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Digital Skills and the Influence of Students' Socio-Economic Background. An Exploratory Study in German Elementary Schools

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Digital Skills and the Influence of Students' Socio-Economic Background. An Exploratory Study in German Elementary Schools

Jana Heinz[*]

Abstract: This article examines the implementation of ICT in German elementary schools, as Germany appears to be behind from an international perspective. The main foci are how teachers align their instruction with students' prior digital knowledge, and how students' socio-economic backgrounds influence their motivation to work with ICT and their level of digital competence. This qualitative study is based on semi-standardized expert-interviews with 15 teachers, principals, experts and representatives of educational policy and administration in Germany. The interviews were analyzed using qualitative content analysis supported by MAXQDA. The results indicate that teachers design ICT-based instruction that is aligned with students' informal knowledge of digital media, interests, class and ethnic background as well as with school-specific curricula. Students' socio-economic backgrounds influence their access to ICT devices and social media at home as well as their motivation to engage in ICT-based learning opportunities in schools. Gaining digital competencies, however, is greatly influenced by other competencies and learning strategies, in particular literacy. The results indicate that while low achieving students seem to benefit from digital learning programmes that can be adapted to their individual prior knowledge, in many ICT-based learning environments they need extra support and guidance. Furthermore, teachers need support for employing ICT in their classrooms and to meet the needs of their students' heterogeneous prior digital knowledge.

Keywords: ICT, digital competence, German elementary schools, instructional designs

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Introduction

ICT in schools has given rise to controversies in Germany. On the one hand, digital technologies are perceived as an opportunity as they prepare pupils to use them in their social environment and professional life. These views are criticized, on the other hand, and ICT in teaching is seen as being merely a trendy distraction from learning that should be banned from schools. Critics argue that new technology alone does not create better lessons and that increased motivation due to the novelty effect will quickly vanish. However all people, in particular children are confronted with ICT tools and cannot avoid them in their lives. Therefore, new technologies should be strategically integrated into lessons to support children in achieving general educational goals, such as literacy or numeracy as well as improving their digital competencies.

The comprehensive implementation of ICT in German schools is being hindered by a lack of appropriate curricula in schools and teacher training; therefore, the use of ICT depends on the teachers as well as on individual university programs. Accordingly, computers are only hesitantly integrated in schools, in particular elementary schools. Therefore, experts warn that German pupils are in danger of falling behind in international comparisons (e.g. Eickelmann, 2014). Indeed, several international studies show that German pupils have low digital competencies and teachers have a low appreciation of computer or web-based activities. Moreover, these reveal a strong correlation between children's digital competencies and social class.

As a consequence, in spring 2015 German politicians initiated a programme to improve pupils' digital competencies (Deutscher Bundestag, 2015). The goals range from providing the technical infrastructure for schools as well as introducing mandatory ICT-curricula. In addition, this programme targets children from lower social and migration backgrounds, as these children in particular obtain lower scores in international comparative tests.

In this study I focus on whether new technologies offer opportunities to reduce the influence of the social origin on school success or if these technologies actually aggravate such problems. There are few studies investigating the implementation of ICT in elementary schools in Germany and the conditions that influence its effectiveness. Therefore, this study

offers insights into the state-of-art of using ICT in schools, problems and positive effects that can arise. Furthermore, it investigates whether students from different social classes participate in and benefit from ICT in schools to differing degrees.

Digital Competencies in schools 2.0

Research on digital media in schools predominantly investigate and describe children's abilities to use web-based programmes or computers. Furthermore, studies explore the effects of digital media on general competencies, such as language skills, natural sciences, social science or mathematical competencies.

Digital competencies

In addition to "*digital competence*", terms like "*computer and information literacy*" (CIL) (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014), "*ICT competencies*" (Aesaert et al., 2015) or "*digital literacy*" (Bawden, 2001) are employed in this field of research. These terms have changed over time, in particular with regard to the abilities considered necessary to work with digital tools. As Bawden (2001) shows, the focus has changed from abilities, like mastery of technology and communication tools, to application of new media to critical reflection. Thus, Aesaert and colleagues (2015, p. 56) describe digital competencies in the 21 century as a "higher-order learning-process oriented competence used in complex, authentic and unpredictable situations, […] underpinned by technical and application ICT knowledge and skills". Similarly, in the EC document "DIGCOMP – A framework for developing and understanding digital competence in Europe" (Ferrari, Punie, & Brečko, 2013, p. 2), digital competence is described as the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society. Digital competencies are regarded as a transversal key competence enabling people to acquire other key competencies in language, mathematics, learning to learn, or cultural awareness. In the EC-report "Mapping Digital Competence: Towards a Conceptual Understanding" Ala-Mutka (2011, p. 6) proposes a definition of digital competence that includes the following areas: "1) Instrumental knowledge and skills for digital tool and media

usage; 2) Advanced skills and knowledge for communication and collaboration, information management, learning and problem-solving, and meaningful participation; 3) Attitudes to strategic skills usage in intercultural, critical, creative, responsible and autonomous ways". This last definition is particularly suitable for the present study as it includes attitudes towards ICT as well as ICT skills, both of which influence teachers' employment of ICT in schools.

