Preprint

# Peer group supervision in Zoom and social VR- Preparing preservice teachers for planning and designing digital media integrated classes

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**Abstract:** 21-century challenges demand a change towards collaborative and constructive seminar designs in initial teacher education regarding preservice teachers acquiring meta-conceptual awareness (TPACK) about how to implement emerging technologies in their future profession. Against this background the paper addresses the following research questions: 1) How should a pedagogical concept for remote initial teacher education be designed to promote metacognitive learning processes of preservice teachers? 2) How do preservice teachers perceive these learning processes in video-based communication and social VR? Regarding the pedagogical concept, peer group supervision and an action- and development-oriented approach using Zoom and social VR were identified as relevant for an instructional design that provides collaborative and constructive learning processes for students. In this exploratory study, 17 students participated in two iterative cycles of peer group supervision performing design tasks in groups. A content analysis of reflective video statements and qualitative group interviews was carried out using a qualitative research design. Results indicate the successful implementation of peer group supervision. Regarding media's implementation, Zoom's screen-sharing option and breakout session benefitted the consultation process as well as social VR's "realistic" experience of creating a "sense of community".

## 1. Introduction

The pandemic emphasized the need for new concepts in initial teacher education to prepare preservice teachers for 21st-century challenges. Shifting from f2f to remote teaching in education, teachers at all school types had to promote students' competencies with a set of available digital tools. Social distancing has restricted communication and collaboration to a specific limit with the consequence that teachers must put more effort in adapting, especially collaborative constructive learning activities to foster students' engagement in online learning scenarios. As most instructional designs in teacher education rarely offer constructive learning scenarios allowing technology integration (Foulger Teresa S. et al., 2017), there was a rise in teachers networking on social media platforms to support each other as a community of interest with methodological know-how for effective media integration into remote teaching and learning scenarios (Hacker et al., 2020). Most teachers did not feel prepared well enough for the complex task of planning, designing, and reflecting learning scenarios with emerging technologies, as this implies a sound knowledge of technology, pedagogy, content, and, more importantly, about how to transfer this knowledge into action. This in turn involves higher-order thinking skills such as reflective and problem-solving thinking processes that offer the potential to promote collaborative, constructive, and meaningful teaching and learning.

Hence, there is the need to design seminar concepts that provide student teachers with diverse learning opportunities, as early as possible in initial teacher education (ITE), offering incentives for the development of metacognitive learning processes as well as promoting, urgingly, media pedagogical competencies that prepare them for their complex tasks in their future profession (Blömeke, 2017; Foulger Teresa S. et al., 2017; Ripka, Tiede et al. 2020).

Against this background, this work will investigate the following two research questions:

1) How should a pedagogical concept for remote initial teacher education be designed to promote the metacognitive learning processes of preservice teachers?
2) How do preservice teachers perceive these learning processes in video-based communication and social VR?

## 2. Literature Review

### TPACK as meta-conceptual knowledge

Between 2009 and 2020, more than 844 works have been published that contribute to the research on TPACK (Tseng et al., 2020). As an extension to Shulman's pedagogical content knowledge concept (Shulman, 1987), Mishra and Koehler (2006) introduced the conceptual framework TPACK. It addresses not only the mere technical aspects of using technology in educational contexts but also the multifaceted and complex pedagogical and content-related implications that go along with it. According to the authors, the framework comprises three core knowledge bases (technological, pedagogical, and content knowledge (TK, PK, CK)) and its intersectional components (technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), technological pedagogical content knowledge (TPACK)) that describe teachers' knowledge of using emerging technologies effectively in educational contexts *(ibid.).* To explain how the knowledge domains interplay with each other and how TPACK is constituted there are two main perspectives in literature: the integrative and transformative view. In the integrative view, “high levels of TPCK will be constituted by high levels of TPK, TCK, PCK, TK, PK, and CK” whereas in the transformative view “TPCK cannot simply be accounted for by summing all other TPACK components, but rather it is a distinct form of knowledge which transforms beyond the components at its base” (Schmid et al., 2020) This work, however, deals with TPACK as a meta-conceptual knowledge as outlined in the following.

Regarding learners' development of TPACK, Mishra and Koehler (2006) point out that "learning through design embodies a process that is present in the construction of artifacts”. In this "learning-by-doing" process, learners are supposed to engage actively "in practices of inquiry, research, and design in collaborative groups" (*ibid.*). Taking the design of lesson plans into focus, Zohar and Schwartzer (2005) indicate that design tasks are complex tasks that "require higher-order thinking in TPCK". Preservice teachers are supposed to make multiple decisions when integrating technology in class, considering contextual factors involving critical thinking and problem-solving. They need to (a) plan and design appropriate learning activities for teaching and learning scenarios with technology (b) choose digital media and content to use in teaching/learning and why; (c) embedding it in the pedagogical method to support that choice (d), deciding when and how to use it (Kramarski & Michalsky, 2010). As an elaboration of the transformative view on TPACK, based on the assumption that the TPACK framework also comprises the metacognitive learning processes involving higher-order thinking, Krauskopf et al. (2012) see TPACK as a meta-conceptual awareness that considers metacognitive aspects integrated into TPACK. This coherent theory is based on the notions that constructing mental models, that comprise a variety of aspects needed to design a lesson plan serve as "mediating variables between a teacher's abstract knowledge and planning the integration of the respective tool into their teaching", and thus lead to TPACK as a "higher mental model" (Krauskopf et al., 2012).

