Chapter 3
AI-Based Virtual Classroom Simulator With a Recommendation System in Preservice Teacher Training During COVID-19

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ABSTRACT

Teaching practicum is an essential component of any teacher training program. It usually involves theoretical knowledge related to content and teaching in general, classroom management strategies, and skills utilized when confronted with challenging situations. Distance learning tools may impact knowledge transfer. Using artificial intelligence-based virtual classrooms posed a challenge for pre-service teachers to address teaching and learning due to the COVID-19 pandemic. This study addresses incorporating an artificial intelligence-based virtual classroom environment with a recommendation feature as an open-access software to help pre-service teachers develop their teaching skills. Also, the study addresses recommendations to support educators' professional development. Finally, further recommendations and future directions provide thought-provoking ideas for using artificial intelligence-based virtual settings for teaching.

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1. INTRODUCTION

Pre-service teachers take practicum courses where they are required to reflect their domain knowledge into real classroom settings (Lee & Wu, 2006). Pre-service teachers were scheduled at schools where they were required to get engaged in planning the teaching process, classroom management, monitoring and evaluating students' learning (Koç & Yıldız, 2012). Unfortunately, due to the COVID-19 pandemic, pre-service teachers could not attend teaching practice courses as well as their field teaching at schools.

However, it is of great importance that teachers, who have the biggest share in qualified education, complete their education by getting enough experience. In this context, we designed an online teaching practicum course that will cover practical and theoretical hours through the COVID-19 pandemic. During the practice hours of this lesson, we aimed for the pre-service teachers to gain experience in a simulated virtual classroom-SimInClass (SVC) instead of real classroom settings. Once we have experienced such an unexpected situation, this tool has been redesigned to keep pre-service teachers on track with their teaching practicum. In this study, it was explained how to redesign the SVC to engage pre-service teachers in the COVID-19 pandemic.

The concept of simulated virtual classroom (SVC) is usually coined with the idea of dispelling the shortcomings in real-world practice. SVCs are expected to model of an authentic classroom environment so that participants could utilize their skills such as problem solving, decision making, and planning to improve their teaching skills. Research also indicate that as the use of SVC increases, the frequency of asking student-specific feedback and questions increases in pre-service teachers' real classroom experiences (Dieker, Hughes, Hynes & Straub, 2017). SVC provides frequent rehearsal experiences, improving the skills of classroom management-communication (Donehower, Bukaty & Dieker, 2020), enhancing the use of teaching methods and techniques (Knezek, Christensen, Tyler-Wood, Fisser, & Gibson, 2012). In addition, SVCs improve pre-service teachers' self-efficacy, strengthen their beliefs about their teaching competencies (Knezek et al., 2012). SVCs make it easier to establish a tight link between teacher training and teaching practice (Theelen, Van den Beemt, & den Brok, 2019). Having considered all these positive and complementary effects, SVCs are considered as a powerful tool for pre-service teachers' professional development.

However, the impact of these environments on pre-service teachers' emotional engagement is controversial. Stavroulia, Botsari, Psycharis, and Kekkeris (2016) found that pre-service teachers using SVC experience negative emotions such as anxiety, disappointment, nervousness. Park and Ryu (2019) stated that pre-service teachers' moods changed in SVC depending on its design features. They found that

when unexpected interaction was provided in the environment, more positive and neutral emotions were experienced. Furthermore, they added that participants had higher emotional engagement than expected interaction. In this study, it was aimed to support teachers emotionally with the design features of the redesigned SVC.

2. ARTIFICIAL INTELLIGENT BASED VIRTUAL CLASSROOM ENVIRONMENT: SIMINCLASS

SimInClass is a three-dimensional game-based computer simulation that imitates authentic events. The simulation aims to benefit from the positive effects of serious games and to help teachers' professional development in alignment with certain goals. It includes lesson planning, recognizing student profiles, interacting according to these profiles, classroom management, and using technology-supported tools in the classroom.

At SimInClass, pre-service teachers are, first, expected to plan the lesson they will practice. This phase includes instructional design of the lessons, classroom seating arrangement, and choosing the numbers and the characteristics of students from a list. The instructional design in virtual lessons is based on the Gagne, Briggs, Wager's (1992) Nine Events of Instruction model. The seating arrangement can be adjusted to either U, circle, group, and/or traditional in-row. The seating arrangement can also be aligned differently for each part of the course.