ICT in schools

The degree of ICT implementation in schools depends on a variety of influences, ranging from country specific characteristics, the availability of a technical infrastructure, to using the internet or computers, as well as sociocultural related factors (Hubwieser, Armoni, & Giannakos, 2015, p. 52). Large scale comparative studies have shown – despite considerable differences between countries – that most pupils have access to the internet and computers and that they use them more often outside school than in the lessons. For instance, the International Computer and Information Literacy Study (ICILS) (Fraillon et al., 2014) examined the extent to which students of grade 8 from 21 countries have developed computer and information literacy. The survey (Fraillon et al., p. 251) shows that, "on average, 87 percent of the students report to use a computer at home at least once a week, whereas 54 percent and 13 percent reported this same frequency of computer use at school and other places respectively". Furthermore, the study finds (Fraillon et al., p. 151) that of all invested countries Germany has the lowest computer use in all subject areas, see Table 1. This pattern also becomes visible with regard to students' ICT self-efficacy scores or the priority that principals place on digital learning resources, as in Germany the mean scores are significantly lower than the ICILS 2013 average (Fraillon et al., p. 168 -178). The TIMSS 2011 study (Bos, 2012) similarly shows that in Germany elementary schools provide fewer opportunities to use computers in mathematical and science lessons as well as have less technical support for ICT than the average of all surveyed countries.

Furthermore, ICT is predominantly used to gain access to digital textbooks and workbooks and to support collaboration on tasks (Irish Department of Education and Science, 2008; Fraillon et al., 2014, p. 257). For instance, internationally in grade 8, about 45% of the ICILS students, on average, were using computers to "prepare reports or essays" at least once a week and for "preparing presentations" (44%). Forty percent of

students report using ICT when working with other students from their own school at least weekly, and 39 % report using a computer once or more a week to complete worksheets or exercises (Fraillon et al., 2014, p. 23).

Table 1: National percentages of students with frequent computer use during lessons in different learning areas

	Germany	ICILS 2013 average
Test language (German)	4	16
Foreign Language	3	17
Mathematics	4	14
Science	7	21
Human Sciences/Humanities	8	20

Source: The date is from the 2014-ICIL-Study (Fraillon et al., 2014: 151ff.)

From these surveys it appears that ICT has been integrated in individual school systems to substantially differing degrees and that digital devices are generally employed to perform simple tasks. Another strand of research focuses on the effects ICT has on learning outcomes. For instance, Skryabin, Zhang, Liu and Zhang (2015) investigate the impact of the national ICT development level on student achievement. Based on large-scale international databases, including TIMSS 2011, PIRLS 2011, and PISA 2012, they explore the influences of ICT on achievements in reading, mathematics, and science for fourth and eighth grade school students. The authors find that individuals in countries with higher ICT levels are more likely to perform better, in particular fourth grade students (ibid., p. 55). The reasons behind these correlations, however, remain unclear. In general, empirical evidence suggests that ICT skills tend to be acquired outside school rather than in classes. For instance, Aesart et al. (2015) investigate which pupil, classroom and school level characteristics are related to primary school pupils' ICT competencies in Flanders (the Dutch speaking part of Belgium). They find, firstly, that the majority of primary school pupils have medium to low scores on the performance-based ICT competence test with regard to retrieving, processing and communicating digital information. Another result of their investigation is that ICT competencies can primarily be considered as a "*pupil phenomenon*", e.g. that in particular individual characteristics as well as parental attitudes toward ICT strongly influence their digital competencies (Aesaert et al., 2015, p. 66). The authors suggest that the strong influence of individual resources on developing digital competencies results from the lack of

opportunity to use ICT in schools. This gap between the frequencies of computer use at home and at school may lead to counterproductive results, such as making traditional education lessons seem boring, as Aagaard (2015) has shown. Aagaard analyzes students' use of technologies for distractive purposes, such as off-task activities and multitasking, and concludes that children who have grown up using computers at home to play games and communicate with peers see the computer as a "*playable tool*" (Aagaard, 2015, p. 95). The constant availability of technological devices might thus contribute to creating a kind of "*mediated impatience*" towards traditional instruction (Aagaard, 2015).

On the whole, these studies suggest a rather limited influence of schools on developing students' digital competencies and thus the need to develop strategies to implement ICT in schools. The authors of the ICILS study (Fraillon et al., 2014, p. 24), for instance, argue that "regardless of whether or not we consider young people to be digital natives, we would be naive to expect them to develop computer and information literacy in the absence of coherent learning programs". Similarly, based on a review of ten years of empirical research on the educational applications of virtual reality, Mikropoulos and Natsis (2011, p. 778) demand that ICT be incorporated in well-designed educational contexts with specific didactic goals. This claim – that digital learning opportunities are not effective in themselves but must be accompanied by effective learning surroundings as well as a baseline level of proficiency in reading and mathematics – is made by nearly all studies investigating the effects of digital learning, e.g. by the OECD report "Students, Computers and Learning" (2015). In another study, Higgins, Xiao and Katsipataki (2012, p. 3) synthesize the evidence from meta-analyses on the impact of the use of digital technology in schools on children's academic achievements and emphasize "that it is not whether technology is used (or not) which makes the difference, but how well the technology is used to support teaching and learning." These results are supported by Hattie's (2009) well-received publication "*Visible Learning*". In his literature review of over 800 studies of factors influencing student achievement, Hattie also investigates learning with computers. According to Hattie, teacher interventions can be regarded as having a positive effect on learning when the effect size (d) is 0,4 or higher. Hattie shows that different forms of media-based learning have little effect: web-based learning (d=0,18), visual and audio-visual methods (d=0,22), simulation and simulation games (d=0,33) and programmed instruction (d=0, 24).

