"It's good because he said so" — The Effects of Pre-Service Teachers' Passive vs. Constructive Engagement on Technology Acceptance

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Abstract: Pre-service teachers' rather suboptimal use of technology in teaching may be explained by low levels of technology acceptance. We assumed that encouraging pre-service teachers to constructively engage with information about technology rather than passively reading information about tools should increase their perceived usefulness (PU), perceived ease of use (PEU) and intention to use (ITU). *N*=53 pre-service teachers were either asked to read a blog post about the potential of a mind mapping tool (passive condition) or to work on small tasks that covered the same informational aspects as the blog post (constructive condition). Contrary to our assumptions, reading a blog post significantly contributed to pre-service teachers' PEU and PU (in tendency) compared to working constructively on open-ended tasks. The results also suggest that it may be necessary to differentiate between the learning activity that is prompted and the activity that is performed. Possible explanations for these effects will be discussed.

Introduction

Digital technology is attributed great potential to facilitate student learning in the classroom. For example, quiz apps can help to incorporate activities that are associated with higher levels of engagement and knowledge change processes of the learners (Sung et al., 2016). However, teachers only partially make use of technology affordances to engage students in high-level learning activities (Sailer et al., 2021).

In the past two decades, a number of researchers have sought to determine what may prevent teachers from an effective use of digital technology in the classroom (e.g., Eickelmann & Vennemann, 2017; Ertmer & Ottenbreit-Leftwich, 2010). For example, low technological pedagogical content knowledge can lead to teachers not using digital technology in a way that is beneficial for learning (Pamuk, 2012; Joo et al., 2018). Also, a possible lack of technology acceptance might be a potential factor of maladaptive use of digital technology, and prior research seems to support this concern (Backfisch et al., 2021). In addition, German teachers in particular show less positive attitudes than teachers from other countries regarding the results of learning with digital technology (Fraillon et al., 2019).

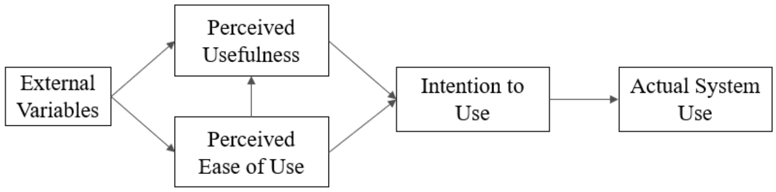
Therefore, since intervention studies that target pre-service teachers' technology acceptance are rare (Kale, 2018), the objective of this study is to determine how pre-service teachers' technology acceptance may be promoted when engaging with information about a particular digital tool. More precisely, the aim is to investigate whether having pre-service teachers engage in different kinds of learning activities (passive vs. constructive; see Chi & Wylie, 2014) while interacting with information on a particular digital tool has differential effects on their technology acceptance.

The technology acceptance model (TAM)

The design of appropriate learning opportunities may be informed by the Technology Acceptance Model, originally developed by Davis (1986). It points to users' perceived usefulness (PU) and perceived ease of use (PEU) of a technology as relevant factors that influence both the intention to use a certain digital technology and its actual use, with the perceived ease of use having a direct influence on perceived usefulness (see Fig. 1).

Davis defined perceived usefulness (PU) as the degree to which a person believes that using a particular technology would enhance her/his job performance. In the case of teachers, Scherer et al. (2015) showed that teachers found those tools useful that promoted learners' interest and learning outcomes. In contrast, perceived ease of use is defined as the degree to which the person believes that using the particular technology would be free of effort (Davis, 1986), for example, whether a teacher finds the user interface of a tool easy to understand. Both beliefs were hypothesized to be directly influenced by external variables (Venkatesh & Davis, 2000), such as system features or user training (Chuttur, 2009; Venkatesh & Davis, 1996).