Each virtual lesson is a simulation of a real 40-minute lesson. In this phase, pre-service teachers practice teaching based on their planned lesson and respond to certain unanticipated misbehavior in the classroom as a challenge. If they had included in the planning phase, pre-service teachers may give tasks that require virtual students to use smart boards and tablets. The performance of the pre-service teachers during the lesson is presented to them through a panel showing students' levels of concentration, entertainment, and knowledge simultaneously (Figure 1).

At the end of the lesson, the pre-service teachers are presented with a performance report, as illustrated in Figure 2. In this report, their performance is scored based on the course plan, the use of technology in the course, and the effectiveness of the coping method towards misbehaving virtual students (Kelleci & Aksoy, 2021). In addition, the report presents graphs of concentration, enjoyment, and knowledge levels of each virtual student during the lesson, and the misbehaviors exhibited are shown on the timeline. It includes the coping method shown by pre-service teachers for misbehaviors and the feedback on the effectiveness of this method.

All these features are valid for the "Practice Against Artificial Intelligence" mode, which is free to use in SimInClass. In addition to this mode, the simulation

Figure 1. SimInClass Interface

Figure 2. Practice Performance Report

"Practice With Colleagues" and "Practice in Virtual Reality Environment" modes are also available (Doğan et al., 2019).

3. INCORPORATING AN ARTIFICIAL INTELLIGENT BASED VIRTUAL CLASSROOM ENVIRONMENT WITH A RECOMMENDATION FEATURE

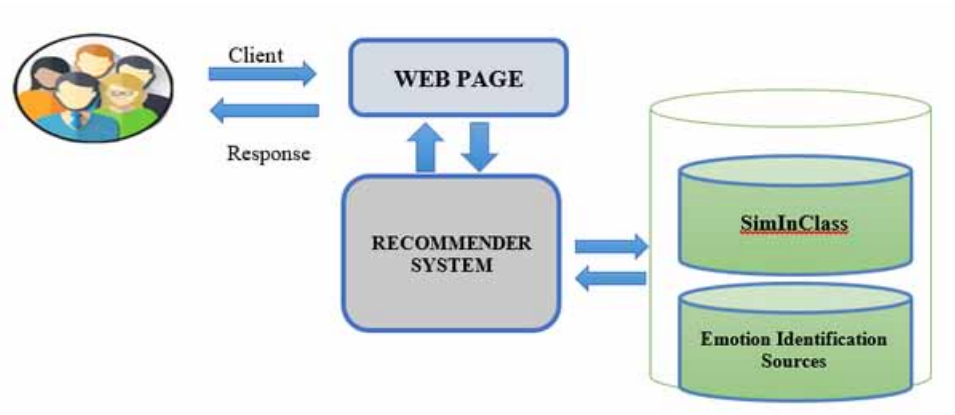
Initially, SimInClass provided a summative report only on pre-service teachers' classroom management competencies. During their teaching practice, AI-based virtual students displayed misbehaviors, and teacher trainees were requested to interfere with appropriate responses. Once the practice was over, the recommendation system produced a report to the teacher trainee to examine. In this study, however, we have also focused on the development of interpersonal and emotional competencies that pre-service teachers performed during and post-teaching practicum courses. For this purpose, first, a series of student–teacher discourse were added to SimInClass. These discourse units had been used to trigger cognitive-emotional responses from teacher trainees when teaching in a virtual class. Secondly, a recommendation feature was also designed and utilized to produce a report based on the pre-service teachers' emotional states resulting from their verbal interactions with students and the events taking place in the classrooms.

Recommender systems generally store users' feedback on the proposed items and use them to improve the recommendation process in the future (Ricci, Rokach, & Shapira, 2011). In this context, the general purpose is to save the users from the mass of information presented in an environment and to direct them to find the most appropriate information that best meets the user's expectations. In an educational context, recommender systems support teaching and learning through access to enhanced information (Rivera, Tapia-Leon, & Lujan-Mora, 2018). In this context, two different sources fed the SimInClass' recommendation module. The first one was the student–teacher discourse. The second source gathered the data from physiological (electroencephalogram-EEG, galvanic skin response-GSR) and physical (facial expression) sensors, which enabled the identification of pre-service teachers' emotions.

Student–teacher discourse had been incorporated into SimInClass based on an analysis of 16- hours of classroom talk, which was collected previously from real classroom settings. The classroom talk had been transcribed into text and the discourse was analysed based on their functional usage. Based on the results of the analysis, eight basic functions have been coded based on the emotional discourse patterns exhibited between students and teachers: making demands, initiating, responding, evaluating, interpreting, explaining, reconciling, and directing. Then, student-teacher discourse units had digitally recorded using text-to-speech software in different emotional tones (positive-negative-neutral) representing male and female voices. These voices, then, had been embedded in the SimInClass environment.