Against this background of TPACK being considered as a meta-conceptual awareness (Krauskopf et al., 2012; Krauskopf et al., 2018) this work follows two lines of thought that set the baseline for the design of a pedagogical concept in remote initial teacher education. First, teachers need to construct complex mental models of integrating technology effectively in class for the development of media-pedagogical competencies *(ibid).* Second, to develop these complex mental models, higher-order learning and collaborative, constructive learning processes are required, leading to TPACK as meta-conceptual awareness of how to implement emerging technologies in class.

Therefore, in the following, peer group supervision as a potential concept to promote collaborative, constructive learning processes will be outlined.

### Peer group supervision

In teacher education, peer group supervision refers mainly to peer coaching approaches for in-service teacher’s professional development. Since the early 1980s, more and more peer learning approaches have been implemented in preservice teacher education. Only a few studies however consider peer group supervision as a pedagogical approach in initial teacher education (Tietze, 2021). In this paper, the term peer group supervision follows the German concept of *kollegialer Fallberatung* of Tietze (2010) and related concepts (Richard & Rodway, 1992). It describes the process of people with the same profession share, reflect, and discuss problems or questions related to their profession. Although one could assume based on the word "supervision" that there is a hierarchical order, the participants are neither subordinate nor superior to each other regarding power structures. The peer group

supervision's main goal is that the participants conclude future actions for their profession through peer feedback and self-reflection (Tietze, 2010).

To distinguish peer group supervision from other similar concepts, Tietze names four critical features of peer group supervision:

(1) the concept must take place in a *group*. The author suggests building groups of five to ten participants depending on the existing conditions.

(2) *questions and cases* addressed are related to a shared profession. Cases should refer to an experienced professional role conflict, dilemma, or problematic interaction. Beyond this, they should also be of personal significance. The participant contributing to the case should be personally involved in it and have a personal interest in new perspectives (Tietze, 2010; 2021).

(3) according to Richard and Rodway (1992) most *consultation processes* follow a basic form of a four-phase structure: (a) The peer group supervision process starts with a participant's request for help, (b) the person presenting the case is exposing more information about it, (c) the group reacts to the question and the case focused on, giving room for further inquiries on the case and deepening the understanding of the presented information, (d) a decision or reflection on further possible actions is taken. The phases help participants as guidelines for communication processes, and thus also support "systematic problem-solving, such as a clear separation of problem description and solution development" (Tietze, 2021). Throughout the peer group supervision process, multiple perspectives play a particularly important role. By working on problems, questions, and cases from different angles, they can be viewed and reflected upon more closely and perceived in their complexity (Hesse & Lütgert, 2020).

(4) all *participants' roles* must be reversible. During the phases, participants fulfill reversible roles. Either participant takes the role of an advice seeker, presenting his/her question/case/problem to others, or he/she can support other advice-seekers as an advisor. Also, he/she can moderate the case consultation process in the peer group.

According to current research peer learning approaches based on constructive learning theories offer the potential to promote competencies needed for the teaching profession (Krauskopf et al., 2012; Krauskopf et al., 2018). Potential benefits of peer learning linked to observational learning based on socio-cognitive learning theory (Bandura, 1979; Tietze, 2010, 2021) are the development of confidence, self-esteem, collaborative skills, critical inquiry, and reflection. The authors also add to the benefits the communication and articulation of knowledge, understanding and skills, managing learning, and how to assess oneself and others (Boud et al., 2001)

Against this background, it is assumed, that with the integration of peer group supervision in remote initial teacher education, higher-order and constructive thinking processes are promoted and are leading to the development of TPACK as meta-conceptual awareness.

**Web-conferencing systems and Social VR's affordances for peer group supervision**

Digital media communication tools are used to replace or complement face-to-face communication. As during COVID-19, a high number of people were forced to use web-conferencing tools such as Zoom and Microsoft Teams, Hacker et al. (2020) investigated the affordances and constraints of web-conference systems for its users. To only name some of the affordances, the study's results lead to the conclusion that the use of web-conference systems supported the social co-presence of people and thus created "a social technology that led to a new virtual togetherness." (*ibid.)* Garrison et al. (2013) identified in their COI framework social presence as one core element of a collaborative constructivist learning environment required to create and sustain a purposeful learning community in online learning environments. Other works, however, show that computer-supported learning environments have limitations regarding synchronousness, non-verbal cues, physical proximity, spatial cohesiveness (Abfalter et al., 2012), and processing (Ferran & Watts, 2008) that might influence the feeling of "virtual togetherness" and thus limit the positive effects they assumingly have on collaborative constructive learning processes.