Only interactive learning videos seem to be effective (d=0,52). Hattie explains that digital devices can have an impact on learning if they are accompanied by general factors of effective learning, such as teacher pre-training.

These studies suggest that schools often have a limited impact on students' digital competencies, while their social lives are pervaded by ICT tools and practices. Additionally, they point out that ICT has no positive effects on its own but has to be complemented by effective instructional methodologies.

Digital gap

Although bringing ICT into the classrooms has sparked many hopes that social inequalities in schools can be reduced, there is evidence that social background strongly influences children's digital competencies in the same way as it influences children's school achievements in general.

Thus, current research (Aesaert et al., 2015, p. 67; Fraillon et al., 2014, pp. 238–240; Litt, 2013, p. 622) reaffirms the strong correlation between social background and education (which appears to be especially strong in Germany), also with regard to digital literacy. Back in 2003, Livingstone (2003) investigated children's internet use and warned that "it is hardly surprising if well-established social contexts and values of family life mean that children's use of the internet is still patterned in traditional ways, perpetuating or even increasing social divisions within society" (Livingstone, 2003, p. 155). More recent research corroborates these suspicions; for example, Litt (2013, pp. 625–626) finds that people from higher social backgrounds benefit from using the internet for activities, such as networking and applying for jobs, while managing to avoid associated losses and risks, like becoming victims of online scams and accidently oversharing private information. Similarly, Hargittai (2010, p. 109), examining a universally wired group of first-year college students with regard to factors influencing their digital competencies, reports that students from higher socio-economic backgrounds tend to use the internet more autonomously, have more online experiences, higher levels of know-how and report engaging in different types of internet and computer usage than the less privileged. She concludes that the internet tends to increases inequality, as the more privileged stand to benefit from it more than those in less advantageous positions. These examples indicate that socio-

economic backgrounds have a significant influence on students' usage of ICT as well as their digital competencies. These differences are investigated using the term "*digital divide*", which is defined as differing levels of access to information, knowledge as well as skills, motivation, autonomy, and amount and types of internet usage. A detailed model to explain the digital divide is developed by Ghobadi and Ghobadi (2013), who differentiate between four different access gaps (motivational, material, skills, and usage) that interact and contribute to the digital divide existing between people from higher and lower socio-economic backgrounds. They find that the digital divide can be explained by motivational-related factors such as lack of interest in IT-related things and lack of motivation to learn recent technology as well as skills-related factors such as operating skills, anti-filtering skills, and lack of IT background from people with lower socio-economic backgrounds (Ghobadi & Ghobadi, 2013, p. 334). Similarly, in a study by Robinson and colleagues (2015) investigating the relationship between digital inequalities and other forms of inequality, the authors argue that first level digital disparities in access go hand in hand with digital engagement gaps, chasms between content consumers and producers, and different forms of participation in the high-tech economy. They speculate that these disadvantage are intensifying, as "the internet is ever more seamlessly integrated in everyday routines" (Robinson et al., 2015, p. 570). Other studies (Ghobadi & Ghobadi) suggest that physical access gaps are more or less closing in the developed countries, while the skills usage gaps continue to expand.

These studies all agree on the strong correlation between socio-economic backgrounds and digital competencies. However, how exactly children's socio-economic backgrounds influence their digitals skills requires exploration, as for instance the OECD calls for: "The connections among students, computers and learning are neither simple nor hard-wired; and the real contributions ICT can make to teaching and learning have yet to be fully realised and exploited" (OECD, 2015 p. 15). Thus, it is especially interesting to discover *how* schools 2.0 can provide learning environments which allow all students, irrespective of their social background, to prosper. As ICT is common among all social classes, schools 2.0 could offer learning opportunities that all children are familiar with, while traditional learning methods appear to be especially beneficial for pupils from middle class backgrounds. Dalhaus (2010; 2011), for

instance, speaks of *gaps of meanings* between knowledge children acquire in their immediate familial environment on the one hand and their daily life world institution, such as schools, on the other. These knowledge gaps are, however, of varying sizes, depending on the social status of their families. A research consensus suggests that middle class parents prepare their children with the attitudes, knowledge and learning strategies necessary to be successful in institutions like school (Hubwieser et al., 2015; Litt, 2013; Skryabin et al., 2015). In contrast, children from lower socio-economic backgrounds usually do not have the advantage of this familial support. Moreover, they tend to use avoidance strategies if they are confronted with *unfamiliar* school standards and thereby minimize their opportunities to learn and benefit from school (Dalhaus, 2010; Dalhaus, 2011). However, as digital tools are common in all families and children grow up using them, it could be supposed that the *digital gaps of meanings* are smaller than general *gaps of meanings*. If children of all social backgrounds are acquainted with digital media, I assume that they will be confident and motivated to learn in digital learning opportunities at school and show less avoidance strategies compared to traditional learning opportunities. My argument is not that ICT in schools will thus reduce social inequality by itself. Rather, in a first step of this study I ask whether digital learning opportunities make it easier for students from lower socio-economic backgrounds to participate in learning, as they have already gained informal digital competencies and familiarity with digital tools at home (1). In a second step I ask how children's socio-economic backgrounds can nevertheless lead to differing digital competencies to such a large extent (2).