The recommendation module is designed as a web-based reporting tool. The general structure of the system is presented in Figure 3. The system, fed by system records from SimInClass and data from sensors, offers the necessary report to its users via a web page.

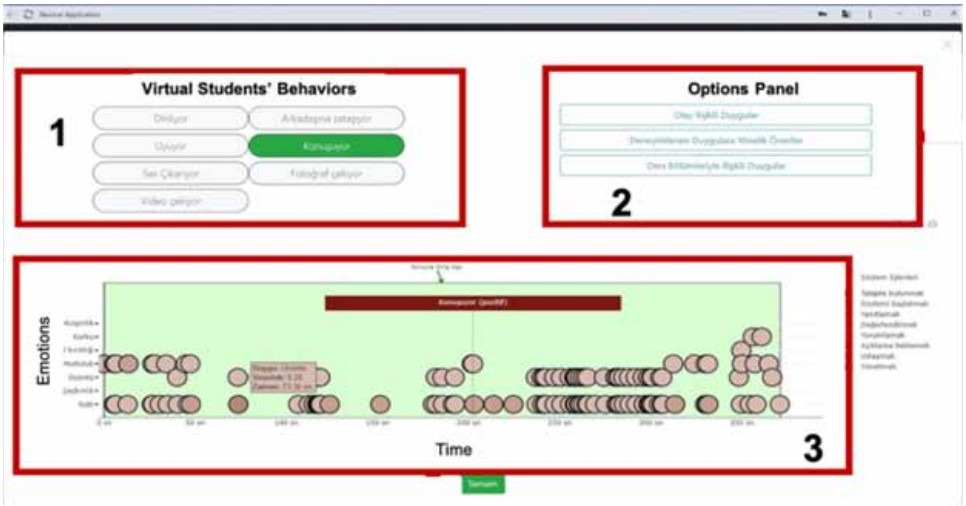
Figure 3. System Architecture for SimInClass Recommendation Feature



The recommendation module is basically designed to include (1) interpreting and visualizing the data obtained from SimInClass and emotion identification sensors, (2) presenting the interpreted data to the user in text format, and (3) providing recommendations to the pre-service teachers.

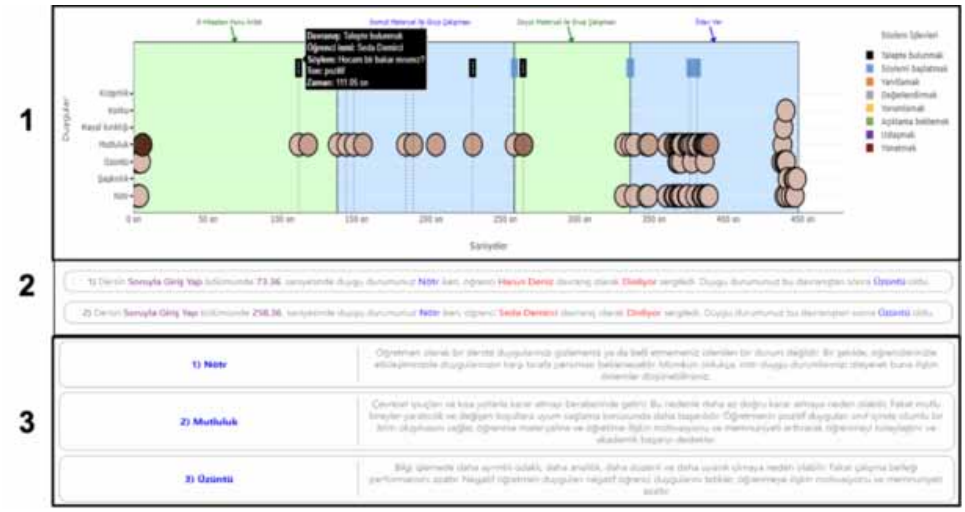
The user interface and the functions of the recommendation module are represented in Figure 4. Section number one displays discourse and misbehaviors exhibited by virtual students. Recommendations and graphics given by the system are presented according to the selected classroom behavioral situation (Speaking, Damaging Equipment, etc.). In section number two, users are provided options to visualize pre-service teachers' emotional state based on the events taking place in the classroom (student–teacher discourse functions or misbehavior types) and on the part of the lesson. Simply by selecting the relevant one, users can access the data analysis. In section number three, pre-service teachers' emotions are mapped across the unit of the lesson and the time of the event based on the events taking place in the virtual classroom. Time-dependent emotions are represented with graphics in accordance with the options selected in the first and second sections. In the graph, the changes in emotional states, the activities in the lesson, the speech functions from the discourse scheme, and the tone of the speech are presented in detail. The graph also displays the time period in which emotional states are experienced.