A medium that also favors mediated social interactions is social VR. Fully immersive VR as a communication and collaboration medium is widely applied and studied in a wide range of areas (Billingsley et al., 2019; Slater & Sanchez-Vives, 2016) Based on its main aspects such as immersion, presence, place illusion, plausibility illusion, and coherence (Bailenson et al., 2008; Latoschik & Wienrich, 2021; Skarbez et al., 2020; Slater & Steed, 2000), social VR offers the possibility of experiencing communication, collaboration, and interactions in VR close to the "real world" sensations. As in previous works outlined (Latoschik et al., 2019; Ripka, Grafe, &

Latoschik, 2020; Ripka, Tiede et al., 2020) fully immersive social VR's characteristics enable the planning and design of collaborative and constructive virtual teaching and learning processes. Yet, as with any medium, the sheer integration of VR in teaching and learning does not guarantee an additional value or improved learning success. A growing number of research works confirm its affordances and suggest additional values when it is included in educational settings reasonably. This however requires from designers of immersive teaching and learning scenarios the proper identification of social VR's appropriate implementation in line with learning objectives in lessons designs without overwhelming its learners (Johnson-Glenberg, 2018).

As communication and collaboration are two vital aspects of performing peer group supervision successfully regarding social learning processes, this work investigates how students perceive Zoom's and social VR's usage performing the peer group supervision cycles and its implications for learning processes.

## 3. Research Methodology

Against this background, built upon results of previous studies (Ripka, Grafe, & Latoschik, 2020) this paper investigates the benefits and challenges of peer group supervision in social VR in ITE to promote media-pedagogical competencies, focusing on the following research questions:

1) How should a pedagogical concept for remote initial teacher education be designed to promote the metacognitive learning processes of preservice teachers?
2) How do preservice teachers perceive these learning processes in video-based communication and social VR?

### Study Design

#### Pedagogical Concept

The pedagogical concept was designed based on action- and development-oriented didactics (Tulodziecki et al., 2017; Tulodziecki et al., 2019) using complex tasks and a structured learning process combined with flipped classroom principles. Its primary pedagogical objective was the students' constructive and iterative design development of a technology-integrated instructional design in teaching and learning scenarios. According to flipped classroom principles, students prepared the learning content in advance asynchronously to perform design tasks throughout the seminar sessions synchronously. Course units comprised a combination of synchronous and asynchronous teaching and learning scenarios supported by digital media platforms such as LMS, Zoom, Miro, Flipgrid, and social VR. The course concept followed a sequenced four-stage structure with its primary focus on stages two and three, in that the peer group supervision cycles took place.

**Stage I** set the ground for the implementation of peer group supervision. Course sessions one to three covered a basic introduction to the seminar and media education, media competencies, and media design. In preparation for the first peer group supervision in session four, preservice teachers had to perform asynchronously a design task. Central to this task was the development and critical reflection of a technology-integrated instructional design in teaching and learning scenarios

**Stage II** starts with the first cycle of peer group supervision. The process was structured according to Tietze's peer group supervision's features (2010):

(1) The *group size* was limited to 3-4 participants. As one seminar session lasted 90 minutes, each participant should have the chance to present a case or a question.
(2) Students had to prepare a complex design task.
(3) The *consultation process* comprised three main phases á 10 minutes:
    a. The advice seeker presents his/her case. The others listen and do not interfere.
    b. The advice-givers ask questions to clarify the stated case and information
    c. The advisers offer ideas, information, or concepts that might help the advice seeker. A discussion or joint reflection can take place.
(4) Three *roles* were assigned: the advice seeker, the advice-giver, and the moderator who also visualized the consultation process results on the online collaboration board. The teacher educator is not present but has the task of being a facilitator that monitors processes and intervenes when necessary.

Following the first peer group supervision, to promote further reflective processes, students uploaded a reflective video statement on Flipgrid, a web-based application that offers a platform for classes to upload engaging media content such as personal video clips that motivate students to interact with each other. Students or teachers can feedback on uploaded content. In addition to individual feedback given by the teacher educator, all participants reflected together on the process of their peer consultation.

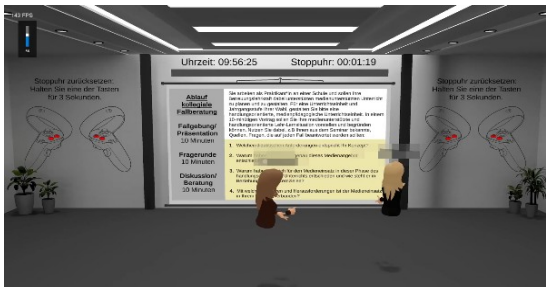
For the second peer group supervision cycle, based on the previous session's content on designing and planning technology integration into the classroom, preservice teachers got a second task to design an instructional design of their choice. To investigate how video-based communication and social VR's affordances favor or hinder peer group supervision, students were allowed to choose either form (Zoom or social VR) of communication and collaboration tool.

