



# The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives



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## ARTICLE INFO

### Article history:

Available online 16 January 2013

### Keywords:

Tablet-PC  
Technology acceptance  
Classroom instruction  
Teacher  
K-12  
School

## ABSTRACT

Limited research has been conducted on the integration of Tablet-PCs in classroom instruction. This paper reports a qualitative study which investigates the acceptance of Tablet-PCs, seen as technological innovation, amongst teachers. The research approach intends to complement research on the acceptance of technology through a more detailed qualitative examination. Semi-structured interviews were conducted with 18 teachers during a pilot project introducing Tablet-PCs to classroom instruction at three different schools. The findings indicate diversity in the attitude of teachers towards the technology, but also with regards to the performance expectancy and the facilitating conditions.

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## 1. Introduction

The integration of digital technologies, such as Tablet-PC (TPC), in classroom instruction is seen as a promising way to facilitate students' learning processes (Banister, 2010; Bonds-Raacke & Raacke, 2005; Enriquez, 2010). In contrast, limited research has been conducted on the acceptance of technological innovations amongst teachers. This is in fact quite astonishing, since for successful technology integration in education it is of utmost interest why technological innovations are accepted or rejected by its users. And given teachers' key role when it comes to technology integration in a school context (Ertmer, 2005), it seems relevant to investigate factors influencing the adoption of technology from

a teachers' perspective.

TPC are a relatively new format of a portable computer offering features which might be beneficial to learning and instruction in classroom settings (Twining & Evans, 2005). There is no doubt that TPC can be seen as a versatile technology with multiple applications allowing students to gather and use information in order to construct and manipulate knowledge (Moran, Hawkes, & El-Gayar, 2010). It is also claimed that the potential of TPC can easily be adopted in classroom instruction to facilitate students' learning processes (Wise, Toto, & Lim, 2006). From an instructional point of view beneficial features of TPC range from the availability of tools such as simulations, cameras and microphones, to eBooks and digital text books, to interactive learning networks and instant

feedback. Furthermore, its distinguished features are a high mobility, a low proneness for software problems as well as an instant usability (Ifenthaler & Eseryel, in press). These characteristics can clearly contribute to a student-centered learning and to a more differentiated form of instruction (Ludwig, Mayrberger, & Weidmann, 2011). But despite the potential of TPC for learning and instruction researchers still need to document the impact of mobile computing technology in classroom settings in order to see whether the promised benefits of this technology can be realized (Banister, 2010; Koile & Singer, 2008).

When it comes to the implementation of TPC in education, research has been conducted in specific pockets of use. In a study on effects of homework system implemented on TPC, Kerawalla et al. (2007) reported a better understanding of learning materials, individual learning history and information of learning objectives between school and home. Another major field of research has been the use of TPC for mathematics teaching (Galligan, Loch, McDonald, & Taylor, 2010; Trouche & Drijvers, 2010) and in addition, studies have been conducted on creating interactive learning networks through the use of TPC and wireless technology (Enriquez, 2010). Furthermore, some studies report about students attitudes towards digital textbooks (Reynolds, 2011; Weisberg, 2011) while others address general questions on instructional design (Lornsen, 2010; van Orden, 2006). Integrating TPC into classroom instruction ultimately centers on students' learning as well as the effectiveness of teachers instructional methods. Yet, to be advantageous for classroom instruction, a technological innovation such as TPC needs to be accepted by teachers and students alike. Bürg and Mandl (2004) pointed out that the integration of technology often fails due to a lack of acceptance by its potential

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users. In consequence, a better understanding of key factors influencing the acceptance of TPC in a school context might improve its sustained integration. Since we can observe a proliferation of TPC in education it seems important not only to evaluate the effects of this technology on learning and instruction, but also to explore factors related to the acceptance of TPC by students and teachers (El-Gayar, Moran, & Hawkes, 2011). Regardless of the technological potential and availability of TPC, a key question is whether teachers demonstrate the behavioral intention to integrate TPC into teaching practice to deliver effective lessons for their students (Brown & Warschauer, 2006). Since the decision to use TPC in classroom instruction is in effect taken by classroom teachers (Ertmer, 2005), we need to gain an understanding of how and why teachers accept mobile computing technology as part of their classroom teaching practice. Accordingly, examining the acceptance of TPC by teachers can contribute to explaining and improving usage patterns and hence assist the full integration of TPC into the educational system.

The integration of mobile technologies into the educational system goes beyond its sole availability. Even though there is no clear definition on technology integration, one typical element cutting across the current discussion can be seen in the use of a specific technology for learning and instruction (Hew & Brush, 2007). But since a lack of user acceptance is an impediment for successful technology integration, user acceptance is a pivotal factor for all innovative technology initiatives. In this regard user acceptance can be understood as a positive adoption decision to employ an innovation by users and can be further differentiated into intended use and actual use of an innovation (Simon, 2001). Whereas the intended use is not observable, the actual use is manifested in an observable behavior. Thus, it functions as an outcome variable of the decision making process of a user towards an innovation.

As a review of the technology acceptance literature reveals some researchers believe that the acceptance of technology has hardly been achieved (Bauer & Kenton, 2005; Franklin & Molebash, 2007; Hew & Brush, 2007), whereas others suggest that it has been more successful in some cases than others (Drucker, 2006; Hughes & Ooms, 2004). Claims about the acceptance of technology are usually based on models provided by the technology acceptance literature. These models provide explanations about the adoption of technological innovations. A prevailing model for user acceptance is the Technology Acceptance Model (TAM; Davis, 1985; Davis, Bagozzi, & Warshaw, 1989). As an adaption of the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975), TAM was developed as a general model to specifically explain computer acceptance (Davis et al., 1989). TAM and its derivations (Venkatesh & Balal, 2008; Venkatesh & Davis, 2000) were frequently used as research tools to investigate the acceptance of technological innovations by end users. However, it became obvious that the TAM could only predict technology acceptance in 40% of the cases (Venkatesh & Davis, 2000). This shortcoming of TAM led to the development of the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh, Morris, Davis, & Davis, 2003) by integrating central elements of eight different technology acceptance models, including TAM. Fig. 1 presents the UTAUT model and depicts the relation of key constructs in terms of usage intention and behavior.

The UTAUT model hypothesizes that users' acceptance of technological innovations can be explained by a number of key determinants. While performance expectancy, effort expectancy, and social influence are direct predictors of behavioral intention and indirect predictors (through behavioral intention) of usage behavior, facilitating conditions has a direct influence on usage behavior. A definition of the UTAUT model's key determinants are shown in Table 1.