Research methodology

Few studies actually ask how German school teachers integrate ICT in elementary classrooms, what experiences they have with the competencies their pupils bring from informal learning situations, and how these are influenced by their familial socio-economic background. To learn more about how ICT is employed in schools, the following research questions guided this investigation.

Research questions

1. How is ICT integrated in elementary schools in Germany?
2. How does ICT in schools 2.0 connect to students' lives and experiences?
3. Can school 2.0 establish better links between school requirements and prior knowledge children from lower social backgrounds possess?

Procedure

While the high correlation between children's socio-economic backgrounds and their digital competencies is well-documented, little is known about the mechanisms operating between these two variables. To study students' learning styles in digital learning opportunities and how these are influenced by their familial backgrounds, I chose a qualitative explorative methodological approach. I conducted semi-standardized expert-interviews (Flick, 2009, p. 403) with elementary teachers and experts in the field of digital education to gain knowledge about processes influencing digital competencies. As this study has an explorative design, the results offer detailed insights into the interviewed people's experiences with digital tools in schools and how children from different social backgrounds benefit from them. The results can thus indicate how socio-economic backgrounds relate to students' achievements; however, these results cannot be generalized to completely different cultural and educational settings.

Regarding claims of criteria of quality in qualitative research, Ellingson (2011) speaks of a continuum of quality criteria, ranging from criteria derived from quantitative research to originally qualitative approaches (see also Denzin, 2011), as qualitative research is characterized by numerous approaches. One criterion is to establish transparency by giving a detailed description of the contexts in which the study was conducted as well as about the steps of choosing the interview partner, data collection and analysis, as well as theory building (Silverman, 2013), which I apply in the following.

Five interview partners were contacted by means of an internet platform called "*teacher online*". There, teachers can upload the ICT lessons they have designed. More than half of the teachers accepted invitations for an interview; two of those interviewed were already retired.

Another group of teachers interviewed are involved in two prominent school-based projects in Bavaria. The first one is the so-called "*reference schools for media education*". In 2010/2011 thirty-one Bavarian schools

became *reference schools for media education*, after they had developed school specific curricula focusing on the development of ICT competencies as a cross-curricular and interdisciplinary educational objective, thus enabling pupils to become competent ICT users. These curricula were one part of the programme, going hand in hand with providing schools the technical infrastructure to use computers and internet as well as teacher development-courses. The teachers participating in these programmes were allowed to reduce their teaching hours. Currently about 150 schools are involved in this project, and they act as multipliers and help other schools to develop tailor-made concepts for employing ICT.

The other project teachers interviewed participate in is called "*mebis*". *Mebis* was initiated by the Bavarian ministry for education, culture, science and art and involves several other organizations in educational science as well as educational administration. This project is supplemented by a media library with digital resources that are protected for license and copyright reasons; many opportunities exist to employ and develop digital competencies in lessons as well links to contact persons and teacher development programmes. In school year 2012/2013, *mebis* was piloted in 90 reference schools for media education and evaluated by a university team. Currently *mebis* is integrated in 1000 Bavarian schools with 250 000 users; however, it is employed to differing degrees. This study's interviews reveal that elementary school teachers predominantly use the *mebis* media library but prefer their custom-developed school software. The programme goal was that by 2016 it would be implemented in all Bavarian schools interested in using it.

Both projects – *the reference schools for media education* and *mebis* – have existed for more than 10 years and have developed into the most influential approaches systematically integrating ICT in Bavarian schools, curricula and teacher education. I contacted six elementary *reference schools for media education* and requested interviews. Four teachers (two of whom are headmasters) agreed to take part this study. Two more interviews were conducted with representatives of the education ministry in charge of developing and disseminating these projects.

Moreover, in Bavarian schools there are teachers who additionally work as consultants for media-pedagogic and IT matters, the so-called "*mibs*". These teachers provide schools with information about effective technical infrastructures, integrating new media in lessons and offer teacher professionalization courses. Of the six *mibs* contacted, one agreed to take

part in the investigation and talk about her work experiences. In addition to these people, two interviews were conducted with experts working at a university in the field of teacher education who were conducting research on new media in schools.

I asked the interviewees about ICT projects and approaches, their positive and negative experiences with ICT, how colleagues and principals support the projects and whether their projects were actually implemented in the long run. The second part of the interview focused on the pupils' experiences and informal competencies. In the third part I asked, whether teachers notice differences in the pupils' competencies, strategies and attitudes with regard to their socio-economic backgrounds.