Figure 1
Technology Acceptance Model (Venkatesh & Davis, 1996)



Existing research indicates that pre-service teachers' perception of the usefulness and ease of use of particular tools predicts their intention to incorporate them in their future teaching (e.g., Joo et al., 2018; Scherer & Teo, 2019). An extended form of the TAM with PU, PEU and subjective norm (i.e., perceived social pressure to perform certain behavior; Teo, 2010) explained about 43% of the variance for intention to use among Swedish pre-service teachers (Ma et al., 2005). Similarly, in a study by Teo (2009) in Singapore and Malaysia, TAM (PU, PEU and attitude towards computers) was able to explain 27% of the variance in pre-service teachers' ITU (Teo, 2009). Scherer et al. (2019) also found in a meta-analysis that TAM is applicable to both pre- and in-service teachers. For example, Sadaf et al. (2016) investigated predictors of student teachers' intention and actual use of Web 2.0 applications in a two-phase, sequential explanatory design with surveys ($N = 189$) and interviews ($N = 12$). They found that PU was one of the strongest predictors of intention to use and actual use of Web 2.0 applications. In addition, there was a significant positive relationship between intention and subsequent behavior of pre-service teachers (Sadaf et al., 2016). In a study by Yuen and Ma (2008), however, PEU was the only determinant to predict ITU.

Taken together, these results point to the importance of technology acceptance of digital tools for their actual use in the classroom. So far, however, research on how to positively influence the perceived usefulness and perceived ease of use of the technology, especially among pre-service teachers, is scarce (Kale, 2018).

Fostering pre-service teachers' technology acceptance with constructive learning activities

When teachers encounter digital tools that might support their teaching, they often do so on the Internet. For instance, there are websites and blogs that contain texts or videos that provide arguments for the effectiveness and usability of a given digital tool to be used in the classroom, such as "www.edutopia.org". In terms of TAM, such websites typically are designed in a way that is intended to facilitate the perceived ease of use and the perceived usefulness of the tool under scrutiny, for example by sharing the experiences of other teachers that report on their positive experiences with the tool.

From an instructional perspective, it however is questionable whether reading about the alleged advantages of a certain tool will be enough to positively influence the perceived usefulness and perceived ease of use on the side of a potential user of that tool. For example, based on the ICAP framework by Chi and Wylie (2014), it might be expected that having learners passively receive information about digital tools would probably be less effective than engaging them to productively interact with that information, for example by having them sort and weigh information about the tool in terms of its usefulness and ease of use.

More specifically, the ICAP framework defines cognitive engagement activities based on students' overt behaviors. It proposes that engagement behaviors can be categorized and differentiated into one of four modes: passive, active, constructive, and interactive (Chi & Wylie, 2014). The so-called ICAP hypothesis states that as students become more engaged with the learning materials, i.e., the more they move from an engagement in passive towards an engagement in interactive activities, the more their learning will increase, because each mode corresponds to a different set of underlying knowledge-change processes and a deeper understanding of the learning material. Thus, reading a website or a blog post would correspond to a *passive* learning activity. In this case, learners simply read a text or watch a video about a digital tool without doing anything else. This way, the received information is stored in an isolated fashion and not well integrated with existing prior knowledge (Chi & Wylie, 2014). In an *active* mode of engagement, learners manipulate the material, for example, by marking passages in the text. In this manner, prior knowledge is activated, and existing schemata may be completed. The new knowledge can then be applied in similar contexts, and there is a superficial understanding (Chi & Wylie, 2014). When learners engage in *constructive* learning activities, they create content that goes beyond the existing materials. This applies, for example, when learners draw concept-maps, take notes in their own words, or explain concepts. As a result, constructive activities are assumed to induce inference processes, whereby new information is integrated with prior knowledge. This way, a deeper understanding and transfer of the learning material can take place (Chi & Wylie, 2014). Finally, being *interactive* requires that learners refer to other learners' ideas, for example by arguing in dyads or small groups about a digital tool. This enables learners to generate new knowledge together through interaction and the opportunities for sharing feedback or ideas that come with it. According to the model, this activity has the potential for an in-depth understanding of the learning material and the greatest possibilities for developing new ideas together.