Venkatesh et al. (2003) reported that the UTAUT explains as much as 70% of user acceptance of technology. By providing a considerably better explanation of technology acceptance it can be con-

sidered superior research model than prior models. Even though the UTAUT model has been used in several domains, its application in education is still scarce. Teo, Lee, and Chai (2008) used the UTAUT as a theoretical foundation to explore the computer attitude of pre-service teachers and found perceived usefulness, perceived ease of use, social norm, and facilitating conditions as significant determinants on pre-service teachers' computer attitudes. As one of the reported limitations the authors point out that pre-service teachers views may be different from practicing teachers. In another study Weitz, Wachsmuth, and Mirliss (2006) investigated the usefulness of TPC at a university faculty, indicating that faculty members are convinced about the meaningful impact of TPC on learning and instruction while only minority is motivated to use it. Moreover, the UTAUT was applied examining university students' acceptance of TPC (El-Gayar et al., 2011; Moran et al., 2010). Results showed students' attitude as the determinant with the most direct influence, followed by facilitating conditions, performance expectancy, and social norm. These results are inconsistent with other research on technology acceptance insofar as students' attitude has a bigger direct influence on technology acceptance than performance expectancy.

For the purpose of clarity, we distinguish between theoretical frameworks, which try to understand social and psychological factors influencing user acceptance on an individual level and those emphasizing on the diffusion of a certain technology within a social system. The technology acceptance literature has a clear focus on investigating determinants influencing the acceptance of individual users at a given point, whereas the diffusion theory (see Rogers, 2003) presents a context in which the uptake of a certain technological innovation within a social system over a period of time can be examined (Dillon & Morris, 1996). Thus, its primary purpose is to provide a narrative of how a certain technology evolves from the stage of innovation to a widespread application within a social system. Insofar the diffusion theory can be distinguished from the acceptance theory, as the acceptance theory tries to explain key factors affecting the acceptance of a technological innovation on a microlevel (i.e., individual level), whereas the diffusion theory presents a framework to debate acceptance on a macrolevel (Dillon & Morris, 1996; Quiring, 2006). Diffusion theory certainly can help to gain an understanding of the uptake of technologies such as TPC in a school context over time. But since our primary research interest was on the dynamic psychological processes of users on which they base their decision about TPC, it seemed self-evident to refer to a theoretical approach conceptualizing acceptance as a dependent variable of those psychological processes. Hence the UTAUT was adopted as a theoretical framework for this study.

### 研究的主要内容

While the UTAUT already served as a theoretical foundation for few studies in higher education it has yet to be applied in a K-12 context. Given the crucial role of teachers pertaining to mobile technology acceptance for classroom instruction, the purpose of this study is to identify factors that influence teachers' acceptance of TPC in a school environment by using a qualitative research design. More specifically, we investigate whether the key determinants of the UTAUT influence teachers' behavioral intention with regards to TPC. As such, our approach was intended to complement research on the acceptance of technology through a more detailed qualitative examination of the topic.

## 2. Method

### 2.1. A qualitative research design

A qualitative research design was chosen for two reasons: firstly, this methodology allows the investigation of key determi-

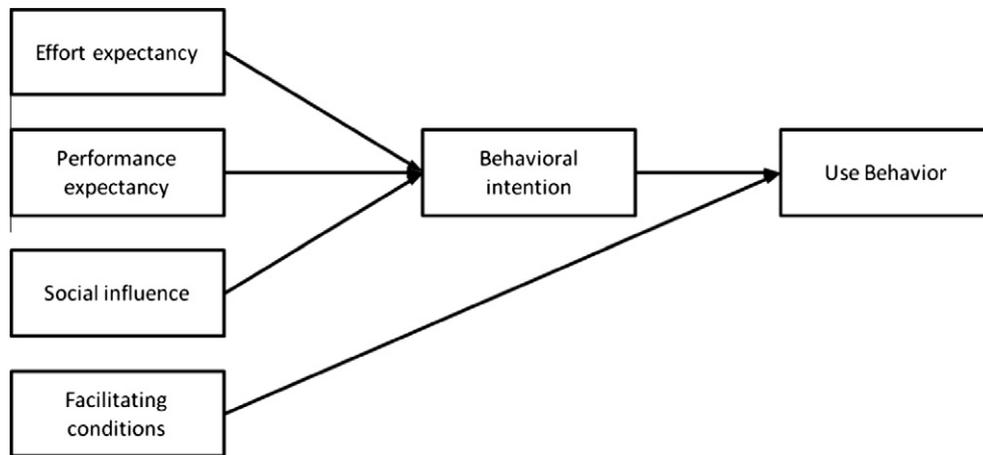


Fig. 1. UTAUT model (adapted from Venkatesh et al., 2003).

**Table 1**  
Constructs and definitions of the UTAUT model.

Constructs	Definition
Performance expectancy	Degree to which a user believes that using a technological innovation will help to improve his/her job performance in
Effort expectancy	The degree to which a user believes that the use of a technological innovation will be free of effort
Social influence	Describes the degree to which a user perceives that important others (e.g. peers) believe that he/she should use the technological innovation in question
Facilitating conditions	The degree to which a user believes that a technical infrastructure exists to support the use of the technical innovation in question
Behavior intention	Intention of a user to use a technological innovation for job related purposes
Use behavior	The degree of the actual use of a technological innovation by a user

nants of technology acceptance beyond the UTAUT model and hence indicate, whether additional factors are relevant to teachers' acceptance of TPC in a K-12 context. Something that would have been difficult to encompass applying a quantitative approach (Kidd, 2002). Secondly, the limited amount of teachers involved in this pilot project did not allow a quantitative research design. In consequence such an approach is statistically not representative, but can be an effective way to investigate and explore so far unknown aspects and key factors (Kelle & Kluge, 1999), which could significantly influence teachers' acceptance of TPC. To collect data, semi-structured interviews were conducted to explore the impact of central constructs of the UTAUT model on teachers' adaption of TPC. Concurrently, the semi-structured nature of the interviews allowed respondents to add new aspects and angles on the topic. Furthermore, the interview guide served as a frame for data collection and data analysis, and therefore allowed the comparison of different interviews (Bortz & Döring, 2006). The qualitative approach helped to gain insight into teachers' perspective on TPC adoption and key determinants of technology acceptance.

## 2.2. Participants and sampling

Sampling was restricted by the limited amount of German schools using TPC. Hence, a random sampling approach was simply not possible, as the key criterion was to be seen in the use of TPC as part of teachers' classroom practice and presently this mobile computing technology is not widely used in the German education sector. Accordingly, a quota sampling approach was out of the question for the same obvious reason. Fortunately, the school authorities of the school district in the German city of Mannheim initiated a pilot project to investigate the possibility of TPC integration in classroom instruction in some schools under their authority. Three middle schools were chosen by the school authorities to participate in this project. In consequence, cooperation with

the school authorities provided us with the opportunity to use a homogenous sampling approach, since we were able to sample all teachers involved in this pilot project.