The interviews were transcribed and then analyzed following main concepts of the qualitative content analyses (Mayring, 2000). This approach provides a systematic, rule-guided qualitative text analysis preserving some methodological strengths of quantitative content analysis, e.g. presenting number of codings in tables, and broadening them to qualitative procedures.

The inductive development and refinement of categories and their deductive application are central procedures of qualitative content analysis. To support these qualitative steps of analysis, MAXQDA was used enabling team work and features for merging qualitative and quantitative analyses (Flick, 2009). Four interviews were coded by two researchers to minimize researchers' bias. In cases where the interviewers' results revealed large differences, the categories were refined.

Altogether, 15 interviews were conducted, 13 of which were telephone interviews. The sample consists of five men and ten women. Except for the five teachers who were contacted via the online-platform *teachers-online* and who come from all parts of Germany, all other interviewees live in Bavaria.

Results

To answer the research questions about how teachers incorporate ICT in elementary classes, how they align ICT-based instruction to students' experiences and whether students' socio-economic background influence learning outcomes, in the following analyses of the qualitative data are presented. Besides interview excerpts illustrating insights and offering

conclusions, the results are presented in tables containing the number of codings and interviews. Due to the explorative character of this study and its qualitative approach, the sample is not representative of approaches to working with new media in German elementary schools. Hence, the outline of the quantitative distribution of categories is limited to the sample here.

Types of media

The respondents refer to various types of ICT that include different devices, like computers in specific computer labs or individual computers in the classrooms, beamers, document cameras, digital cameras, iPads, laptops, DVD-players, interactive whiteboards, or smartphones as part of the so-called bring-your-own-device approach. ICT can also subsume internet connections; for instance, some schools have developed separate internet accesses for teachers and students:

Students are given limited internet access via specific interfaces with whitelists. Finally, ICT also includes learning apps, digital learning platforms as well as social media designed specifically for children and young students.

Students' ages -

The interviews were conducted with elementary teachers or focused on elementary schools. As elementary school years differ in the 16 German federal states, e.g. from first to fourth grade in Bavaria to first to sixth grade in Berlin, the students' age range is from 6 to 12 years. The majority of teachers reported using ICT tools from the second school year on, once children have acquired basic reading skills.

Forms of ICT-based instruction in elementary schools

Respondents were first asked how they incorporate ICT in their teaching.

ICT was employed in the form of projects as well as being part of the regular teaching routine to nearly equal extents, see Table 2. In a few cases, digital media was systematically incorporated in the schools investigated with a mandatory curriculum encompassing all subjects and school years.

Table 2. Type of activity

	Number codings	*Number interviews*
ICT-projects	23	9
ICT incorporated in regular teaching routines	21	9
ICT permanently integrated, e.g. in elementary media curricula	6	4
mibs (projects, support, teacher professionalization)	16	2
Teacher professionalisation	1	1
Total	67	12

In other examples, such as the *reference schools for media education*, often a comparable curriculum existed; however, the interviews suggest that it contained recommendations rather than guidelines and so teachers appear to have been free to follow it or not.

Connections between ICT-based instruction and students' social life

The second research question seeks information on how teachers align their ICT-based instruction to students' social lives. In the main, teachers see a need to refer to students' experiences and interests in teaching, see Table 3. In some cases, ICT is used as a tool to achieve learning objectives defined in the school curricula.

Table 3: Connections between ICT and schools

	Number codings	*Number documents*
ICT tools in students' homes e.g. devices, games, social media	15	7
Student's interests	9	7
Curricula	5	4
Others (students' digitalized living environment)	3	3
Total	32	14

The interviewees often talked about their reasons for integration ICT into their instruction. The following two interview excerpts illustrate the intention to teach digital skills to help make students fit for the requirements of daily life and the professional world:

> I think pedagogically, the urgency, you know, how important [digital media] is in the children's lives prevails. [Interview 11].

> I cannot say precisely; however, to me it is a fact children come from an increasingly digital world. And there is a great certainty that I will send them into an increasingly digital world. These are the circumstances. And I

> am trying to orientate myself on them. This means for me, when I am teaching reading in a seminar, I'm interested in the children's reading experiences and what kind of reading socialization these children have. There was the Reading Foundation (Stiftung Lesen) study showing that fathers increasingly read aloud from digital books, not analogue anymore. When children have these experiences, schools have to link to them. I can spread that to all areas; we have parallel worlds, indeed. Likewise I try to take into consideration – and every teacher should do this – learning capabilities and learning possibilities and this includes media experiences. [Interview 01].

In designing ICT projects and digital learning units, teachers attempt to link them to students' prior experiences, e.g. digital devices or social media at home:

> At the age of 10 they get their first smart phone. In grade six, at the age of 12, they already have their second one. The first one was a HTC and now they have a Samsung and now they have this and that and the equipment is user friendly, so they can do a lot with these devices, play a lot, take a lot of pictures, and that is a point, too, where I develop starting points to meet their interests. [Interview 03].