A study by Menekse et al. (2013) confirmed the ICAP hypothesis in a study with engineering students. They investigated the effects of all four modes of engagement on learning outcomes in a learning unit on atomic bonds and crystal structures. With respect to the comparison we intend to investigate in our study, the results showed that students' knowledge significantly increased in the constructive condition in which students were instructed to interpret a diagram that contained information from a text compared to the passive condition (in which students only read the text) from pre- to posttest. However, a few studies also suggest that under some circumstances, passive learning may be more beneficial for learning success. For example, MacDonald and Frank (2016) showed that learners perform better in sequences in which they first passively and then actively engage with the learning material than vice versa. For this reason, it is questionable whether higher-order learning activities as defined by the ICAP model are generally associated with higher learning success than passive learning activities. Even though the ICAP model does not focus on the effects of student engagement in these different kinds of activities on attitude change, but rather on knowledge acquisition, it is conceivable that a more comprehensive knowledge about the tool, such as its potential or application scenarios, might be positively related to technology acceptance. Therefore, student engagement in constructive activities should be beneficial for reaching higher levels of PU, PEU, and ITU. However, this has not yet been investigated in previous research. Thus, the aim of this study is to compare the effects of passive and constructive learning activities on the technology acceptance of pre-service teachers.

Research questions and hypotheses

In this quasi-experimental study, we provided pre-service teachers with information about a specific digital tool that might be used in the classroom to support student learning. We then created two experimental conditions: In one condition, students just read a blog post about the tool (passive condition), while in the other, students were instructed to perform six constructive tasks covering the same aspects as the blog post.

Consequently, our research question was: To which degree does an engagement in constructive learning activities while learning about the potentials of a certain digital tool (compared to an engagement in passive activities) have a positive effect on pre-service teachers' (1) PU and (2) PEU and (3) ITU of technology?

Based on ICAP, we assumed that because an engagement in constructive activities should result in deeper processing of information about the tool than an engagement in passive activities, student engagement in constructive compared to passive learning activities should contribute to higher perceived usefulness (H1), higher perceived ease of use (H2), and an increased intention to use the tool (H3).

Method

Participants and design

A total of 53 pre-service teachers participated, who were on average 22 years old (*M*Age = 21.42, *SD*Age = 4.18). The majority of our participants were in their second semester (*M*Sem = 1.94, *SD* = .99) and mostly female (approximately 69.8%). They took part in an online experiment that was embedded in a psychology lecture, which was compulsory for all students. They received course credit for participation. Establishing a 1x2 between-subjects design, students were randomly assigned to a passive or a constructive condition (*N*passive = 25, *N*constructive = 28). According to their allocation, participants in each condition had to carry out one passive or several constructive tasks related to a specific digital classroom tool (see below).

Procedure

After completing a survey that asked for demographic data, participants received basic information about an online collaborative mind mapping tool, called Coggle (https://coggle.it/). The user interface of the tool and an example for a mind map were shown. As a short description of its features, it was stated that Coggle can be used to generate collaborative mind maps in real time. This way, participants should get a rough idea of the tool, even if they were not familiar with it yet. After that, they were asked to rate its PU, PEU and ITU.

In a next step, all participants read a one-page text about the ICAP framework to help them understand the subsequently presented learning-related potentials of the tool. Then, participants in the *passive* condition were asked to read a blog entry of a fictitious teacher who described his personal experiences handling the tool and who addressed its usefulness by referencing the ICAP framework. In the *constructive* condition, participants worked on six, mostly open-ended exercises covering the same informational aspects as the blog entry. For example, in the first task of the constructive group as well as in the blog post, there was a labelled illustration of the user interface of the tool. Participants in the constructive condition were instructed to inspect the illustration and to describe the illustrated functions of the tool in a text field in their own words. In the blog post of the passive group, the functions are described in sentences by the teacher. Furthermore, in a second task, a diagram from an article by Menekse et al. (2013) about learning success in a knowledge test after performing different learning activities was presented. The constructive group was instructed to interpret the graph in their own words in the light of the ICAP model. The same graph was also included in the blog post. There, the teacher talked about the results of the study and described the graph. In addition, for example, participants in the constructive condition were instructed in another task to develop usage scenarios of the tool based on the ICAP model, whereas participants in the passive condition could read about the usage scenarios of the fictitious teacher in the blog post. In the posttest, participants rated their PU, PEU and ITU again.