In total, 18 teachers (9 male, 9 female) of three different middle schools participated in the interviews. The average age of the interviewees was 36.83 years ( $SD = 5.5$ ). The average teaching experience was 7.83 years ( $SD = 4.92$ ), with 17 respondents holding a full teaching qualification, while one of the participants was still a trainee teacher in the second stage of the German teacher-training scheme. All teachers participated at the interviews on a voluntary basis, but in one case a participant felt some pressure by his principal as well, due to his role as school network administrator. Of the involved schools only teachers using TPC in the context of the pilot study were permitted to participate in this pilot study. However, the extent of TPC usage by individual teachers was determined by the different modes of use at the three schools involved. Whereas one school got a set of TPC to be used for one class only, a second school got a set of TPC to be used by different classes specifically for project work purposes. The third school's focus was to use TPC to integrate physically disabled pupils into a regular class. In consequence, the availability of TPC for the involved teachers' varied considerably. Since these interview sessions were held at the beginning of the pilot project as part of a longitudinal survey, this matter did not seem relevant at this point, because all teachers were commencing to integrate TPC into teaching practice. However, the varying degree of technology availability was certainly an aspect which needed some attention during the project progression, particularly since the key relationships within the UTAUT model are moderated by experience.

## 2.3. The interviews

Data were collected conducting semi-structured interviews. These interviews were held in December 2011 and January 2012

**Table 2**  
Examples of the pre-defined interview questions (translated from German).

Do you use the iPad to prepare lessons?
What benefits do you see in the iPad compare to Notebooks?
Do you expect that learning to operate the iPad for teaching purposes will be ease for you?
Does your school have the necessary resources to use the iPad in the classroom?
What is your attitude towards the use of the iPads?

in the course of 18 interview sessions. All participants gave informed consent for audio recording of the interviews and were informed about the purpose of this study. Participants were questioned with the intent to explore factors influencing their acceptance of TPC in classroom instruction. The interviewers collected biographical data as well as respondents' pre-experience with ICT and TPC in classroom practice. This was followed by questions related to topics such as performance expectancy, facilitating conditions, effort expectancy, general attitude towards TPC, expectations with respect to students' performance and motivation, and expected problems respectively difficulties while using the technology. The topics were derived from the technology acceptance literature, in particular the *Unified Theory of Acceptance and Use of Technology* (UTAUT; Venkatesh et al., 2003), the *Technology Acceptance Model* (TAM; Davis, 1985), and the *Theory of Reasoned Action* (TRA; Fishbein & Ajzen, 1975) and adjusted to the context of this study. Table 2 provides examples of the pre-designed questions asked during interviews.

In total, 37 questions were asked, of which 8 were follow up questions. The semi-structured nature of the interview procedure allowed the development and refinement of the topics during research, especially where interviewees raised additional aspects. The duration of the conducted interviews varied considerably between 11 and 30 min in length. The considerable discrepancy can be explained due to the varying experience amongst individual teachers, since interview sessions were held at the beginning of the pilot project.

#### 2.4. Data coding and analysis

All interview sessions were recorded and fully transcribed with f4 transcription software. The transcripts provided the basis to produce summaries of participants' statements and their key perceptions about TPC use in classroom practice. For further analysis a code system was generated. Establishing codes can be accomplished deductively based on an established theoretical foundation or inductively using the data collected (Kuckartz, 1999). Since the technology acceptance literature provides a fast knowledge about technology adaption, procedures were as such, that an a priori code system was derived (Kelle & Kluge, 1999). These general codes were complemented by researchers adding further codes to the code system while analyzing the transcripts. Table 3 provides examples of codes and subcodes applied for analysis.

**Table 3**  
Examples of codes and subcodes (translated from German).

Codes	Subcodes	Meaning
Pre-experience	ICT TPC	Participants pre-experience using technology in instruction
Attitude towards TPC		Participants' general attitude towards using TPC for instruction
Performance expectancy	Improvement of instructional practices Students motivation Students learning processes	Participants believe that TPC can be a tool to improve learning and instruction
Ease of use		The degree to which a participant believed that he/she could easily use TPC in classroom instruction

Subsequently the transcripts were coded using the analyzing software MaxQDA. As coding can be understood as the attribution of text passages to codes (Bortz & Döring, 2006), each transcript was in consequence repeatedly reviewed during analysis until all parts of the transcripts were attributed to codes.

### 3. Results

Findings are presented according to the generated code system. Adopted from UTAUT (Venkatesh et al., 2003), TAM (Davis, 1985) and TRA (Fishbein & Ajzen, 1975), interviews were coded for evidence according to three main categories: (1) Pre-experience with ICT and TPC, (2) Acceptance, (3) Expectations, the focus clearly being the second category. Where references to participants' responses are made during result presentation, those will be paraphrased since the original interviews were held in German.

#### 3.1. Previous experience with ICT and TPC

All 18 respondents had previous experience using ICT as part of their classroom practice even though the intensity varied considerably. While one of the male teachers uses computers in his ICT lessons frequently, another teacher uses it on a daily basis for one of his disabled pupils. In contrast about a third of the respondents indicate a frequency of computer use once every week, while others use computers twice or three times a week. Overall, where ICT was used as a means of integrating disabled pupils into regular classes, teachers reported a much higher frequency of use, mainly because their disabled students depended on the technology.

Interview 4 (18-18): I use it on a daily basis. There are pupils, who can't hold a pen due to their handicap, hence can't write. They for example use a notebook to write.

In those cases the availability and access to technology was provided by school leaders and authorities to a sufficient extent. This was the case in one school. Respondents of the other two schools reported that a problematic access to computers restricted their intention to use ICT more frequently.

Interview 10 (20-24): I would say once or twice a week across all subjects. . . We have got two computer rooms, which a limiting aspect for its use because they are often occupied.

Interview 16 (18-26): Computers maybe three times a year. . . The computer room is often occupied. . . We have 800 students at our school. . . Each computer room has 15 computers and when you have a class size of 31 or 32 students it is good to have two computer rooms at the same time. And that is difficult to accomplish.

Respondents pre-experience with regards to TPC shows a more diverse picture. Six respondents used TPC in a private context prior to the school project, mainly for Internet research and emails. In four cases a TPC was accessible within a household, while one person had frequent access of a TPC through acquaintances and

another participant owned a TPC in the past but abandoned it in the meantime. A majority of nine respondents used a TPC for the first time as preparation for their school project, but only to familiarize themselves with the device.

Interview 17 (28–30): I grabbed one of the schools iPads over Christmas holidays and tried to get accustomed with it... I just tried to get engaged with the device... use the internet and find out how to log into the App-store... getting used to the virtual keyboard... just in a playful way.

Interview 7 (22–22): I haven't used an iPad before I got this one.

