SIMULATION-BASED LEARNING ENVIRONMENTS: DO THEY AFFECT LEARNERS' RELEVANT INTERESTS?

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The use of simulation-based learning environments to foster professional competences attracts more and more research. The role of participants' interest for learning is quite undisputable also in this context. Recent research findings emphasize that interest may trigger the activation of professional knowledge during participation in a simulation. Using data from N = 81 pre-service teachers who participated in four simulations over one semester, this contribution investigates how characteristics of the simulation (role-play vs. video) and participants' perception of the simulation affect the development of participants' interests. Results reveal that, beyond the perception of the simulation, development of participants' interests is weakly related to simulation characteristics.

INTRODUCTION

Diagnosing students' thinking is an important practice in teachers' professional life. In teacher education, learning environments based on role-play- or video-based simulations are applied to link conceptual knowledge with procedural components (Marczynski et al., in press). As learners' interests relevant in the simulation content can be seen as a "door-opener" for knowledge activation in such simulation-based learning environments (Kron et al., under review), the development of participants' interest becomes a crucial issue. The presentation may play a role here: While highly interactive simulation designs may increase interest, they run at danger of putting cognitive demand on participants, reducing the positive effects of interactivity.

Approximations of practice (AoPs) in pre-service teacher education

Simulation-based learning environments are special forms of approximations of practice (AoPs, Grossman et al., 2009). AoPs are intended to trigger knowledge activation in authentic, yet controlled situations. For example by using simulations, real-life situations are reconstructed to provide learning experiences, which are less cognitive demanding than real classroom situations, and reduce disruptive factors (Grossman et al., 2009). Especially in teacher education, AoPs are recommended to foster pre-service teachers' competences by allowing an application and extension of professional knowledge in authentic, yet not overwhelming situations (Codreanu et al., 2020). These competences entail cognitive as well as affective components, such as learners' interests (Heitzmann et al., 2019). As such, AoPs are discussed being effective tools for teacher training (Meletiou-Mavrotheris & Mavrou, 2013), for example to engage in the diagnosis of student thinking (Marczynski et al., in press).

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For the design of AoPs as learning environments, two criteria are highlighted to be relevant for learning: (1) the AoPs should be perceived as being authentic and (2) they should allow the learners to immerse themselves into the simulated situation (Goeze et al., 2014). However, the design of such authentic and immersive simulations is often at danger of increasing the extraneous cognitive load, which may impede their effectiveness (Sweller, 2010). Whereas teacher education commonly uses video-based simulations (e.g., Seidel et al., 2011), medical education has focused on role-play simulations, with trained actors as simulated patients (e.g., Stegmann et al., 2012). While role-plays may offer more opportunities for interaction and may thus be perceived as more authentic and immersive, video-based simulations with pre-structured options for action may lead to lower cognitive load during learning.

Development of learners' relevant interests in AoPs

Pre-service teachers' interest likely affect how they engage in such AoPs or other learning opportunities in university-based teacher education. Following Krapp (2002), interest is a relatively stable relation between a person and an object, reflecting the "tendency to occupy oneself with an object of interest" (intrinsic component, Krapp, 2002). Besides this "intrinsic component", interest also comprises a positive emotional relation to the object (Krapp, 2002), and ascribes a certain value to the object of interest (Schiefele et al., 1992). This person-object relation may change or develop whenever an individual encounters the object (Hidi & Renninger, 2006). An object of interest can be any entity from the individuals' "life-space" (Krapp, 2002), such as a professional practice, or a field of study. Relevant interests of pre-service mathematics teachers may, for example, address mathematics education content, or professional practices such as diagnosing student thinking.

Hidi and Renninger (2006) argue, that interest "as a motivational variable refers to the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time". Research distinguishes between individual interest and situational interest (Hidi, 1990). Whereas situational interest is a temporary experience in a specific moment (Hidi, 1990), that results from "[…] an interaction of learners' and situational features" (Rach, 2021), individual interest refers to a relatively stable motivational trait. As such, situational interest has been found to enhance learning (Wade, 1992), whereas individual interest had positive effects on attention, recognition, and recall (Hidi & Renninger, 2006).