Variables

The scales used to measure PU, PEU and ITU were adapted from Hu et al. (2003), Teo (2011) and Venkatesh et al. (2003) and were reformulated to fit the tool “Coggle”. Before and after the intervention, participants were asked to rate its PU (5 items, e.g., „Using Coggle would enhance my job performance“, Cronbach’s α=.90) and PEU (5 items, e.g., „I find it easy to get Coggle to do what I want it to do“, Cronbach’s α=.75) and ITU (4 items, e.g., „I intend to use Coggle in my lessons in the future”, Cronbach’s α=.84) on a Likert scale from (1) do not agree to (4) totally agree.

Statistical analyses

To examine our research question, we performed three separate mixed ANOVAs. The condition represented the between-subjects factor (passive vs. constructive), whereas the within-subjects factor was time (pre- vs. posttest). The alpha level of all analyses was set to 5%.

Results

Effects of engagement in passive vs. constructive activities on PU, PEU, and ITU

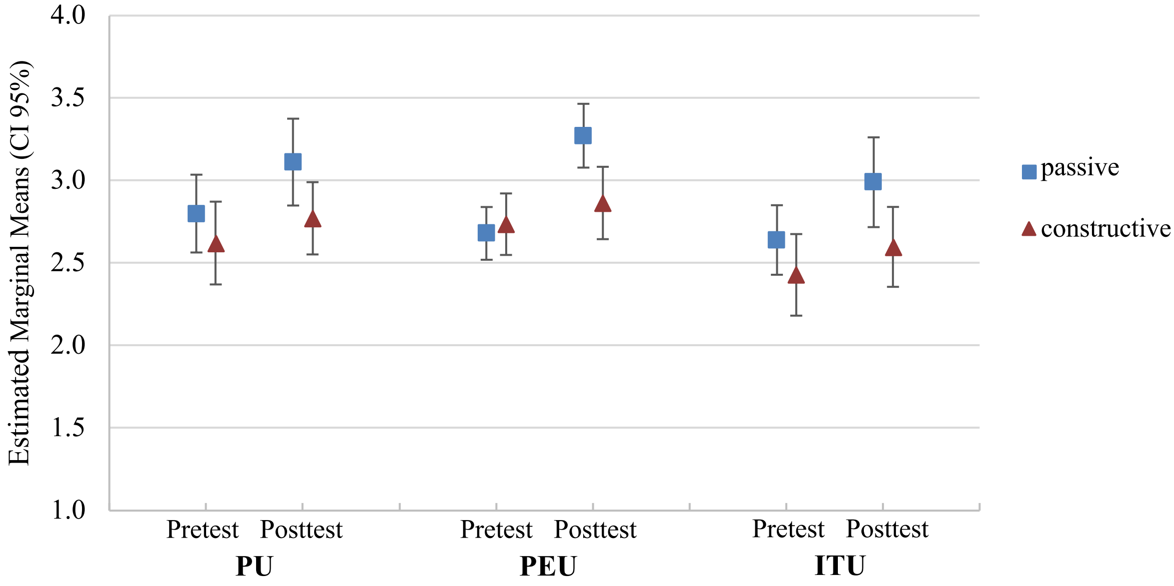
Concerning H1, figure 2 illustrates the descriptive statistics for PU for both groups. Descriptively, the means of both groups were higher in the posttest than in the pretest, and learners from the passive condition generally (i.e., both in pre- and posttest) displayed higher values of PU than learners from the constructive condition.

A mixed ANOVA with condition (passive vs. constructive) as between- and time as within-subject factor did not result in a significant interaction for PU, $F(1,51) = 1.15$, $p = .29$, partial $\eta^2 = .02$. A main effect of group was only significant by tendency in favor of participants in the passive condition, $F(1, 51) = 3.04$, $p = .087$, partial $\eta^2 = .06$. However, the increase of PU over time for both conditions was significant, $F(1, 51) = 9.38$, $p = .004$, partial $\eta^2 = .16$.

Regarding H2, figure 2 illustrates that PEU increased over time for both conditions, with a more pronounced increase from pre- to posttest in the passive condition. Subsequently, a mixed ANOVA with condition as between-subjects factor and time as within-subjects factor and PEU as dependent variable showed a significant interaction effect, $F(1,51) = 8.88$, $p = .004$, partial $\eta^2 = .15$, albeit in an unexpected direction. The simple main effect of condition was significant in the posttest, partial $\eta^2 = .14$ $p = .006$. The simple main effect of time was significant in the passive condition, $F(1, 24) = 44.95$, $p < .001$, partial $\eta^2 = .65$, but not in the constructive condition, $F(1, 27) = 1.08$, partial $\eta^2 = .04$, $p = .31$.