Figure 4. User Interface of SimInClass Recommendation Feature



Graphical representation of the in-depth recommendation feature of SimInClass is presented in Figure 5. The events, units of the lesson, and emotions are represented across time scale in the first section. Teacher trainees' data had been reflected in dots with varying sizes so that they can observe what kinds of emotions they had displayed at which section of their teaching. The changes in emotional stances had also been presented under this graph in textual format (see Number 2). Magnifying option has also been included so that they could zoom in and out to certain part of their teaching to examine more in depth. Finally, in section 3, recommendations are provided to pre-service teachers according to the dominant emotional state they had experienced. These recommendations were created based on the research

Figure 5. Graphical Representation of the Recommendation Feature of SimInClass



results from existing literature. General and awareness-raising suggestions are presented to pre-service teachers. In this way, pre-service teachers can predict how they will experience emotions based on events from their real teaching experiences. Recommendations are created by focusing on the effects of pre-service teachers' emotional states on their teaching performances, learning performances, classroom climates, and cognitive performances.

4. IMPLEMENTATION OF ARTIFICIAL INTELLIGENT BASED VIRTUAL CLASSROOM ENVIRONMENT

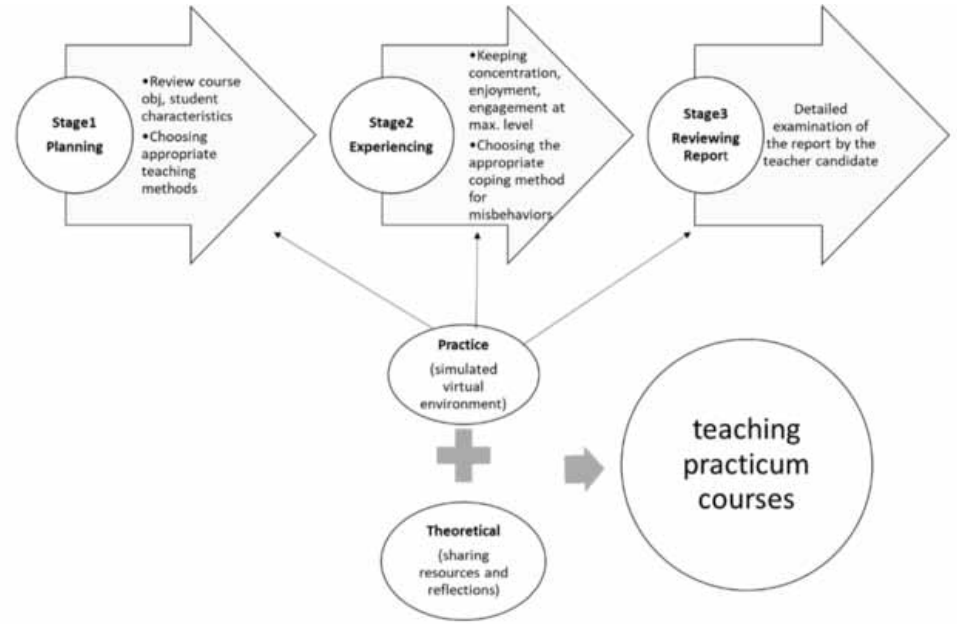
SimInClass is utilized to complement the process of teaching practicum courses for pre-service teachers who could not attend teaching practice courses due to the COVID-19 Pandemic. Practicum course was designed to include both theoretical and practicum sessions as modeled in Figure 6. Theoretical sessions are presented both in synchronous and/or asynchronous modalities through a learning management system (LMS). Practicum sessions are simulated in this AI-based virtual classroom so that pre-service teachers are urged to practice their teaching skills during the practice hour.

During theoretical sessions, pre-service teachers are asked to complete reading tasks in order to consolidate their subject area knowledge and pedagogical knowledge along with their reflections on them with the lecturer and peers in synchronous lessons.