Thus, diagnostically relevant interests may play an important role when engaging pre-service teachers with AoPs on diagnosis, for example by playing the role of a "door-opener" for the activation of professional knowledge: Kron et al. (under review) report that the relation between pre-service teachers' professional knowledge and their performance in simulated one-on-one diagnostic interviews depended on their interest in mathematics education and diagnosis, This leads to the question how these interests may be developed in pre-service teacher education. Meaningful experiences in simulations may strengthen the person-object relation and lead to more intense interest

in contents of the simulation and the simulated activities. However, research about how such learning environments contribute to the development of interest, is scarce.

Regarding this development, also Hidi and Renninger (2006) argue that experiences during a learning situation might trigger situational interest, if the learning environments are authentic and immersive, and "provide meaningful and personally involving activities". Beyond authenticity and immersion, cognitive load has been found to affect learners' situational interest negatively (Park et al., 2015). If sustained over time, situational interest may contribute to the development of individual interest (Hidi & Renninger, 2006). However, it is quite unclear how pre-service teachers' interest develops during repeated participation in simulation-based learning environments beyond short term effects of the simulation.

THE PRESENT STUDY

Despite the increasing research focus on interest development and the use of AoPs in teacher education, research linking these two fields is scare. We investigate the development of pre-service teachers' relevant situational interests during repeated participation in a simulation-based learning environment on diagnosis of student thinking. We compare role-play- and video-based presentation formats. Since role-play simulations may offer more opportunities for authentic and immersive experiences, but may also result in a higher cognitive load, we did not have specific hypotheses which presentation format would be more beneficial for interest development. We addressed the following questions:

RQ1: Does the presentation format of a simulation-based learning environment affect participants' relevant situational interests reported after the simulation?

RQ2: How do participants' initial individual interests and their perception of the simulation affect participants' situational interests after the simulation? We expected that higher initial interest, as well as perceiving the simulation as authentic and immersive, would go along with higher interest after the simulation, whereas higher extraneous cognitive load would decrease interest.

RQ3: Does the presentation format influence the development of situational interest over multiple simulations, after controlling for the perception of the simulation?

METHOD

To answer these questions, we used simulated diagnostic one-on-one interviews. Pre-service secondary school mathematics teachers at a large university in Germany were randomly allocated to one of the two parallel presentation formats (role-play: $N = 39$; video: $N = 42$). During summer term 2021, every participant participated in four simulations with a constant presentation format ($N = 324$ interviews, in total). The simulations were embedded in a web-based interview system. Initial individual interests were assessed before the first simulation. During each simulation, participants

reported their perception of the AoP. We applied scales for situational interests directly at the end of each simulation session.

Simulation

Simulated diagnostic one-on-one interviews were developed (Marczynski et al., in press) as an AoP for mathematics teacher education. Pre-service teachers act in the role of a teacher, diagnosing the mathematical thinking of a 6th grader in the field of decimal fractions, by using a given set of diagnostic tasks. Four different student case profiles were constructed, with different profiles of mathematical understanding in the field of decimal fractions. Trained research assistants played the student role in the role-play format, while scripted videos of 6th graders were prepared for the video simulation. Whereas the participants of the role-play simulation interacted with the simulated student directly, participants of the video-version watched the provided videos. Each simulation contains four phases: (1) The participants got familiarized with the interview system, their role as the teacher, and reviewed the given set of diagnostic tasks (only first simulation). (2) The participants had 25 minutes time to interview the simulated student. They chose tasks from the given task-set, observed the student's response, and posed probing questions (in the video-simulation they selected from a range of possible probing questions). (3) After the interview, they prepared a diagnostic report about the interviewed student's mathematical thinking. (4) The simulation ended with a debriefing, providing informing about an expert's diagnosis of the student. Each participant conducted four simulations, one every two weeks.