The remaining three participants never used a TPC at all. Overall, even though most participants did use a TPC for private purpose, none did so in a professional context. Hence, experience using TPC for learning and instruction is nonexistent. Nevertheless, respondents' impression of the device is more varied.

Having used TPC, participants find it very easy to use. Answers ranged from "very easy", over "intuitive" to "simple". In addition, a female respondent calls it a "Spielzeug" (Toy), while others emphasized positively the instant applicability of it, whereas three respondents criticized the lack of a USB port. In summary, due to respondents' rudimentary knowledge about TPC, especially with regards to classroom practice, responses were far from being profound.

Interview 17 (36–36): Therefore I need to know what possibility iPad apps offer. That means I need to become acquainted with it... I assume that there are apps especially for Math... but I can't say to what extent.

### 3.2. Acceptance of TPC

The following sub-categories were derived from the technology acceptance literature (Davis, 1985; Davis et al., 1989; Fishbein & Ajzen, 1975; Venkatesh & Balal, 2008; Venkatesh & Davis, 2000; Venkatesh et al., 2003): (a) attitude towards TPC, (b) performance expectancy, (c) facilitating conditions, (d) effort expectancy, and (e) self-efficacy. In addition, a further category emerged during data analysis: (f) intended use, which was analyzed on the distinction between low-level and high-level technology use (Ertmer, 2005).

#### 3.2.1. Attitude towards TPC

For the purpose of our study the general attitude of teachers towards TPC can be grouped under three main categories. The detailed transcript data revealed that a majority of ten interviewees expressed a positive attitude towards TPC, while two respondents see themselves as open minded towards it.

Interview 2 (52–52): Positive. I think the students are excited... the more variety in classroom instruction the more students are able to concentrate.

Interview 6 (67–69): Positive. I think it is a good thing... because I find that the exposure to computers is absolutely contemporary.

In contrast a relatively big group of six respondents' attitude can be summarized as skeptical or critical towards TPC.

Interview 3 (82–82): To begin with skeptical... that the technology is running smoothly... very skeptical...

Interview 18 (68–68): In the context of learning and instruction I am quite critical about the use of TPC... My concern is that the iPads, in most cases, just replace the computer room... and iPads are very expensive...

Although a summary of the study's findings with regards to the general attitude towards TPC is helpful, a closer view of the data shows that in spite of a positive attitude there are considerable

reservations amongst these participants, which in turn influence their positive attitude. In one case a respondent's answer was clearly positive, whereas another respondent expressed the need to know more about the technology itself. In another case the response suggested reservations about the technical infrastructure. The subject's attitude is clearly positive once the technical infrastructure is running. However, at present there are too many obstacles and problems hindering the usability of TPC.

Interview 11 (68–75): Some things are still unclear... How do I charge the iPads? Do I have to plug in 32 iPads into 32 plugs or work with extension leads? That's too time consuming... that is not realistic for a school... And then the software does not work properly... that has not worked yet... the technical infrastructure does not run yet...

Accordingly a respondents' argument clearly indicated that a once positive attitude shifted rather to the opposite due to the required effort and time with regards to the technical infrastructure. An untypical example was that of a female interviewee who changed from a negative to a positive attitude due to a changing mode of use at the school. She didn't support the original approach to distribute a set of TPCs to one class only. The change in her attitude was triggered by a modification of this mode of use in favor of a project-oriented approach which allows a variety of classes and teachers to use TPC. Two respondents expressed an open attitude towards TPC but indicated some curiosity about the durability of TPC in a school context and some skepticism about the implementation of TPC within large classes.

Interview 13 (70–70): Still relatively open... admittedly with certain skepticism on how to implement this in a large class.

In contrast six respondents expressed a rather skeptical attitude. As well as concerns about the applicability across subjects, the technical infrastructure complemented by the associated effort and the lack of experience and knowledge about the availability of educational applications have been mentioned as the main causes for the respondents skepticism. Regardless of the initial orientation the individual attitude towards TPC seems to be under the influence of the technological infrastructure as well as individual knowledge about the applicability of the technology. Furthermore, it seems remarkable that already in the initial stages of the implementation of TPC in classroom instruction the attitude of two respondents has shifted due to the changed mode of use on one hand and by perceived technical problems on the other hand.

Interview 11 (67–67): Generally, I had a rather positive attitude. But now when I see what was promised... what kind of workload my colleague has... I must say now, it has almost turned into the opposite...

Interview 16 (76–76): As we heard at the beginning that we should get iPads, it wasn't clearly project focused. It was said that one class would get them over the whole school year... I was against it, because I think our students do not read enough as it is and should rather use a book once in a while... But now, using the iPads occasionally is great... and I believe that our students will have fun and will be motivated...

#### 3.2.2. Performance expectancy

With regards to the performance expectancy of TPC for learning and instruction only a minority of respondents believed that learning and instruction could be improved due to TPC. In four cases respondents hoped to improve their classroom practice through TPC.

Interview 9 (58–60): I hope that the quality of learning and instruction reaches a higher level... Yes, I expect it... I imagine

that there are good applications for foreign languages. . . I think that it can lead to a better quality. . .

This point of view was rather based on beliefs and hopes than experience or knowledge about the technology. In contrast two respondents clearly deny any positive impact of TPC for classroom instruction.

Interview 11 (46-50): No, actually no. . . what I intent to do is mainly research on the internet, and less the creation of things. . . looking at the work and effort I need to distribute and collect the iPads . . . in the same time I can go to the computer room and do the same. . .

The biggest group of six respondents sees TPC as addition to existing classroom practice. One respondent expressed the idea of having the possibility of a greater variation with regards to learning and instruction, while another respondent sees, at best, the advantage of TPC reduced to a simplification of daily routines by getting internet connection into the classroom instead of moving with the whole class to the schools' computer room. Indeed, there have been some indications that there are uncertainties with regards to the impact of TPC on learning and instruction due to a lack of knowledge about available applications. For example, one respondent reported that he did not know whether he could improve learning and instruction through TPC since it depends on the quality of available applications.

Interview 14 (71-71): Whether a qualitative improvement is possible, I do not know. . . In any case it will be more varied if one uses different media and methods. But about the quality I do not know. That depends on the applications.

Another five respondents could not give any indication yet due to a lack of experience. Complementary to these findings are the respondents' ideas expressed about the intended use of TPC. Fifteen interviewees had no clear idea yet how to integrate TPC into their classroom practice and had only rudimentary knowledge about available applications for their subject.

Interview 2 (34-34): As I said before, I have not considered yet, how I could use it at school. . . I mean, to do some research or to go online one can use the computer room as well. . .

Interview 8 (40-40): I cannot tell, since I do not know the iPad and the possibilities it offers. . . So it depends on the possibilities. . . If it offers good opportunities I can imagine using it quite frequently. . .