Practicum sessions are designed in three stages: lesson planning, classroom management, and monitoring and evaluation skills of the virtual students in the SVC. At the end of their each practice, personalized recommendation report was provided by the system to them so that separate mentoring sessions could be organized accordingly. Before they proceed to teach, some classroom arrangements and information sessions are provided to the pre-service teachers.

In the first Stage, pre-service teachers plan their teaching process by taking into consideration the objectives of the course they would deliver in the SVC. Then, pre-service teachers are requested to deliver their classes in the simulation environment. During their practice teaching, pre-service teachers are advised to keep the level of concentration, enjoyment and knowledge levels of virtual students at the highest level with the activities they had prepared. Once they complete their course, they have presented a detailed report by the simulation. The report can also be saved and compared to the results of the next levels, which are more complex (Stage3).

Figure 6. Teaching Practicum Courses during COVID-19 Pandemic



5. CONCLUSION

It is valuable for pre-service teachers to receive recommendations regarding their teaching experience from their mentors. SVCs offer and extend this opportunity further to reinforce their experience with virtual students in various authentic classroom environments during their training. Thus, they may increase the frequency of their practicum hours and receive constant feedback to improve their teaching performance (Rayner & Fluck, 2014). Moreover, SVCs are seen as an especially useful tool for teaching practicum courses in universities as they facilitate the discussion of sample scenarios for classroom teaching (Kelleci & Aksoy, 2021). SVCs also promote the professional development of pre-service teachers with their reports in lack of actual classrooms and face-to-face mentor meetings due to the COVID-19 pandemic.

On the other hand, it should also be noted that whether an SVC contributes to the professional development of pre-service teachers depends largely on the design features (Stavroulia et al., 2016; Park & Ryu, 2019) and how they are utilized. Therefore, a new recommendation feature was designed and embedded into SimInClass to support the interpersonal and emotional competencies of pre-service teachers, which are two important components in developing teachers' classroom management skills (Theelen, Van den Beemt, & den Brok, 2019).

In SimInClass, authentic tasks which require certain cognitive skills needed during teaching (such as problem-solving, decision-making, and planning) are developed and presented to pre-service teachers. Since cognitive processes are intermingled with emotional processes (Kaltner & Jansen, 2014), these interactive patterns have been gathered to be analyzed later. The analyses of data indicated that teachers experienced a combination of emotions while teaching, including happiness, anxiety, and confusion, which play an important role in improving the quality of instruction and knowledge acquisition in teacher education (Linnenbrink-Garcia, Patall, & Pekrun, 2016). Consequently, pre-service teachers could access the recommendation feature, which displayed how their cognitive-emotional stances changed and/or maintained while coping with the tasks provided.

Rivera, Tapia-Leon, and Lujan-Mora (2018) examined the use of recommender systems in educational contexts. They found that majority of those studies reported the functions of recommender systems to be providing advice on educational options, personalized curriculum, and orientation to learning material. They further pointed out that very few recommendation systems exist to help professional development, and only one study by Kong, Boll, and Heuten (2013) focused on the professional development of teachers. Kong, Boll, and Heuten (2013) explored the design of a recommender system that enabled information sharing and transfer between teachers and pre-service teachers. Pre-service teachers' behaviors and reactions were evaluated with the added recommendation feature based on expert knowledge. In this study, an in-house recommendation system was reported to show how it might support teachers' both individual and interpersonal competencies in a simulated virtual class environment. It was observed that the recommender system has contributed to the professional development of pre-service teachers during the COVID-19 pandemic. As stated by Garcia-Martinez and Hamou-Lhadj (2013), recommendation systems have quite significant potentials in increasing learning performance, improving social learning, and increasing motivation.

6. RECOMMENDATIONS AND FUTURE DIRECTIONS

Although teaching in a virtual class cannot replace teaching in real settings, it is thought that SVCs are usable for a couple of reasons. First, teacher trainees could have the opportunity to experience quite a variety of classroom contexts in those environments. When they attend to teach in a real classroom, their teaching experience would have been limited to whatever is available. However, in SVCs, various scenarios in various settings could be modeled so that pre-service or prospective teachers could find opportunities to practice in different classrooms. Secondly, feedback and recommendations from mentors and/or peers might be limited to whatever

recorded and/or observed in a limited time span. With the help of computerized recommendations, teacher trainees could have the chance to observe how and what they performed as well as what they felt during teaching their classes. Last but not the least, if such environments could not have been utilized, their experience would have been limited to theoretical discussions with no practice if such exposures are not available to them, as in during the COVID-19 pandemic.

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