Instruments

Interest: To assess participants' relevant interests, we adopted scales of Rotgans and Schmidt (2011), considering interest in mathematics education and interest in diagnosis to be relevant in the context of the simulation (three items per scale, five-point Likert scales from 0 = not true at all; 4 = very true for me; $\alpha_{math.ed} = .89$; $\alpha_{diagnosis} = .76$).

Perception of the simulation: Participants' perception of the simulation was assessed by established scales (e.g., Seidel et al., 2010) using three items for authenticity and four items for immersion on a five-point Likert scale (0 = not true at all; 4 = very true for me; $\alpha_{auth} = .88$; $\alpha_{immers} = .67$). Extraneous cognitive load was assessed by three items (five-point Likert scale; 0 = very easy; 4 = very difficult; $\alpha_{extr.load} = .75$).

Statistical analyses: All data were collected in log files by the web-based interview system. Due to the nested structure of the dataset (multiple simulations per participant), we used linear mixed models to estimate effects of the perception of the simulation, its presentation format, and repeated participation, on interest reports after each simulation. In a first step, only the effect of the presentation format was investigated. Then, participants' initial reported interest and the perception of the simulation were included. Finally, we added the number of the simulation (0 = first – 3 = last) as a metric covariate and its interaction with the presentation format. We used planned contrasts of estimated marginal means to investigate our research questions.

RESULTS

Average interest ratings after all four simulations were above the midpoint of the scale for mathematics education ($M = 2.44$, $SD = 0.81$) and diagnosis ($M = 2.78$, $SD = 0.66$).

Interest in mathematics education: *(RQ1)* Participants reported significantly higher interest in mathematics education after the video ($M = 2.61$, $SE = 0.11$) than after the role-play simulation ($M = 2.25$, $SE = 0.11$; $B = 0.36$, $p < .05$). *(RQ2)* These interest ratings were positively influenced by perceived authenticity ($B = 0.18$, $p < .001$) and immersion ($B = 0.15$, $p < .01$), and negatively by extraneous cognitive load ($B = -0.21$, $p < .001$). Initial interest in mathematics education did not predict the interest reported after the simulations significantly ($B = 0.04$, $p = .67$). Controlling for effects of the perception of the simulation, the difference in interest between the presentation formats, averaged over four simulations, was not significant anymore ($B = 0.20$, $p = .12$). *(RQ3)* Controlling for those effects of perception, the difference between the presentation formats was significant in the first ($M_{rp} = 2.32$, $SE_{rp} = 0.11$, $M_{vi} = 2.61$, $SE_{vi} = 0.10$; $B = 0.29$, $p < .05$), but not for the last simulation ($M_{rp} = 2.35$, $SE_{rp} = 0.11$, $M_{vi} = 2.46$, $SE_{vi} = 0.10$; $B = 0.11$, $p = .44$) due to declining interest in video simulation.

Interest in diagnosis: *(RQ1)* Participants did not report significantly different interest in diagnosis after the video simulation ($M = 2.83$, $SE = 0.09$) than after the role-play simulation ($M = 2.73$, $SE = 0.09$; $B = 0.10$, $p = .42$). *(RQ2)* These interest ratings were positively influenced by the perceived authenticity ($B = 0.13$, $p < .01$) and immersion ($B = 0.11$, $p < .05$), and negatively by extraneous cognitive load ($B = -0.13$, $p < .01$). Initial interest in diagnosis positively predicted the interest reported after the simulations ($B = 0.42$, $p < .001$). *(RQ3)* Controlling for the perception of the simulation, we observed a significant decline of interest ratings over the four simulations ($B = -0.04$, $p < .05$), which corresponds to a difference of $B = 0.13$ on the interest scale (0-4) over all four simulations. This decline did not differ significantly between the two presentation formats ($B = -0.03$, $p = .36$).