Where a concrete intention of usage was expressed it was either Internet research or the use of e-books. Only one respondent intended a higher-level-use (Ertmer, 2005) by inventing an TPC music band. This provides the indication that for many teachers it is still unclear how TPC can improve learning and instruction.

### 3.2.3. Facilitating conditions

For all respondents, the technical infrastructure is a prerequisite for technology use and is associated with being provided by school authorities. Being asked if she needs support using TPC a 36 year old female teacher replied that use of a technical device such as TPC means to actually being able to utilize it. The minute any soft- or hardware problems arise, she would not be able to handle respectively solve the problems but at the same time would not be interested in solving the problems anyway. She adds further, that in the case of technical problems she will simply stop using the device and return to conventional teaching practice.

Interview 14 (50-50): I assume utilizing means to use it. . . And I don't need support to use an iPad which is applicable. . . as soon

as there is a software or hardware problem I am stuck. . . I do not want to be engaged in any technical problems. . . If any technical problems arise, I put it aside and do not use it anymore. That's it.

Another respondent expresses it more positive, but claims a clearly negative effect on the quality of learning and instruction if any technical problems arise. One of the schools' network administrators, a 36 year old male teacher, goes so far as to assert, that the technical infrastructure is a key element for a successful integration of TPC. In summary, collected data show a consentaneous picture in terms of the necessity of a smoothly running infrastructure. This provides a strong indication that for a successful acceptance of this technology a technical infrastructure needs to be in place.

In addition, most respondents expressed the need of a more comprehensive support system, which goes beyond technical aspects and encompasses instructional aspects as well. For example, a 47 old male teacher, who describes himself as a person having a rather low affinity to technology, expressed not only the need for technological assistance but instructional assistance as well. Similarly, a 37 year old female teacher would appreciate an introductory training course, otherwise she expects a prolonged period of time to familiarize and adjust herself to the use of TPC. She bases her argument on her limited knowledge about the technology which would push her quickly to her boundaries.

Interview 5 (45-45): Without any support it would prolong the process of applying the iPad for learning and instruction, because I would have to train myself which, due to my knowledge, would lead me quickly to my limits . . . where I could not make my teaching practice easier, because I do not know how. . . it would be great to have an introductory course, to get to know the scope. . .

Moreover, identifying appropriate applications for certain subjects and content was seen as a being critical in terms of intended use of TPC.

Interview 1 (42-44): First of all I have to choose appropriate applications. . . of course, there is no reference to it in school books or the curriculum. . . the teachers working with the iPad have the intention to meet once a week for an exchange. . . With 400000 applications, or something, it is very difficult to keep an overview. . . of course it would be great having a concept ready, telling you that you need these 20 applications. . . it would save a lot of work and time. . .

One reason was seen in a somewhat unclear and confusing market supply with thousands of educational applications on offer, but of which not all of them have a profound educational value (Murray & Olcese, 2011). As a 40 year old male teacher commented, it is not easy to keep an overview over thousand of applications and it would be nice to have a designed concept which already links applications to school curriculum. The same teacher added that this would save valuable time, especially since teachers get no temporal relief with respect to their teaching time and hence the project stands and falls with the commitment of the teachers.

Overall ten teachers expressed the need of a support system, while three respondents claimed to need support only sporadically and a further five respondents expressed enough confidence to use TPC without the need of any support. It is worth to mention, that these participants are quite confident to use TPC without the need of assistance, but at the same time only intent a low-level-use of this technology (e.g., Internet research).

### 3.2.4. Effort expectancy

While all 18 respondents did refer to a functioning technical infrastructure as a prerequisite to integrate TPC into classroom practice, a high proportion of those interviewed consider the use

of the actual device as reasonably free of effort. Being questioned if they expect to quickly familiarize and acquire the ability to use TPC in classroom instruction, a majority of 14 respondents' replies indicate a strong persuasion about the ease of use of TPC. For instance, a 42 year old male teacher sees absolutely no problem in the handling of the device for either teachers or students, but points out that his opinion is based on the assumption that the technical requirements are met, which is not the case at his school yet. Similarly, a 32 year old female teacher's response was a straight yes, as with most of the interviewees. However, it is remarkable that participants did refer to technical aspects of the device only, but did not relate the question to instructional aspects at all. Whether this is because teachers do not consider changing their mode of instruction and in consequence simply focused on the technical device cannot be resolved conclusively at this point.

In contrast to the above, four respondents are less confident and are rather unsure about how much effort it will take them to utilize TPC. A 38 year old male teacher is not quite sure how quickly he will come to terms with TPC in a classroom context. Although he did not specify any reasons for this, he emphasized elsewhere in the interview, that he has only rudimentary experience with TPC and certainly will depend on assistance at least in the initial stages of the project. Very similar to this, a 47 year old male teacher shows some uneasiness since he is not technologically adept. But interestingly enough he highlights that not the device itself is of importance but the availability of suitable applications.

Interview 4 (38–38): I'm not sure if I can easily use the iPad. . . I have not much of a technical affinity. . . momentarily I am a bit skeptical since it is not the device which is crucial but applications or programs available. . . if I do not have any I do not see an advantage over notebooks. . .

An interesting case is a 36 year old teacher, which not only supports the schools network administrator but also teaches IT as a subject teacher. Consequently, one could assume that based on his technical affinity and knowledge he would expect the use of TPC as relatively free of effort. In his response he said that he would hope so, which clearly reveals a certain degree of uncertainty. A more profound inquiry revealed that due to his post as assistant network administrator he experienced a great deal of technical problems with regards to the technical infrastructure, which influenced his estimation towards effort expectancy. But at the end it turned out, that he believes to use TPC relatively free of effort, once the technical problems at his school have been solved.

### 3.2.5. Intended use of technology

Classroom teachers are the ultimate authority deciding whether and how to use TPC (Ertmer, 2005). In accordance with the technology acceptance literature it can be assumed that teachers are hesitating to use TPC when they do not see any benefits to their job performance since performance expectancy is the key determinant of the intention to use a certain technology (see Venkatesh & Davis, 2000; Venkatesh et al., 2003). Therefore, to what degree teachers already have conceptions or imaginations about integrating TPC into classroom practice in the early stages of technology integration was examined. It appeared that due to the early stages of the project, respondents' intention to use TPC was somewhat inexplicit and imprecise. While some teachers did not get engaged yet, others expressed vague ideas, while a minority of respondents could already articulate a somehow clear vision of TPC use in specific subjects. Thus, a 40 year old male teacher admitted that he did not get engaged yet with TPC and that he has no idea which benefits TPC offers beyond the schools well equipped computer rooms.

Interview 2 (50–50): It is not just quite clear to me what benefits the iPads offer over our two well equipped computer room-

s. . . Of course I cannot use the computer rooms at all time- s. . . which might be an advantage of the iPads. . . apart from that I do not see an advantage, because I have not looked into any applications yet.