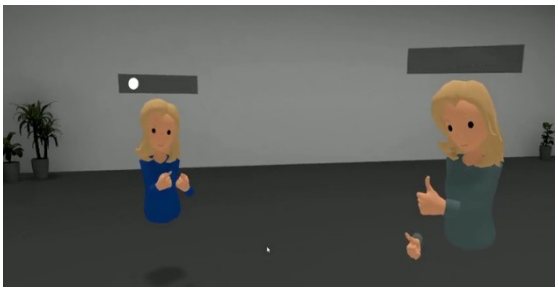
**Stage III** started with the second peer group supervision cycle in Zoom and social VR. Again, following the peer group supervision cycle, preservice teachers uploaded their guided reflective video statement that the teacher educator commented on. The following session served as a joint reflection and opportunity for feedback.

At the end of the semester, in **stage IV**, students presented their final version of their technology-integrated instructional designs based on sound reasoning and their pedagogical, technological, and content choices.

**Social VR prototype**

The social VR prototype, based on Unity 2019.4 and optimized for Microsoft Windows 10, offered a fully immersive seminar room. The Oculus Rift S, a Head Mounted Display, and a Laptop served as VR hardware. To avoid unnecessary distractions for the students, the virtual seminar room is kept clean and simple, offering room for collaboration and interaction.



Virtual instructions guide the user to set up the avatar and one's virtual representation. For avatar representation, a comic-alike abstract avatar is available. Outer appearances like the color of the upper body, gender, and name are customizable for the users. After entering the preferred avatar choice, representations' names appear over the avatar's head, visible for all participants. Before joining the group room, students can see their representation in a virtual mirror and train how to use the controller elements. For the facilitation of communication, a bright pulsating dot next to the speaker's name signals the speaker's turns. As the peer group supervision follows a fixed-timed structure, students can set a virtual stopwatch that runs for all participants visibly next to the presentation wall. On the wall, participants can see the peer group supervision procedure as a guideline.

**Methodology and data collection**

The convenience sample consisted of 17 preservice teachers (12 female and 5 male). The students had the opportunity to sign up voluntarily for the intervention. Data was collected using qualitative methods at three points of time:

1) After peer group, supervision I and II, preservice teachers had to upload guided reflective video statements on the online platform Flipgrid (n=17)
2) After peer group supervision II, qualitative half-structured group interviews were conducted. Groups were divided according to the medium they participated in, Zoom or social VR. (Zoom: n =5; social VR: n = 12)

Due to COVID-19 restrictions at the university, web-based social VR's participation required a stable internet connection and living no more than 10 km away from the university's location. That is why only a limited number of students could participate, as not all students met the requirements.

Regarding reflective video statements on Flipgrid, students watched an introductory video statement of the teacher educator who gave two main reflective prompts. The prompts follow Schön's (1987) understanding of "reflection on action" and were presented after each peer group supervision as follows:

a) Describe in short how you perceived peer group supervision.
b) Peer group supervision is supposed to offer the possibility of receiving new impulses and perspectives based on the exchange with your fellow students.
    - Which aspects of the peer group supervision did you perceive as goal-oriented or, more minor goal-oriented?
    - Which aspects of the video conferencing software ZOOM did you perceive as supportive or obstructive in the three phases (case presentation, question round, discussion/ reflection round?

Besides students' self-reflection, group interviews were conducted to consider also group reflection with the goal that group dynamics lead to a multidimensional understanding of group processes in Zoom and social VR.

The interview questions for the qualitative group interviews were derived from Tietze's peer group supervision, aiming to understand the nature of performing the consultation process twice in remote teacher education:

a) Compared to peer group supervision I in Zoom, how did you perceive the communication processes with your peers throughout the first phase, the presentation phase?
b) Compared to peer group supervision I in Zoom, how did you perceive the communication processes with your peers throughout the second phase, throughout question phase?
c) Compared to peer group supervision I in Zoom, how did you perceive the communication processes with your peers throughout the third phase, the discussion/ reflection phase?
d) Compared peer group supervision I, what technology's characteristics (Zoom and/ or social VR) did you, as a group, find supportive or obstructive throughout the consultation process?