Teachers often report of students being ahead of them with regard to ICT knowledge and usage of digital devices and programmes:

> My impression is that children are ahead of us and school is behind. Many children have smart phones now, got them in the last two years, and many children, I have fourth graders, are in a children's chat. And my feeling is that many colleagues are not aware of how many children are using media. You no longer have to teach them much anymore, rather learn much from them. [Interview 12].

Projects are also oriented towards students' ethnic backgrounds and their interests. One teacher, for instance, explains why she has developed an online-based instruction unit about breakfast traditions in different countries and regions:

> I did not take it from some other site. It developed in the context of this group of children whose characteristics were their mixture of nationalities

> and thus this topic 'how does the world eat breakfast' matched their interests well. [Interview 02].

In one case, a teacher reports that an offer to provide iPads to a class was rejected, as the teachers decided the pupils were not capable of taking care of these devices:

> We had an inquiry from a university, a researcher wanted to develop a learning app. We did not take part in this project. From our experiences we knew the iPads would be lost within two days. Therefore, we said this would not work out, the gadgets would not be stolen, just lost, because we see how much gets lost by these children, and the parents are overwhelmed by providing their children with a structure in daily life. […] The teachers said we have to raise the students first before we can use new media in the classroom. [Interview 12].

In general these examples show that to a large extent teachers align their instructional designs to students' characteristics and needs. To determine more precisely which characteristics and needs students have, teachers were asked what prior digital knowledge students possess to work with ICT in schools. Table 4 illustrates teachers' differing perceptions of students' digital competencies.

Table 4: Students' prior digital knowledge and competencies

	Number codings	*Number interviews*
Large amount of prior knowledge	19	9
- e.g. informal knowledge	5	1
Small number of competencies	13	9
- e.g. user knowledge	3	2
Attitudes and motivation (no sense of trepidation, high level of motivation)	9	7
Total	41	12

The teachers report that a majority of students have experience and high prior knowledge enabling them to easily work with ICT in school:

> This [digital media] is very interesting and of course a good thing for the children but sometimes alarmingly conventional for them, too. They turn on their iPad, take photos and download these. All of a sudden, this has started and we grown-ups watch to see how this works. Everyone has his own

> tablet, but you are not used to employing it in the classroom. And there are worlds of differences in how teachers and grown-ups work with digital media and what that means for instruction. [Interview 03].

Often, interviewees emphasize that students acquire these ICT-skills outside schools:

> They have surprisingly many competencies; however, I have to say that what German children learn [about ICT] they do not learn in schools. [Interview 01].

However, this high prior knowledge is qualified by many teachers as being limited to user knowledge, such as finding videos on you-tube or playing online games:

> Although we notice that children can use individual software applications, on the whole they do not have comprehensive knowledge. [Interview 10].

A teacher explains the students' prior knowledge in the following particularly descriptive way:

> Often they have prior experiences which are of a superficial nature, gained from their sisters and brothers, and they have tips and advice, gained from their parents. [Interview 13].

In contrast to these differing perceptions of the students' informal prior digital competencies, the interviewees agree on the students' high motivation and the absence of

> fear and reservations. They are not as reluctant as adults to engage with it, to not use it in the right way or make mistakes. They are totally free of fear and open-minded. That is a fabulous starting position. [Interview 02].

Respondents see this motivation in all children; hence, integrating digital media in schools is based on good starting positions.

Which students benefit the most from ICT in schools?

To find out how the socio-economic backgrounds of students influence their motivation to learn with ICT and their learning outcomes, teachers

were asked which kinds of students benefit most from the digital media in schools.

Table 5: Students' socio-economic background and its influence on engaging with and benefitting from ICT

	Number codings	*Number interviews*
No difference	12	8
Different usage of ICT depending on students' socio-economic background	13	9
Greatest benefits for students from high socio-economic family backgrounds	9	4
Greatest benefits for students from low socio-economic family backgrounds	8	6
Greatest benefits for students with no ICT tools at home	4	3
Total	46	13

Whether students' socio-economic background influences their motivation to use ICT in schools and benefit was answered negatively by about half of the respondents, see Table 5. However, the other teachers report differences with regard to student's social backgrounds and access to ICT. Thus, children from lower socio-economic backgrounds appear to have unlimited and unmonitored access to the internet:

> However, they are set no limits about how often and how long they use a computer or have breaks, and in many families no attention is paid to this. I would guess more than half of what children consume is in the internet. Thus, they watch you-tube videos on their own, unattended; you can easily get to strange videos. [Interview 12].

Some parents from higher socio-economic backgrounds try to keep their children away from ICT and criticize schools for employing them.

> There are many parents saying they reject the idea that schools also involve children in new media-activities. Parenthood is extremely heterogeneous, there are objectors and pushers. [Interview 01].

Likewise, only parents from higher socio-economic backgrounds are perceived by teachers as guiding their children in using ICT and acquiring digital competencies:

> Maybe there are parents who are generally better informed about educational facilities and have a higher standard for how their children use

> new media and therefore learn more or differently than parents whose standards are lower. [Interview 01].

