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Precision Education Evaluations for Small Class Courses Using Artificial Intelligence

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Abstract: Recently, small class course teaching, with less than 30 students, seems to outperform the traditional large class course teaching in the field of education. Students can use online private course platform to preview course-related knowledge and promote practical experiences of offline courses. In this study, an evaluation strategy has been proposed for precision education protocol in small class course (SCC) based on artificial intelligence (AI), with the goal of focusing on the curriculum design and teaching approaches. By using the AI precision education model, the teaching approaches of SCC can be integrated into the traditional classroom. The results showed that the AI precision education model can promote the learning outcomes and enhance students' learning achievements.

Keywords: Small class course; Artificial intelligence; Precision education; Education model

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1. Introduction

Massive open online courses (MOOCs) are a novel way of teaching and learning in universities. However, it still has drawbacks that must be addressed, such as low completion rate with high registration and high costs for platform maintenance. Furthermore, when compared to physical courses, the interaction between teachers and students poses a huge gap, and the effectiveness of the course as well as the evaluation of attendance are still in need of refinement.

Recent years, many AI based models have been proposed for small online courses and MOOCs. Results have shown that while these types of courses cannot replace teachers in the traditional education pipeline, they can improve educational efficiency [1]. In this way, contrary to various teaching paradigm, there are still some defects in the online and offline module. Small private online courses (SPOCs) are another type of online course that can be used as a supplement in the classroom to boost teaching and learning in specific situations. SPOCs, which have a high class completion rate, are very effective in promoting physical classroom education outcomes and have received much attention from all around the world. This method, on the other hand, focuses solely on form and effectiveness, with limited exchanges between teachers and students. Furthermore, all of these courses necessitate the commitment of additional time and the right to select a specific course, with emphasis on learners' experience.

In the educational process, teachers are frequently confronted with students' individual differences in terms of ability, attentiveness, and learning effectiveness. These mostly limit the course outcome based on various instructional planning and measures, and most of these challenges increase the likelihood of success [2]. In small class courses, adaptive teaching has evolved into focusing on the flexibility and diversity of students’ learning styles, which is vital for learning the patterns and opportunities concerning students’ learning paradigm. Unfortunately, some students are still accustomed to following their teachers’ instructions and are struggling to adapt to the new style, demonstrating the relevance of individual variations among students in SCC [3]. Personalized education usually integrates technical resources and methods with the habits of learners, and all of these protocols lead to the concept of “precision,” which is a trend that has been inspiring researchers. This study intends to determine if an artificial intelligence assisted learning system with high interactivity between teachers and students in a hybrid learning model can improve the teaching effect in the context of SSC and personalized education.

This research aims to make comparisons among MOOCs, SPOCs, and SCCs by using the proposed AI precision education model, and a quantitative measurement experiment is used on these education platforms.

2. Literature review

2.1. MOOCs, SPOCs, and SCCs

The open digital learning method – MOOC – has attracted many learners to participate in courses via the web. It is originally from the MIT’s “Open Course Ware” (OCW), which began in 2002, and it provides a comprehensive overview of physical teaching. The research on the quality of MOOCs can be separated into evaluations-based methods and development process [1-6]. Learning analysis promotes the mastery of the learning process, while evaluation improves the effectiveness of explanations, instructive videos, and methods in the curriculum.

SPOCs are another open-course format derived from MOOCs, which can provide a small number of students with a private course to meet specific needs, thus enhancing the participation in learning and the course completion rate [7-10]. It helps students better understand a certain topic prior to class. In that way, teachers can teach higher-level contents during class. By using SPOCs, students can communicate with their teachers, receive high quality teaching, and produce better outcomes.

SCCs are classes with less than the required number of students: twelve for undergraduate courses, and six for graduate courses. Prior to the start of each term (short terms inclusive), the Office of Undergraduate Studies and Academic Partnerships begins exchanging reports of small classes with the teachers, and they will receive a daily report for that term just the week before each term begins. Students will have more opportunities for interaction with their teachers and earn considerably more incentives through this method compared to other types of courses [11-14].

2.2. AI precision education

In this century, artificial intelligence has advanced significantly, making it easy to shift from a “teacher-oriented” model to a “student-oriented” model. Additionally, virtual and physical reality technologies can be used to create a parallel teaching technology system for online or offline use. Students, following the paradigm of self-directed learners, have varying abilities for learning and knowledge acquisition. Therefore, their strengths and weaknesses vary with the time required for learning along with their adaptation to the learning rhythm [15-17]. Traditionally, education has required students to use the same materials and follow the same learning rhythm as their teachers, but their individual differences and learning paradigm cannot be met at the same time [18]. A new sort of precision education has emerged as a result of personalized and accurate prediction. Big data analysis and cloud computing can accurately address the differences among students as well as support the desired education and training based on specific personal criteria [19]. In addition, teachers can also deal with various situations about a specific education setting and solve the challenges during teaching and learning [20].