The interviews were recorded, transcribed, and analyzed through qualitative content analysis (Mayring, 2015).They were coded using MAXQDA (Rädiker & Kuckartz, 2019). The following categories were determined deductively following the approach of Mayring (2015) and the four main features of peer group supervision according to Tietze (2010, 2013, 2018, 2021):

(1) Group size
(2) Design task
(3) Peer group supervision cycle
(4) Communication and collaboration with peers in reversible roles

## 4. Results

The results of the guided reflective video statements and qualitative group interviews conducted with preservice teachers will be presented systematically following the two cycles of peer group supervision (PGS 1 and 2), in stages two and three, and structured according to selected categories derived from Tietze's peer group supervision features (2010). The categories were adapted and extended according to research interest.

| **Categories** | **Students' perceptions** | **Examples** |
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| ***PGS I (Zoom)*** | ***Reflective video statements on Flipgrid*** | |
| (1) Group size | • Students perceived group sizes of three and four persons as interactive and helpful. | *"Um, I can only speak from experience: the smaller the group, the more sense it makes. The more, um, effective you are in the discussion, I think."* *(Student K_PGS1)* |
| | • Limited timeframe of 90 minutes for each group did not allow more group participants. | *"Good group of three. Good preparation and different approaches were insightful."* *(Student K_PGS I_Video statements)* |

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| | | *"I find it quite good in small groups. (...)I imagine the time limit to be a bit difficult, if one carries out this with colleagues at school in this way and then has only 10 minutes to look for possible solutions and so on... because I think this can be very difficult, especially when selecting the right approaches […]."* (Student J_PGS1) |
| (2) Design Task I | • Design task was complex and not easy to approach which led to some insecurities performing the task.<br>• Task's complexity permitted individual approaches of how to perform the task. | *"First of all, I found it reassuring that my two group members didn't present a sample solution, we were struggling with how to approach the task."* (Student H_PGS1)<br><br>*"There were three of us and we really had three completely different - that is, lesson designs and approaches - and that was kind of cool to see."* (Student F_PGS1) |
| (3) Peer group supervision cycle I | • All groups had difficulties sticking to the given structure and PGS`s phases were mixed up.<br>• Students asked questions at the presentation's exact point without waiting for the next phase to start.<br>• Students that loosely followed a given structure perceived the questioning round as the most valuable part of peer group supervision, recognizing the gaps in their approaches to a solution.<br>• Some students felt overwhelmed by peer group supervision.<br>• In general, independently of the cycle's structure, most students perceived peer group supervision as practical and helpful. | *"Um, the only thing is that the question round had included the discussion round. If someone had questions about their own case, then it was actually immediately also - um - discussed in the discussion round […]."* (Student M_PGS1)<br><br>*"Well, I must admit that I didn't perceive the peer group supervision well at first, and to be honest, I was still a bit overwhelmed at the beginning and didn't know what to expect. And that's why I had a lot of questions and - but once we started, it got easier and easier. Or rather, you feel, um - a little more confident."* (Student N_PGS1)<br><br>*" […] the feedback from my three fellow students, in the group, was really very purposeful and very beneficial, too."* (Student L_PGS1) |
| (4) Communication and collaboration with peers in reversible roles (Zoom) | • Most students perceived communication as interactive, helpful, and supportive.<br>• While most students thought their peers 'feedback helped the design's development, some felt the need for more expert feedback.<br>• Regarding reversible roles, students recognized the roles' function as a facilitator for work processes.<br>• For a successful peer group supervision, students realized that they must be open to criticism and that the team has to work together. | *"So, I think, mmm, the.... - yes, it's like always - the higher the expertise in some area, the better you can also um, help others or maybe express yourself." (Student J_PGS1)*<br><br>*"Aspects that I found purposeful: above all, the joint agreement, and the distribution of roles. Just that you had this moderator and case 1, 2, 3, and 4. Um, took a lot of organizational work off at the beginning and, um, everyone knew roughly in which role he was and what he had to do."* (Student M_PGS1)<br><br>*"Openness to criticism must be present. A* |

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| | Regarding Zoom`s affordances:<br><br>• The screen sharing option was numerously named as good support for collaborating throughout the process. When questions came up that students could not answer ad hoc, they shared their screens to share material or information to follow or help the group to find the information needed.<br>• Using the breakout rooms without any supervision of teachers gave students the feeling of speaking openly and without pressure. | *functioning team is crucial for this."* *(Student J_PGS1)*<br><br>*"Yes, regarding Zoom, what I actually thought was helpful about the Zoom application that we always had the working material visible, and we could easily switch from our presentation to the Internet using the screen sharing option. There, we had the syllabus displayed, which was actually super useful, because then we could always show directly what we referred to or what we had in mind."* *(Student P_PGS1)*<br><br>*"I thought it was great in the way we did it: So completely unevaluated, just us students among ourselves. So that you could really exchange ideas and also - yes, try to help the others without being judged or feeling like you were being watched. I thought that was good - it was a very pleasant setting."* *(Student H_PGS1)* |
| **PGS II (Zoom and social VR)** | ***Reflective video statements on Flipgrid and qualitative group interviews*** | |
| (1) Group size | • Students favored groups of three to four for productive group work.<br>• The students of a group of only two participants stated that this had no negative consequences for the process, as they had more time to talk about their two design concepts, but they would have wished for more perspectives and feedbacks. | *There were only two of us. On the one hand, that had advantages because we were able to have a good conversation and exchanged ideas...and helped each other. Um, this time, like last time, there were cool new ideas that helped me. Well, because we were only two people, it was just, yes.... Impulses or the perspective of two people*." *(Student F_PGS2_video statement)* |
| (2) Design Task II | • Students gained more confidence in creating their instructional design based on the seminar's theoretical basis. | *"I thought there was definitely clear learning progress. Both, um, with my concept on which I had continued to work, as well as with my two fellow students, with whom I was in the VR session. Um. Actually, the concept was more advanced and, of course, also more goal-oriented. Because we had all been through peer group supervision and reflection before, and there we still had had questions in our heads. I went into the peer group supervision and didn't really know what I was actually doing. That has definitely improved a lot. Of course, also through the session that we had again with you. Then in general I would like to say that I perceived the session as very pleasant."* *(Student H_PGS2_video statement)* |
| (3) Peer group supervision cycle II | a. In Zoom<br>• Most students perceived the second PGS II as more structured. | *"In the first one, I had little idea what I was doing. In the second, I felt quite confident,* |