Although children from lower socio-economic backgrounds seem to spend more time using ICT, they often have no advantage with regard to gaining higher digital competencies. ICT competencies appear to be influenced by other competencies instead, such as proficient literacy:

> Thus, when they start what you notice at once [the difficulty is] is about searches and the choice of search keywords. There they already fail, or you see unsureness. Or they type in key-words and look at internet pages and have to filter the information for certain information that is important for them. What they [children from different social backgrounds] do equally well is starting and when there are games, they just try and start this and they do equally well. However, if it is about finding information, there you can see obvious differences. [Interview 10].

One teacher even pointed out differing attitudes and motivations related to students' social background that enable students from higher social classes to work independently with demanding ICT tasks, such as programming learning apps:

> What I notice is there are students who express the wish to programme something. This can be done with learning apps. Programming is not the right word; essentially one creates a learning game. I noticed that the pupils, four, five, six of my best students, created this partly on their own. Because I told them, you can do this on your own quite easily, and they partly created this in their free time. It should not be forgotten that they are fourth graders, ten-year old students. For this you need persistence and tenacity, which low achieving students do not always have. And these students, unfortunately, often come from lower social backgrounds. [Interview 13].

Other teachers, on the other hand, notice that children coming from lower socio-economic backgrounds have an advantage when engaging in digital learning opportunities:

> Low-achieving children, I have a specific student in mind who is very weak but has an enormous computer knowledge. When he sees he is better than others and can help them, this is extremely motivating. [Interview 09].

In another case, a teacher was able to motivate a student to participate in learning again:

> A positive thing is that children like to use computers and do not have the difficulties they have in traditional instruction. A different form of attention develops. [...] Once I worked with a child from a different school class. I let him play learning games to practice reading and arithmetic. This child was nearly always depressive in traditional lessons, because the family situation is very difficult. However, he knew computers from home, playing computer games was his only hobby, and so this was something positive for him, and therefore he liked doing these learning tasks, and had a level of concentration, he did not have otherwise. [Interview 12].

Besides enhancing students' motivation to participate in learning again with the help of digital-based instruction, teachers see another advantage of digital learning programmes, as they can be adapted to a student's individual level of knowledge:

> What they can benefit from in any case is a variety of learning programmes to practice vocabulary, words and simple multiplication. The computer has the big advantage that it keeps the motivation high much longer than any other traditional forms I know. The computer I'm sitting in front of gives a task and feedback immediately. This approach to teaching can keep their attention, and I think in a situation when there is no one at home, who practices with me and motivates me or does not know properly, then doing arithmetic at the computer is a huge advantage, as it does it correctly and gives feedback and motivates me. Therefore, I think to practice with children, to teach the basic tools, to practice alone, is a great chance. [Interview 02].

Furthermore, teachers ascribe the benefit of using ICT in schools not to certain social backgrounds but to whether the children have computers at home.

In conclusion, it seems that high prior general competencies and attitudes, such as literacy and persistence have a positive influence on gaining digital competencies; these are characteristics that teachers tend to see in students from higher social backgrounds. Students from lower socio-economic backgrounds also appear to benefit from individual learning programmes, as they have a greater acquaintance with ICT and are eager to use it at home as well as in schools.

Finally, I was interested in learning whether students prefer traditional teaching and learning methods to ICT-based instruction and which characteristics influence this choice.

Table 6: Do students prefer traditional teaching methods?

	Number codings	*Number interviews*
Yes	17	8
- ICT too demanding	6	3
- Students do not like team work	4	1
- Students from lower social backgrounds are sated by digital media	2	2
- Children are afraid of damaging something	2	2
- Others	3	2
No	6	5
Total	23	12

The number of answers to this question shows that six respondents report that children do not prefer traditional instructional methods, while 17 experienced some children who prefer these. The teachers gave the following reasons: ICT-based instruction is often very demanding and requires team work, see Table 6. In the following interview sequence, a principle explains that in grade four the amount of learning content is enormous; therefore, children welcome instructional methods allowing them to be passive:

> Sometimes teachers demand a lot; much information is provided. This is sometimes too much for some students who are usually the ones happy just to write a text or listen to a story, the more well-behaved and quiet, to some extent also the weaker ones, they prefer this. [Interview 13].

One teacher explains that low-achieving students in particular need the additional structure and support that is often lacking in ICT instructional methods. A teacher of a so-called high-risk school even reports that students are more interested in face-to-face communication with each other and the teacher than in working with computers, as they are already confronted with ICT extensively already at home:

> Often it is said that frontal teaching, the teacher standing in front and explaining something, is not so good. However, I notice with our children, they like it very much, just talking, just a class discussion, where everyone can participate and the teacher explains and intervenes or not. They like this

> a lot. In our families, however, this is often not the case. Many families do not communicate, or just in the sense 'Dad, when are you picking up the kid'. They do not communicate about feelings, experiences what I would consider to be traditional. Because they like class discussions very much, they love talking. So I had to stop with the computer lab, because there was no more interest. They were bored. [Interview 12].

Altogether these examples reveal contrasting results: The unlimited access to ICT does not necessarily result in higher digital competencies and motivations to work with ICT in the classroom. Such access can also have the opposite effect, as this example shows. Here, children expect schools to be places of communication and face-to-face interaction. This example contrasts with the previous case, where a student could be engaged in learning when instruction was computer-based but he did not participate in traditional learning opportunities.