DISCUSSION

The aim of this contribution was to provide insights, how the presentation format of an AoP and the participants' perception of that presentation format affect their situational interest and its development, considering two different objects of interest. We intended to disentangle effects of situational experiences and developments of interest over time.

Pre-service teachers, who perceived the simulation as authentic and immersing, reported a higher level of interest directly after participation in the simulation (RQ2). These relations between authenticity and immersion and interest are in line with assumptions based on work by Hidi and Renninger (2006) on interest development. The negative relation of extraneous cognitive load and interest development confirmed results of Park et al. (2015). This highlights, that AoPs need to be designed in an authentic and immersing way, also considering potential sources of extraneous

cognitive load. In fact, these requirements may run contrary to each other, as described on our assumptions about the two presentation formats (see also Codreanu et al., 2020).

While prior interest in diagnosis was substantially related to post-simulation interest in diagnosis, this was not the case for interest in mathematics education. Authentic encounters with the object of interest are assumed to contribute to interest development (Hidi & Renninger, 2006). Beyond lectures and exercise sessions, this was one of the first opportunities for the participants to apply their mathematics education knowledge in an authentic (though simulated) situation. These results may indicate, that participants re-evaluated their interest in mathematics education more strongly based on the situational perception of the AoP than their interest in diagnosis.

Without consideration of other factors, the video simulation triggered more positive ratings of interest in mathematics education than the role-play simulation (RQ1). According to our assumptions, this indicates that potential advantages of the video simulation in terms of lower extraneous cognitive load may have exceeded advantages of the role-play simulation in terms of higher authenticity and immersion (Hidi & Renninger, 2006; Park et al., 2015). Indeed, these situational perceptions explained almost all differences between the presentation formats. For interest in diagnosis, no differences in post-simulation interest by presentation format occurred. One interpretation of this finding could be that the presentation format was neutral regarding the emergence of situational interest in diagnosis, but not so for situational interest in mathematics education. The more structured interaction format of the video simulation (e.g., selecting from provided probing questions, instead of asking questions freely) might have helped participants to apply their knowledge from mathematics education and to experience it as helpful and valuable. In line with the idea of AoPs (Grossman et al., 2009) this result points to the importance of finding an appropriate level of complexity when designing AoPs.

Considering interest development under control of situational factors (RQ3), only one significant difference between the presentation formats occurred. The initially positive effect of the video-based simulation on interest in mathematics education vanished until the last simulation. This short-term effect may be due to the novelty of the video-based simulation format, which is rarely used at the university under study. Firstly, this indicates that the presentation format mostly affected situational interest, but that these effects did not transfer to long-term development. Apart from this decline for the video format, interest in mathematics education was stable over four simulations. In light of other studies usually finding declining interest in repeated measures designs (e.g., Rotgans & Schmidt, 2011), we take this stability of interest in mathematics education in our study as an encouraging sign. As in other studies on interest, we find a general decline of interest in diagnosis over the four simulations. Explicating the value of diagnosing student thinking was briefly addressed in the simulation activities, but more directed interventions, such as explicitly experiencing the value of diagnosis to design

individual support, and reflecting on this value (Hulleman et al., 2010) might be necessary to develop pre-service teachers' interests in diagnostic activities.

The role of interest as a "door-opener" for deep learning in general (Hidi & Renninger, 2006) as well as for knowledge activation in AoPs (Kron et al., under review) is undisputed. We contribute to understanding the emergence of situational interest during AoPs on the diagnosis students' mathematical thinking. Systematic changes in situational interest over a longer time, under control of situational factors, can point towards possible developments of individual interest. Our findings indicate that current learning experiences shape participants' interests, but that it is possible to identify developments over the course of a semester beyond these situational factors. It is crucial to disentangle pure novelty effects of new simulation formats from long-term developments of situational, and potentially also individual, interests. Further research should investigate effects of AoPs, but also explicit interventions regarding their potential to sustain and develop pre-service teachers' relevant interests.

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