But he also pointed out that he did not want to use TPC too often since his students are highly exposed to digital media anyway and he made clear to be an adherent of conventional school books and text, a notion which was stressed by several teachers across the three schools.

The vast majority of respondents expressed some implementation possibilities, but they were still not very specific. This is evident for example in the statement of a 26 year old female teacher who intends to let her students' work independently with TPC to create a certain output but could not explain her ideas more concretely. Similarly, a 38 year old male teacher wants to use TPC in his German lessons enabling students to quickly look up things and do some research on the Internet. As a general pattern, Internet research was the dominant form of intended application expressed by the interviewees.

Interview 12 (56–56): . . . and partly do some research on the internet. It would be great, if that were possible. . .

Further, under the assumption that there are relevant applications, a 44 year old female teacher intends to use these applications in mathematics to somehow fill gaps. But once more, a detailed and specific concept of how it could be integrated into subject content and be linked to the schools' curriculum could not be made.

In three cases, respondents expressed to use TPC for project purposes. But in all three cases respondents could not say, whether TPC would be used either for word processing and Internet research or for a higher-level technology. What seems remarkable is the fact that in all three cases participants are teaching at the school, which has got only one class set of TPC at disposal. This raises the question whether this influenced participants' responses since it was officially communicated that the mode of usage at this school would be for project purposes.

On a positive note some teachers had already more concrete ideas. A 40 year old male teacher wants to form a TPC band in his music class while a 32 year old female teacher intends to use comic live in her German class.

Interview 1 (54–54): . . . specially in music. . . my dream would be to have a small iPad band. . . playing the drums and guitars on their iPads. . .

An exceptional situation is found in the one school where TPC is used as a means of integrating physically disabled pupils in regular lessons. As a consequence, a 47 year old male teacher states that he will use TPC on a daily basis since the disabled pupil he is in charge of will use it as a substitute of a school book.

Interview 4 (64–64): For this disabled student on a daily basis. . . since he will use it instead of an exercise book. . .

### 3.3. Expectations

Within the third category our intention was to examine teachers' expectations linked to TPC integration. Teachers' expectations were analyzed according to the following sub-categories: (a) students' performance, (b) student motivation, and (c) expected problems.

#### 3.3.1. Students' performance

With regards to improving students' performance the data revealed an inhomogeneous and diverse picture. About a third of

the teachers questioned belief that students' learning outcomes will not be affected by TPC. One of those respondents does not expect much change in students' performance and argues that students with previously good results will do well through TPC and students with poor results won't do better through TPC.

Interview 10 (88-88): I do not believe that there will be a big change... I think students who worked well with a computer will do well with an iPad... students who previously did not perform well, will not do so well with the iPad either...

In another case it was pointed out that the use of TPC might raise students' motivation but it will not make them "little Einsteins". In contrast some other teachers see the possibility to improve students' learning outcomes. One respondent claims that whatever new method he adds to his classroom practice is aimed at improving students' learning. Another teacher sees the possibility to reintegrate those students who switch off during normal classes by giving them a chance to present themselves in a positive way through TPC. Especially for students with a low self-esteem but good computer skills TPC might be beneficial. Some other teachers though show a rather observing and reserved attitude with regards to improving students' learning outcomes.

Interview 13 (80-80): ... I think that a different kind of student has the chance to show, what they are capable of... especially students, who switch off during regular lessons but might be competent with computers... have the chance to come forward a little bit...

The responses suggest that the reasons for this lie in particular in a lack of knowledge about the quality of available applications. Further responses point out that the distracting effects of such a device might hinder learning processes at least in the initial stage of use. Of particular interest is that most teachers attribute a higher learning motivation of their students' on the basis of TPC usage.

### 3.3.2. Student motivation

In accordance with the interview guide, interviewers did not ask explicitly about teachers' expectations concerning the impact of TPC on students learning motivation. Nevertheless, eleven participants expect a positive impact on students' learning motivation due to TPC and given the importance of motivation for learning it seems meaningful to refer to this aspect. For example a 40 year old male teacher anticipates that students are generally more motivated, more motivated with regards to school subjects and content through the integration of TPC in classroom practice.

Interview 1 (64-64): I expect that students are in general more motivated, motivated for the topic and the subject... the students motivation is very important to me... normally our students attitude towards school is not very positive...

A 37 year old female teacher expressed similar thoughts and assumes that it is more attractive and motivating for pupils to perform set tasks on TPC rather than resorting to a school book. Only one person expressed a contrary opposite point of view and cannot imagine that a desired learning motivation can be enhanced by a technical device.

Interview 4 (88-88): ... if it should succeed, what I cannot imagine, to increase students motivation through the combination of desired content with a technical device... that would be a success... but do not believe in it...

### 3.3.3. Expected problems

The main source of problems associated with the use of TPC was technology related. A great diversity was apparent as respondents

referred to many different technological aspects ranging from a smooth running of the general technological infrastructure, to the lack of USB connection, to the synchronization of TPC. For instance, a 42 year old male teacher the problems to set up the technical infrastructure are pushing his school already to its limits. Similar arguments are expressed by a 47 year old female who added that it is still unclear how to recharge the devices which seems too time consuming anyway and not realistic for a school environment. For a 38 year old female teacher the lacking USB-port seems a huge problem and even questions the possibility of working continuously without it.

Furthermore, concerns were raised by five respondents about the likelihood of damaging TPC and the financial expenditure associated with the technology. Less frequently mentioned were problems regarding an immense effort required to integrate TPC, classroom management, distraction of students, legal issues, colleagues refusal to use TPC, and negative effects of TPC with regards to writing skills.

Interview 5 (71-71): ...when it comes to exclusivity... then I find it a bit dangerous, because writing and spelling skills are more sustainable writing with a pen. When I type everything, I do not learn any spelling...

## 4. Discussion and conclusion

In general, TPC is a relatively new technology with a potential to support students' learning processes (Wise et al., 2006). But whether the promised benefits of this technology can be realized in a school environment depends whether teachers will accept this technology and integrate it into classroom practice. Although research on the acceptance of technological innovations is not new, only limited evidence exists about the acceptance of technology in schools (El-Gayar et al., 2011). Yet, without a clear understanding of how and why teachers accept or reject technology in classroom practice, the full integration of technology as advocated by constructivism seems difficult.

The findings presented in this paper depend on a very small and specific group of 18 respondents due to the limitations of this pilot project and due to the still marginal distribution of TPC in German schools. This can be cause of criticism for our qualitative approach (Kidd, 2002). Despite the restrictions caused by the homogenous sampling approach we chose, our findings provide insights into key factors influencing teachers' acceptance of TPC in a k-12 classroom setting.