With respect to H3, figure 2 shows that ITU increased over time in both conditions. For ITU, an analogous mixed ANOVA with condition as between-subjects factor and time as within-subjects factor and ITU as dependent variable did not result in a significant interaction ($F(1, 51) = 1.15$, $p = .25$, partial $\eta^2 = .03$). However, the main effect of condition was significant, $F(1, 51) = 4.05$, $p = .05$, partial $\eta^2 = .07$, with students in the passive condition displaying a higher level of ITU than students in the constructive condition. There was a significant increase of ITU over time for both conditions ($F(1, 51) = 11.45$, $p = .001$, partial $\eta^2 = .18$).

Figure 2
Means and 95%-confidence intervals of PU, PEU and ITU by mode of engagement



Further analyses

Based on the hypotheses, these results were rather unexpected. Therefore, we wondered to what extent participants in the constructive condition actually engaged in constructive activities (N = 28). For this reason, we looked at how extensively the tasks in the constructive condition were actually carried out. As a first indicator, we found that the number of words in the first task significantly and positively predicted the change in PEU between pretest and posttest, $F(1, 26) = 5.98$, $\beta = .48$, $p = .02$, indicating that the more constructive students were, the more positive they rated the PEU of the tool. However, the prediction of the change in PU was not significant, $F(1, 26) = .94$, $\beta = -.39$, $p = .34$.

Discussion

The present study was designed to determine the effects of prompting pre-service teachers to engage in passive and constructive learning activities on their acceptance of a particular kind of technology. The literature on technology acceptance provides very little information on the question of how technology acceptance can be influenced (Kale, 2018). Based on the ICAP framework by Chi and Wylie (2014), we assumed that a constructive engagement with learning material about the digital tool would result in a higher technology acceptance than an engagement in passive activities when being confronted with the tool. Yet, at least at first sight, our results do not provide much evidence for this assumption.

Regarding hypothesis 1, no significant interaction between time and group on PU was found. Nevertheless, the significant effect of time on PU suggests that participants' PU improved significantly regardless of condition. Thus, on the basis of this result, an engagement in constructive activities does not seem to have larger effects on PU than an engagement in passive activities. Obviously, reading about a fictitious teacher's positive experiences regarding the usefulness of digital tools may already suffice to boost PU in the intended direction.

Concerning hypothesis 2, we found a significant interaction effect for PEU. Contrary to our expectations, however, reading a blog entry passively seemed to have a stronger positive effect on PEU compared to working constructively on open-ended exercises. Moreover, this effect can be considered large (Cohen, 1988). Interestingly, the examination of the simple main effect of time also shows that only passively reading the blog post resulted in a significant improvement in PEU, but not performing the constructive tasks.

Finally, with respect to hypothesis 3 for ITU, the results show no interaction effect. Yet, a significant effect of time and group could be observed. The effect of time again suggests that participants' ITU improved regardless of their condition. In other words, both passive and constructive learning activities thus might be related to an improvement in ITU. Moreover, this effect can again be regarded as large (Cohen, 1988). Presumably, this can be interpreted as a result of the fact that PU and PEU were supposed to predict ITU and that similar effects were observed in the previous analyses (e.g. Joo et al., 2018; Ma et al., 2005; Teo, 2009).

Consequently, contrary to expectations, for none of the factors PU, PEU or ITU did the constructive tasks have a larger effect than reading the blog post. The only interaction effect indicates that reading a blog entry passively seemed to have (at least partially) contributed to pre-service teachers' more positive technology acceptance as compared to working constructively on open-ended exercises, having a significant effect on a more positive PEU. Also, the effect of reading the blog post on PU tended to be almost significant.