Discussion and conclusion

In this study, I investigated German elementary schools' approaches to employing digital media in classrooms. As international comparative studies show, Germany has a relatively low level of digitalization, e.g. with regard to schools' technical infrastructure as well as with the lack of encouragement of teachers and principals to implement new media in schools. My intent was not to prove that ICT automatically leads to higher learning results and decreasing social inequality, but to investigate how ICT can influence the learning of all students. The main focus was on the teachers who use ICT to link their ICT-based lessons to students' experiences and prior knowledge and how students from lower socio-economic backgrounds benefit from digital instructional designs.

A series of interviews were conducted with teachers and principals who are very engaged in incorporating ICT in their classroom teaching as well as with representatives of schools with media-focused curricula. Thus, people with critical attitudes toward ICT and digitally-based instruction were not part of this sample. Nevertheless, the interviews suggest the existence of a huge gap between teachers' engagement with ICT. Some teachers integrate digital media in their teaching as a matter of course and discuss school-related digital issues in social media chats, while others are led by their students to explain how digital devices work. In Bavaria two

prominent approaches – the so-called *reference schools for media education* and the online-platform *mebis* – were initiated by the ministry of education to link classrooms to an increasingly digitalized world and to systematically implement ICT in schools.

The interviews show the great variety of ICT devices, teachers use in classrooms, for projects as well as for their regular teaching. Half of the teachers maintain that the majority of the students have considerable experience in employing digital media. Interviews suggest that many students have gained these skills at home on their own, while some children are taught to use digital devices and social media by their parents. Other teachers perceive students' prior digital competencies, however, as being rather weak and limited to watching internet videos or playing online games. On the whole, the results indicate that students' prior knowledge is quite heterogeneous. Thus, teachers and other stakeholders, e.g. for policy development, in education have to acknowledge these differences and develop modules appropriate for differing digital competencies, ages and subjects. In combination with some teachers' perceptions that students are ahead in their digital knowledge, teachers need support to work with ICT and to be prepared for the students' as well as parents' heterogeneous digital skills and attitudes towards digital media.

The results furthermore show that teachers align their ICT-based instruction with student's prior knowledge and experiences; moreover, digital media projects are linked with students' interests as well as their school's curricula. In general, the preconditions for employing ICT in schools are promising as children frequently have a high motivation to work with the technologies. However, as discussed previously this motivation will only have a positive result on their academic success if it can be channeled into learning (Higgins, Xiao, & Katsipataki, 2012).

In addition, the interviews support previous research results regarding the high influence students' social backgrounds often have on developing digital skills. This correlation becomes visible first of all with regard to the access to ICT. Students from lower socio-economic backgrounds appear to have more, and unattended, access to digital media than middle class students. Likewise, gaining digital skills is influenced by other competencies, such as literacy or attitudes, like persistence. Teachers notice a correlation between these learning preconditions and students' socio-economic backgrounds, and students coming from lower socio-economic backgrounds seem to be at a disadvantage. Additionally, teachers

acknowledge the demanding character of ICT-based instruction which requires active and often cooperative student involvement. At the same time, low-achieving students often need additional support and structure so that students from higher socio-economic backgrounds more easily perform well in these learning situations. Teachers regard these characteristics as reasons why some students prefer traditional instructional methods.

Nevertheless, the interviews reveal that students from lower socio-economic backgrounds are familiar with digital media, exhibit fewer avoidance strategies and also tend to be motivated to work with it in schools. In accordance with Eva Dalhaus' theory of individuals' subjective educational knowledge (Subjektives Bildungswissen), ICT can provide motivational resources that especially children from lower socio-economic backgrounds benefit from. Furthermore, ICT has the advantage of offering more student-directed learning and teaching, as it provides opportunities to spontaneously answer students' questions and thus increase their learning motivation. Moreover, online learning programmes can be adapted to each student's prior knowledge and provide immediate individual feedback, which should have a positive impact on learning achievements and motivation. Thus, ICT in schools offers the opportunity to individualize instruction, from which low as well as high achieving students can benefit. While high-achieving students can independently solve demanding tasks, low-achieving students are often familiar with digital devices and have a higher motivation to work with it than with traditional teaching.

While this study contributes insight into effects of using ICT in elementary schools, the interviews provide contrasting results, which suggest incorporating ICT in the classroom is not simply "plug and play". Therefore, many questions remain open, and the results here should lead to future research questions, such as: How can the high motivation of students from lower socio-economic backgrounds to learn with digital media be transferred to higher learning outcomes in ICT-based learning environments? Furthermore, the results indicate that digital competencies depend on other skills, such as literacy. Thus, it would be helpful to determine which prior skills are necessary to support effective learning by means of ICT-based instruction. Further questions could be: What extra support and guidance for low-achieving students is necessary to achieve the best learning outcomes? Which mix of traditional and new-media achieves the best learning outcomes? Answering these questions will help to better

incorporate ICT in elementary schools and improve learning for all students irrespective of their socio-economic backgrounds.

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