Our results address many of the aspects discussed in the technology acceptance literature (Davis, 1985; Davis et al., 1989; Venkatesh & Balal, 2008; Venkatesh & Davis, 2000; Venkatesh et al., 2003). Diversity is apparent not only in the attitude of teachers towards the technology, but also with regards to the performance expectancy and the facilitating conditions. A significant outcome is that only a minority of respondents believe in improving learning and instruction through the use of TPC. According to Venkatesh et al. (2003), performance expectancy is the strongest predictor of behavioral intention and refers to the individual belief that using a specific technological innovation will help to improve job performance. But the findings of this paper show that for most participants it is not quite clear how TPC can be used as an innovative tool to facilitate learning and instruction. Even in cases where participants assume a positive impact, their opinions are based on assumptions rather than on secure knowledge and experience. Similarly, responses referring to expected impact on students' performance showed a quite inhomogeneous picture. During our interviews it became clear that even respondents with a generally positive attitude towards TPC had considerable reservations while others are clearly skeptical about this technology. Even though the

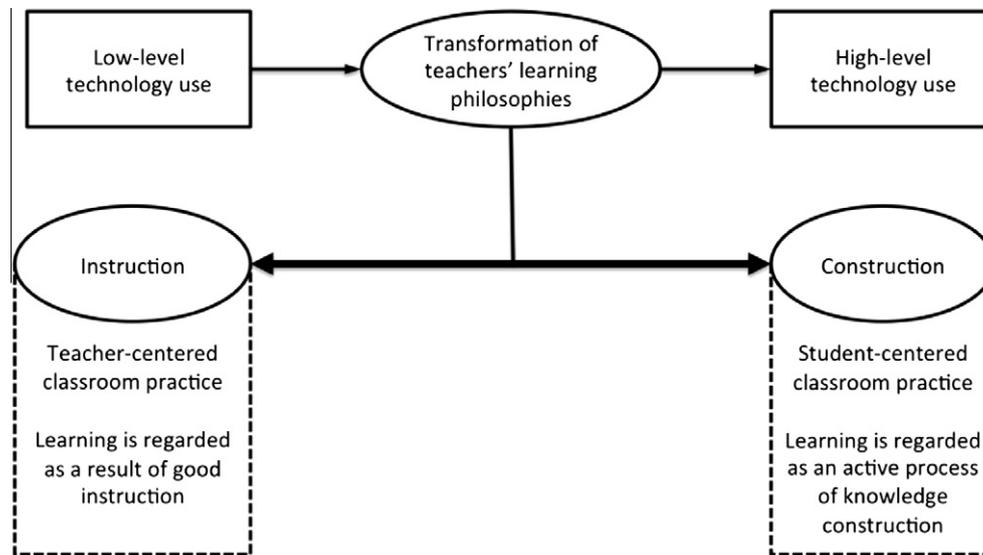


Fig. 2. Connection between learning philosophies and a high- and low-level technology use (adapted from Hooper & Rieber, 1995).

construct attitude is not part of the original UTAUT model (Venkatesh et al., 2003) other studies found it to be a stronger predictor on the intention to use a certain technology than the construct performance expectancy (Moran et al., 2010).

Furthermore, there were some indications that respondents' attitude are, at least in the early stage of technology integration, capable of being influenced by certain factors. Influencing the attitude can be both positive and negative of nature. Furthermore, all teachers interviewed expressed the need of a smoothly running technical infrastructure as a prerequisite for TPC use and a majority of respondents need a supporting infrastructure while using TPC in classroom instruction. In fact, the degree and intensity of support needed varied considerably amongst individual teachers. Reasons for this could be a pre-experience of different intensity with TPC as well as a varying degree of technology affinity amongst teachers, which might lead to a situation where teachers with a lesser affinity to TPC maintain traditional classroom practices out of fear from a lack of technical support while integrating TPC into teaching. This is complimented by the fact, that participants' intentions to use TPC were merely focusing on backing up existing classroom practice rather than transforming current teaching practice. As such, in only two cases we found indications of a high-level-use of TPC (Cuban, Kirkpatrick, & Peck, 2001). These findings are not surprising since it takes some years to accumulate relevant expertise (Becker & Ravitz, 1999). This leads to the assumption that a persistent use of TPC could lead to a change in teachers' practices (Ertmer, 2005). Whether this may be true is subject to future research. But considering the moderating effect of teachers experience as advocated by the UTAUT model (Venkatesh et al., 2003), it might be worthwhile to investigate this by using a longitudinal perspective.

One particularly interesting aspect would be the transformational process of teachers' learning philosophies linked to specific type of technology use as shown in Fig. 2, because teachers' technology integration needs to go not just beyond utilization, but will go along a change in their concept about a teacher's role in classroom instruction (Hooper & Rieber, 1995).

If teachers develop expertise over a prolonged period of time to apply a high-level technology use, then this might lead to a change towards a student oriented teaching practice. Whether this transformation process is actually happening and under which conditions is subject to further research. Furthermore, research can focus on the question how the above mentioned process can be support mecha-

nisms, might have a positive impact on teachers' experience, and hence support a successful integration of TPC. This includes opportunities for teachers to gain sufficient technology skills.

#### Acknowledgements

Funding for this research was provided by the University of Mannheim and the city of Mannheim. We thank our student research assistant Sarah Neitzel for her assistance in the transcription of the interview protocols and in the analysis of the data.

#### References

- Banister, S. (2010). Integrating the iPod Touch in K-12 education: Visions and vices. *Computers in the Schools*, 27(2), 121–131. <http://dx.doi.org/10.1080/07380561003801590>.
- Bauer, J., & Kenton, J. (2005). Toward technology integration in schools: Why it isn't happening. *Journal of Technology and Teacher Education*, 13(4), 519–546.
- Becker, H. J., & Ravitz, J. (1999). The influence of computer and Internet use on teachers' pedagogical practices and perceptions. *Journal of Research on Computing in Education*, 31(4), 356–384.
- Bonds-Raacke, J., & Raacke, J. D. (2005). Using Tablet PCs in the classroom. An investigation of students' expectations and reactions. *Journal of Instructional Psychology*, 35(3), 235–239.
- Bortz, J., & Döring, N. (2006). *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler*. Berlin: Springer.
- Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: Students' experiences in learning to integrate technology in instruction. *Journal of Technology and Teacher Education*, 14(3), 599–621.
- Bürg, O., & Mandl, H. (2004). Akzeptanz von E-Learning in Unternehmen (Forschungsbericht Nr. 167). München: Ludwig-Maximilians-Universität, Department Psychologie, Institut für Pädagogische Psychologie.
- Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, 38(4), 813–834.
- Davis, F. D. (1985). Technology Acceptance Model for empirically testing new end-user information systems: Theory and results. Doctoral Dissertation, Massachusetts Institute of Technology, Cambridge, MA.
- Davis, F. D., Bagozzi, R. D., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8), 982–1003.
- Dillon, A., & Morris, M. G. (1996). User acceptance of new information technology - theories and models. In M. Williams (Ed.), *Annual review of information science and technology* (Vol. 31, pp. 3–32). Medford, NJ: Information Today.
- Drucker, M. J. (2006). Commentary: Crossing the digital divide: How race, class, and culture matter. *Contemporary Issues in Technology and Teacher Education*, 6(1), 43–45.
- El-Gayar, O., Moran, M., & Hawkes, M. (2011). Students' acceptance of Tablet PCs and implications for educational institutions. *Educational Technology and Society*, 14(2), 58–70.
- Enriquez, A. G. (2010). Enhancing student performance using Tablet computers. *College Teaching*, 58(3), 77–84. <http://dx.doi.org/10.1080/87567550903263859>.

- Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, 53(4), 25–39.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Franklin, C. A., & Molebash, P. E. (2007). Technology in the elementary social studies classroom: Teacher preparation does matter. *Theory and Research in Social Education*, 35(2), 153–173.
- Galligan, L., Loch, B., McDonald, C., & Taylor, J. A. (2010). The use of tablet and related technologies in mathematics teaching. *Australian Senior Mathematics Journal*, 24(1), 38–51.
- Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, 55(3), 223–252.
- Hooper, S., & Rieber, L. P. (1995). Teaching with technology. In A. C. Ornstein (Ed.), *Teaching: Theory into practice* (pp. 155–170). Needham Heights, MA: Allyn and Bacon.
- Hughes, J. E., & Ooms, A. (2004). Content-focused technology inquiry groups: Preparing urban teachers to integrate technology to transform student learning. *Journal of Research on Technology in Education*, 36(4), 397–411.
- Ifenthaler, D., & Eseryel, D. (in press). Facilitating complex learning by mobile augmented reality learning environments. In R. Huang, J. M. Spector & Kinshuk (Eds.), *Reshaping learning: The frontiers of learning technologies in a global context*. New York: Springer.
- Kelle, U., & Kluge, S. (1999). *Vom Einzelfall zum Typus: Fallvergleich und Fallkontrastierung in der qualitativen Sozialforschung*. Opladen: Leske + Budrich.
- Kerawalla, L., O'Connor, J., Underwood, J., du Boulay, B., Holmberg, J., Luckin, R., et al. (2007). Exploring the potential of the homework system and Tablet PCs to support continuity of numeracy practices between home and primary school. *Educational Media International*, 44(4), 289–303. <http://dx.doi.org/10.1080/09523980701680904>.
- Kidd, S. A. (2002). The role of qualitative research in psychological journals. *Psychological Methods*, 7(1), 126–138. <http://dx.doi.org/10.1037/1082-989X.7.1.126>.
- Koile, K., & Singer, D. (2008). *Assessing the impact of a Tablet-PC-based classroom interaction system*. Paper presented at the Proceedings of the workshop on the impact of pen-based technology on education (WIPTe), West Lafayette, IN.
- Kuckartz, U. (1999). *Computergestützte Analyse qualitativer Daten. Einführung in Methoden und Arbeitstechniken*. Opladen: Westdeutscher Verlag.
- Lornsen, T. (2010). Online assignments: Free Web 2.0 tools in German language classes. *Die Unterrichtspraxis/Teaching German*, 43(2), 194–204. <http://dx.doi.org/10.1111/j.1756-1221.2010.00080>.
- Ludwig, L., Mayrberger, K., & Weidmann, A. (2011). Einsatz personalisierter iPads im Unterricht aus Perspektive der Schülerinnen und Schüler. In S. Friedrich, A. Kienle & H. Rohland (Eds.), *DeLFI 2011: Die 9. e-Learning Fachtagung Informatik* (pp. 7–17). Dresden: TUDpress.
- Moran, M., Hawkes, M., & El-Gayar, O. (2010). Tablet personal computer integration in higher education: Applying the unified theory of acceptance and use technology model to understand supporting factors. *Educational Computing Research*, 42(1), 79–101. <http://dx.doi.org/10.2190/EC.42.1.d>.
- Murray, O. T., & Olcese, N. R. (2011). Teaching and learning with iPads, ready or not? *TechTrends*, 55(6), 42–48. <http://dx.doi.org/10.1007/s11528-011-0540-6>.
- Quiring, O. (2006). Methodische Aspekte der Akzeptanzforschung bei interaktiven Medientechnologien. *Elektronische Publikationen der Universität München. Kommunikations- und Medienforschung. Münchner Beiträge zur Kommunikationswissenschaft Nr.6*. <<http://epub.ub.uni-muenchen.de/archive/00001348>>.
- Reynolds, R. (2011). Trends influencing the growth of digital textbooks in US higher education. *Publishing Research Quarterly*, 27(2), 178–187. <http://dx.doi.org/10.1007/s12109-011-9216-5>.
- Rogers, E. M. (2003). *Diffusion of innovations*. New York: Free Press.
- Simon, B. (2001). *Wissensmedien im Bildungssektor. Eine Akzeptanzuntersuchung an Hochschulen*. Dissertation, Wirtschaftsuniversität Wien. <<http://epub.wu.ac.at/1869/1/document.pdf>>.
- Teo, T., Lee, C. B., & Chai, C. S. (2008). Understanding pre-service teachers' computer attitudes: applying and extending the technology acceptance model. *Journal of Computer Assisted Learning*, 24, 128–143. <http://dx.doi.org/10.1111/j.1365-2729.2007.00247.x>.
- Trouche, L., & Drijvers, P. (2010). Handheld technology for mathematics education: flashback into the future. *ZDM*, 42, 667–681. <http://dx.doi.org/10.1007/s11858-010-0269-2>.
- Twining, P., & Evans, D. (2005). Should there be a future for Tablet PCs in schools? *Journal of Interactive Media in Education*, 20, 1–8.
- van Orden, S. (2006). Using a Tablet PC in the German classroom to enliven teacher input. *Die Unterrichtspraxis/Teaching German*, 39(1–2), 109–112. <http://dx.doi.org/10.1111/j.1756-1221.2006.tb00022.x>.
- Venkatesh, V., & Balal, H. (2008). Technology Acceptance Model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273–316.
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), 186–204.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478.
- Weisberg, M. (2011). Student attitudes and behaviors towards digital textbooks. *Publishing Research Quarterly*, 27(2), 188–196. <http://dx.doi.org/10.1007/s12109-011-9217-4>.
- Weitz, R. R., Wachsmuth, B., & Mirliss, D. (2006). The Tablet PC for faculty: A pilot project. *Educational Technology and Society*, 9(2), 68–83.
- Wise, J. C., Toto, R., & Lim, K. Y. (2006). *Introducing Tablet PCs: Initial results from the classroom*. Paper presented at the 36th Annual ASEE/IEEE Frontiers in Engineering Conference, Chicago, IL.