However, these initially surprising results could be explained in several ways related to the assumptions of the ICAP model: First, there may be differences between (a) the activities that learners are instructed to perform and (b) the activities that they actually carry out (Vogel et al., 2017). For example, learners may have been instructed to constructively summarise the functions of the tool, but then might simply have copied the information. This in turn would mean that they did not work constructively, but rather actively. This might also be concluded on the basis of the preliminary analysis on word count. The opposite scenario is also conceivable: Even if the learners were instructed to merely read the text information, it is possible that they thought more deeply about the content, such as explaining it to themselves. This in turn would mean that they elaborated on the content more than the ICAP model would assume (Chi & Wylie, 2014). For this reason, it is possible that the participants in the constructive condition showed a lower level of engagement or in the passive group a higher level of engagement than actually assumed. Ultimately, the ICAP model only ever refers to a probability that certain visible activities are related to the corresponding (possibly more profound) learning processes. Chi and Wylie (2014) recommend that the outputs generated by the learners should be analysed in order to arrive at an indication of which activity was actually carried out. It is possible that further analysis of learner responses could be helpful in uncovering such discrepancies. Beyond that, it is likewise conceivable that in this case a certain sequence of learning activities, beginning with passive learning activities, are better suited to promoting technology acceptance, similarly as in terms of learning success (MacDonald & Frank, 2016).

Yet, there are further possible explanations for our findings: For example, it might be that the constructive condition imposed high cognitive load on students, with the effect that they might not have had sufficient opportunity to invest effort in elaborating the information about the tool, as following the task instructions might have been too strenuous to follow. Indeed, research shows that working on complex tasks without further instructional guidance is particularly ineffective when learners have little prior knowledge (Kalyuga et al., 2001; van Gog, et al., 2008), which might have been the case for our sample of (beginning) pre-service teachers. In this sense, the tasks of the constructive condition might be seen as complex tasks in which the learners have not received any additional support. In contrast, the elaborated blog post of a teacher about the potentials and the use of the tool might be considered as a worked example to the constructive tasks, in which participants in the constructive condition had to generate the corresponding knowledge themselves. In view of the present sample of students in the second semester with a supposedly low level of prior knowledge, a so-called worked example effect might have occurred in the passive condition (Renkl, 2014).

The low level of prior knowledge is accompanied by another challenge: students with little prior domain-specific knowledge tend to overestimate their competences (Dunning et al., 2003). If students only superficially engage in a topic, they may mistakenly think that they have already grasped the learning content, although this is not always the case (Renkl, 2014). It is possible that reading the blog post and the teacher's explanations gave the students the impression that they had already comprehended the affordances of the tool. For this reason, the passive learners might underestimate the challenges occurring when using the tool and overestimate the PU or PEU of the tool accordingly. Consequently, future studies should control for learners' prior knowledge and assess their cognitive load. In light of this reasoning, it would then also be thinkable that the actual use in the classroom differs in a similar way and is, for example, associated with greater difficulties.

Limitations and conclusions

Of course, this study is not without limitations. Besides our rather small sample size, it is important to note that we exclusively used subjective data. Thus, we do not know whether students who indicated a high ITU would actually use the tool in their classrooms more often than students with lower levels of ITU. Second, applying ICAP (which actually focuses on learning processes and outcomes) on the build-up and change of attitudes might be an inappropriate theoretical stretch. Perhaps, taking more specific theories into account that may explain attitude change (such as Elaboration-Likelihood-Model, Petty & Cacioppo, 1986) might be more fruitful for the design of effective interventions.

Furthermore, it must be taken into account that we did not include a control condition without treatment. Also, follow-up studies are needed to test the sustainability of the effects. In addition, it must be examined whether the higher intention to use actually results in more frequent use in the classroom in the long term. Moreover, the small sample size increases the likelihood of a type II error. Future studies should therefore be conducted with larger samples and a subsequent investigation should assess actual use of the tool.

Despite these limitations, our study suggests that technology acceptance can be promoted by engaging with information about a digital tool. If an experienced teacher's accounts, as in the form of the blog post, are particularly conducive to technology acceptance, a possible approach would be for in-service teachers to share their personal experiences of digital tools and their use in the classroom. In this way, pre-service teachers' technology acceptance might potentially be promoted in a very economical way. Thus, the present study provides important insights on how the technology acceptance of pre-service teachers could be further investigated and promoted.

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