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| | • They described the process as more coherent and goal-oriented as structure was followed more strictly.<br>• Groups seemed to be more focused.<br>• Students who took part via Zoom underlined the positive supervision's development regarding structure and workflow.<br><br>b. In social VR<br>• In contrast to participants in Zoom, students in social VR had no online platform to collaborate and had no chance to use written notes. Many preservice teachers that joined PGS II in social VR reported that the first phase, in contrast to PGS I in Zoom, was strictly performed as a presentation phase, and no one asked any questions. Reasons given for this were mainly the restricted communication cues in social VR. As students could not interpret speakers' turns because of missing gestures or facial expressions, they waited for the person presenting to end the talk before asking questions. Following this, boundaries of the subsequent two phases, question round, and discussion/reflection blurred and blended. Some students in each group reminded others of sticking to the given structure<br>• In some groups, it was difficult to maintain an orderly process as several participants felt the need to take one or more breaks due to feeling exhausted wearing the VR headset. Several students said they realized very late that they needed a break as they focused intensely on the group work. | *and uh. I also have to admit that my fellow students… they have had a deeper understanding, uh, of the topic. Because this time we stuck to the concept. […]* (Student N_PGS2_video statement)<br><br>*"I also think that since more and more theoretical knowledge was added over time, you also build up a different structure for yourself when you introduce things, so you just give more reasons, which is not the case the first time, […] but I honestly didn't understand it deeply: How to connect this and that? The first time it was just like I write something down and the second time it was already very well-founded and somehow also, yes for me already more structured from preparation on.* (Student M_PGS2_interview)<br><br>*"This also shifted the distribution of roles a bit - we didn't do it in such a way that everyone presented their topics first, but rather we went straight to the questions afterward - we more or less confronted the presentation with the questions. Otherwise, it would have been lost, and you had the feeling: When can I finally refer back to what she said? That's why after the first presentation we said: Ok, now the questions and discussion, and then the next person presents first. Before we all present, then do the big round of questions, and then the discussion."* (Student I_PGS2_video statement)<br><br>*"I didn't even notice that I needed a break, but afterward I was completely exhausted for half an hour and couldn't do anything anymore. Although throughout the process I actually felt totally fine. Such a mandatory break I think would be really useful!"* (Student G_PG2_interview) |
| (4) Communication and collaboratio | a. In Zoom<br>• Many students agreed on Zoom as a practical communication and collaboration | *" I think everything worked without any problems. It really was like a face-to-face live talk, with the chance to interrupt and engage* |

