCES

1. Bingham, A. J., Pane, J. F., Steiner, E. D., & Hamilton, L. S. (2018). Ahead of the curve: Implementation challenges in personalized learning school models. Educational Policy, 32(3), 454–489.
2. Bray, B., &mcclaskey, K. (2015). Make learning personal: The what, who, wow, where, and why. Sage. Cornelius-White, J. (2007). Learner-centered teacher-student relationships are efective: A meta-analysis. Review of Educational Research, 77(1), 113–143. Https://doi.org/10.3102/003465430298563
3. Dabbagh, N., & Castaneda, L. (2020). The PLE as a framework for developing agency in lifelong learning. Educational Technology Research and Development. Https://doi.org/10.1007/s11423-020-09831-z
4. Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., &Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. Computers & Education, 59(2), 423–435. Every Student Succeeds Act, 20U.S.C. §, 6301 (2015).
5. Gierl, M., Bulut, O., & Zhang, X. (2018). Using computerized formative testing to support personalized

learning in higher education. In R. Zheng (Ed.), Digital technologies and instructional design for personalized learning (pp. 99–119). IGI Global. Hattie, J. (2008). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. Routledge. Huang, Y.-M., Liang, T.-H., Su, Y.-N., & Chen, N.-S. (2012). Empowering personalized learning with an interactive e-book learning system for elementary school students. Educational Technology Research and Development, 60(4), 703–722. Https://doi.org/10.1007/s11423-012-9237-6 Keefe, J. W. (2007). What is personalization? Phi Delta Kappan, 89(3), 217–223. Https://doi.org/10.1177/00317 2170708900312

6. Kim, R., Olfman, L., Ryan, T., &Eryilmaz, E. (2014). Leveraging a personalized system to improve selfdirected learning in online educational environments. Computers & Education, 70, 150–160. Https://doi.org/ 10.1016/j.compedu.2013.08.006
7. Law, N., Pelgrum, W. J., &Plomp, T. (2008). Pedagogy and ICT use in schools around the world: Findings from the IEA SITES, 2006 study. Springer. Lazonder, A. W., &Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Efects of guidance. Review of Educational Research, 86(3), 681–718.
8. Lee, D., Huh, Y., Lin, C.-Y., &Reigeluth, C. M. (2018). Technology functions for personalized learning in learner-centered schools. Educational Technology Research and Development, 66(5), 1269–1302. Https:// doi.org/10.1007/s11423-018-9615-9 Mayring, P. (2010). Qualitative inhaltsanalyse.
9. In G. Mey& K. Mruck (Eds.), Handbuch qualitative forschung in der psychologie (pp. 601–613). VS VerlagfürSozialwissenschaften. Mcloughlin, C., & Lee, M. J. W. (2010). Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. Australasian Journal of Educational Technology, 26(1), 28–43. Https://doi.org/10.14742/ajet.1100
10. Examining the use of digital technology in schools with a... 389 1 3 Miliband, D. (2006). Choice and voice in personalised learning. In OECD (Ed.), Schooling for tomorrow: Personalising education (pp. 21–30). OECD Publishing.
11. Nedungadi, P., & Raman, R. (2012). A new approach to personalization: Integrating e-learning and m-learning. Educational Technology Research and Development, 60(4), 659–678. Https://doi.org/10.1007/ s11423-012-9250-9
12. Niederhauser, D. S., & Lindstrom, D. L. (2018). Instructional Technology integration models and frameworks: Difusion, competencies, attitudes, and dispositions.