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| n with peers in reversible roles (Zoom and social VR) | tool. One student emphasized its advantages compared to f2f seminars at university.<br>• They agreed on the usefulness of the screen sharing and breakout session functions.<br>• The positive effects of heterogeneous groups were that diverse perspectives were added to question and discussion rounds, pointing at unclear content.<br>• However, one student felt it hard to put herself in the others' perspective and the age of their future students, and thus, it was challenging to give helpful advice.<br><br>b. In Social VR<br>• Participants perceived PGS II in social VR as intensive and close to reality.<br>• Regarding communication and collaboration, many students had the impression that the interaction with others to be more "real" because of their avatar's representation. Also, they felt a sense of community.<br>• One said he had a "first person effect" and could speak more freely than in Zoom. Interestingly, he had the feeling that in social VR his stuttering was minor, and he gained more stability because of the given feedback.<br>• The reduced non-verbal cues in social VR led to positive and negative effects on the participants' communication. The preservice teachers perceived that everyone | *in speech, or, yes I think one understands more when everyone can freely speak and see each other."* (Student N_PGS2_interview)<br><br>*"In general, in Zoom, I think the breakout rooms are super helpful because when I imagine how this works at Uni, this always takes time until one set up the workspace, this, however, is super relaxed, two klicks and you are in the group, and you can start right away to collaborate."* (Student_D_PGS2_ interview)<br><br>*"And we also all had different, uh.... uh... types of schools. I actually thought it was interesting that we were able to see the designs of the other types of schools and also what challenges this meant for the others. I thought it was good that we didn't just saw one school-type design."* (Student B_PGS2_video statement)<br><br>*"Although I would say that (...) I find it hard enough sometimes to put myself in my pupils' perspective, i.e. the ones I will be teaching in the defined framework of the 1st-4th grade, and it is quite good to exchange ideas with people who are in the same grade and not to exchange ideas with someone else of other grades."* (Student F_PGS2_interview)<br><br>*"Mhm and also really one has the feeling that one is really sitting next to each other and I personally thought that was super, super cool. Um, also the consultation is in my opinion, compared to the last time, much,...yes almost more intensive, somehow."* (Student L_PGS2_video statement)<br><br>*"You somehow feel a bit closer, because you have a virtual person standing in front of you. Exactly, um, feels somehow a bit more real (laughter) than via ZOOM or similar, even though (in Zoom) you can also actually see each other."* (Student E_PG2_video statement)<br><br>*" I think about Zoom you always have the problem that you see yourself and because it's first person in social VR, um, you don't have this problem and you can just talk much more freely with the other people. And um, also that you can manage it much better - no to stutter and everything. Um, in any case, VR has helped a lot as far as speaking freely is* |

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| | in social VR complied strictly with conversation rules because of missing gestures or facial expressions. In addition to this, most of students focused more on the spoken word and the presented content. However, because of this, participants did not dare to ask questions at the corresponding parts. Without the opportunity of taking notes in social VR, consequently, they forgot the questions before having asked them. Thus, the question and discussion round were shorter than in PGS I, and some felt they missed meaningful opportunities of reflecting on their design.<br>• In one group observed, seated positions of participants were incorrectly calibrated, and thus one student was a lot smaller virtually represented than the other two. The three stated that this was irritating for conversation. The lower-positioned student had the feeling that everyone was looking down on her while speaking. She felt uncomfortable and tried to stand up on her chair to become taller.<br>• Some students remarked that they did not know their social VR peers and would like to have had a picture of the real person in mind. One added, though, that her peers' anonymity caused her feeling more secure in presenting her case and her questions, as she had not the feeling to say something stupid. | *concerned." (Student C_PG2_video statement)*<br><br>*" In the presentation phase, it was very noticeable that there was a lot of monologue, which is not a bad thing. At least I didn't dare to ask questions back, because you don't see any gestures or facial expressions, and you don't notice whether the person is fully involved in his or her presentation and shouldn't be disturbed. And so one concentrated very strongly on listening and always thought: I'll keep the question in mind for now. But I guess a few questions were lost that we actually would have had for the second part." (Student I_PGS2_interview)*<br><br>*"Well, it's uncomfortable for me to talk to you, because you're so above me." (Student K_PGS2_interview)*<br><br>*"That made me a little sad, because I didn't know what they looked like, but they knew what they looked like. But otherwise - I also paid a lot of attention to the nodding of the head or the shaking, or the hands, actually (...) I think that I was perhaps a bit more confident in my presentation because I didn't look around all the time to see how people are looking or reacting. And I think I wouldn't necessarily have asked a lot of questions because I thought to myself at the moment, maybe that's a stupid question - but I didn't see how people were looking at the moment anyway, so I was more likely to ask them and say what I was thinking. (Student G_PGS2_video statement)* |

## 5. Discussion and Implications

The results summarized above are subject to certain limitations. Regarding the samples of this exploratory study, it is essential to note that a convenience sample was used. Hence, against the background of the qualitative research approach and sampling method, the interviewees are not representative of their respective groups. Thus, the results may not apply to other preservice teachers in the same way. Furthermore, in this first exploratory study, the focus was on the perceived learning processes but not on the effects of the instructional design on the advancement of TPACK as meta-conceptual knowledge. This focus was chosen to better understand the effective implementation of video-based communication and a fully immersive learning environment for instructional design.

Concerning the further development of a pedagogical concept for initial teacher education, the results and the participatory observation of the study are leading to the following conclusions and pedagogical implications for an instructional design that promotes metacognitive learning processes in remote teaching and learning, taking into account preservice teachers' perceptions of the peer group supervision cycles in Zoom and social VR:

(1) Group size

To adapt the concept of peer group supervision to the seminar's conditions, the seminar duration was set to 90 minutes to give every participant the same amount of time to present a case or question. Consequently, no more than three to four participants (each 30 minutes supervision cycle) could form a group.

- ➔ Small size groups of up to a maximum of four people were perceived as productive and helpful. However, less than three participants would lead to less input and limited exchange of perspectives and opinions.

(2) Design task

At the beginning of introducing the design tasks and the new concept of peer group supervision, students faced multiple insecurities such as how to perform the complex task that allows multiple approaches and how to conduct peer group supervision. Moreover, students did not know each other and what to expect from their peers. However, this led to the initiation of questioning, reasoning, and reflective processes necessary to start creating their design. Students realized that there were several approaches of how to conduct the design task, observing their peers. For the students´ support throughout this process, timely teacher feedback is essential. This way, insecurities related to their approaches can be reduced, and students become more confident to follow their design. As observed, the second design task was perceived as more manageable and clearer. Also, students seemed to be more focused and goal-oriented in working on their designs. After the second peer group supervision, reflection statements led to the assumption that students gained more confidence in presenting their design drafts and showed fewer insecurities. Based on the video statements and the interviews, peer and teacher feedback related to the designing process played a vital role.

- ➔ The design task and PGS cycles need a thorough introduction and a test run.
- ➔ Teacher’s feedback should be placed after each PGS to clarify uncertainties.

(3) Peer group supervision cycle

As already mentioned, one can assume that preservice teachers gained more confidence throughout the design process from PGS I to PGS II and reported a more effective workflow in groups.

Participants who took part in Zoom in PGS I followed the PGS cycle's structure more consistently than in cycle one. Assumingly, students became more acquainted with the task, the cycle, their peers, and their design process. As a consequence, they felt more comfortable with interrupting their peers and risking the cycle's structure, but at the same time, this led to a lively exchange.

Preservice teachers that took part in the new social VR environment in PGS II had some difficulties in following the structure as intended. First, it took longer for them to start with the PGS cycle as they were distracted by social VR's surroundings and avatar representations. After starting the process, missing non-verbal communication cues led to uncertainties when to speak without interrupting peers. As a result, students listened more closely to each other's presentations and paid attention to gestures and body movements to interpret speakers' turns. On the one side, this might promote the cycle's consistency, as fewer interruptions will occur. On the other side, prompt questions and peer feedback might also be reduced and, thus, also its value for the learning process.

- ➔ For future PGS in social VR, it is recommendable to have more social VR sessions, so that students get used to the social VR surroundings, preventing too much time spent with VR's distractions.

(4) Communication and collaboration with peers in reversible roles

Concerning the implementation of digital collaboration media supported communication and collaboration throughout the PGS cycles, from students’ perspective Zoom was beneficial for the group work in the PGS cycles. The screen sharing option and the breakout rooms resembled the peers' communication and collaboration style. Described as "realistic" and like "f2f" discussions, communication in Zoom was not perceived as disruptive. However, Zoom and the other collaboration platform (Miro) were the main communication tools throughout the semester and thus were frequently used. Through this repetitive media usage of the teacher educator as well as in group works, students internalized how to integrate the platforms in their PGS. In seminar sessions, when PGS did not take place student tutors and the teacher educator accompanied closely breakout sessions to support media usage and to give prompt feedback.

Communication and collaboration in social VR were not perceived as disruptive. However, communication processes were hindered or restricted due to missing non-verbal communication cues. Although the pulsating dot signaled the speaker's turn, it cost more concentration and cognitive load to interpret how group communication processes work. Within 90 minutes, the groups in social VR had to manage more cognitive load on top of managing

the PGS cycle's structure. This could be facilitated with more support measures, adapting it to social VR's conditions. Such measures could be:

- ➔ more breaks throughout the PGS cycles signaled in VR by a watch
- ➔ implementation of features that allow note-taking, f.e. a virtual chat
- ➔ regular social VR sessions so that students get acquainted with VR hard-and software and thus communication and collaboration processes
- ➔ more than two PGS cycles to facilitate structure to be followed
- ➔ strengthening the sense of community with group tasks at the beginning of the semester
- ➔ flexibility in teacher presence and absence so that students have someone to turn to with questions but still mainly collaborate with peers

Simultaneously, the notions of the consequences of social VR's anonymity based on avatar representation might help students to be more self-confident, not fearing to be judged by others, or reducing stuttering and this way offering pedagogical potentials like promoting self-regulation and self-efficacy. This effect could be used, when groups are acquainted with each other and with the process, groups could be mixed up with changing avatar representations to create the anonymity effect and to promote change of perspectives that favors the reflecting process.

From a teacher educator's perspective, the implementation of peer group supervision in social VR requires thorough planning and designing of seminar sessions. The difficulty lies within finding the right balance of knowledge transfer, technology integration, and giving enough time for students to construct knowledge on their own without overwhelming them. Most importantly is the close teacher's support for students throughout the process. As the constructive learning process and the technology are perceived as new and connected to a sense of insecurity, students tend to struggle with the detachment of teacher-centered seminar sessions.

For future works, it will be necessary to investigate how preservice teachers' TPACK development takes place and how video-based communication and social VR might influence it.

The findings from this exploratory study are currently incorporated into the further development of pedagogical concepts using social VR in teacher education. The provision of the pedagogical approaches and the developed materials, as well as the social virtual environment as open-source, will contribute to the dissemination of social VR scenarios in different educational contexts.

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