3. Methodology

In this study, the small class course and offline course of Beijing University of Architecture and Civil Engineering were used to conduct teaching trials. The core contents of the courses from three different schools in the university were almost identical. The goal of this study is to improve learning effectiveness so that learners can better integrate theory into practice than they could have in traditional offline courses, as well as bridge the gap between learning and application. A questionnaire survey was carried out to gather relevant data, and these data were then analyzed. In addition, several students were also interviewed to better understand the curriculum design and teaching effect following the implementation of MOOCs in the university. **Figure 1** shows the whole paradigm of the teaching model, taking into consideration of the students' attitude, learning satisfaction, and behavior.

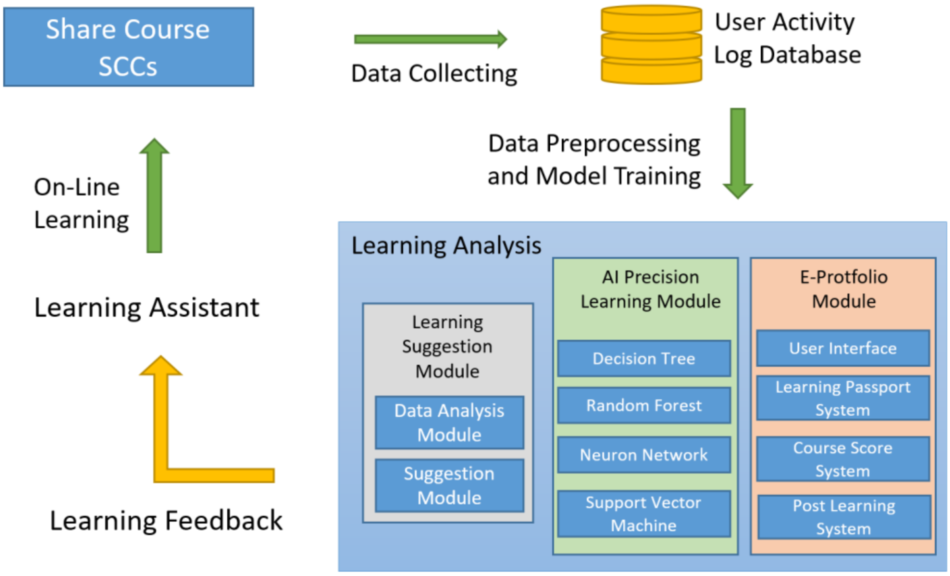

Figure 1. Paradigm of the artificial intelligence-based education model

3.1. Subjects

This study included students from the School of Electrical and Information Engineering (EE), School of Environmental and Energy Engineering (EnvE), and School of Mechanical and Electrical Engineering (MEE) in Beijing University of Architecture and Civil Engineering. These students have all registered under the small class course. There were 43, 42, and 33 students in the three schools, respectively. The students were divided into three groups: training, experiment, and control. The AI precision education model was used for the first and second groups, and some tests were performed to evaluate if SCCs could improve students' learning effectiveness.

3.2. Research process

In order to understand the divergence of different teaching models and evaluate the teaching assistants, a questionnaire survey was carried out to evaluate the AI precision education model. In order to analyze the collected data from SCCs, machine learning models were employed to compare students' enthusiasm in learning and their satisfaction. In order to control the baseline knowledge basic ability, all the students were evaluated using an internet knowledge platform to ensure that each student is at the same starting point. A t-test was performed to determine any significance difference in the students' level across the three schools. Course exercises, handouts, discussions, videos, and other supplementary materials were provided and initiated to support the students' learning upon the commencement of SCCs.

3.3. Research methods

For data integration, the SCCs were registered on the learning platform. All the students were enrolled in a ten-week SCC online and off-line learning course at the university, which includes MOOCs and SPOCs. In order to assume precision education, an AI precision model was introduced. **Figure 2** shows the pipeline of the experiments and the teaching modes with different interactions between teachers and students. All the experiments included one or more variables in the real course setting under our control. As shown in **Table 1**, for the interviews, a questionnaire survey was used. For offline courses, the innovative teaching pipeline is used for AI education model evaluations.

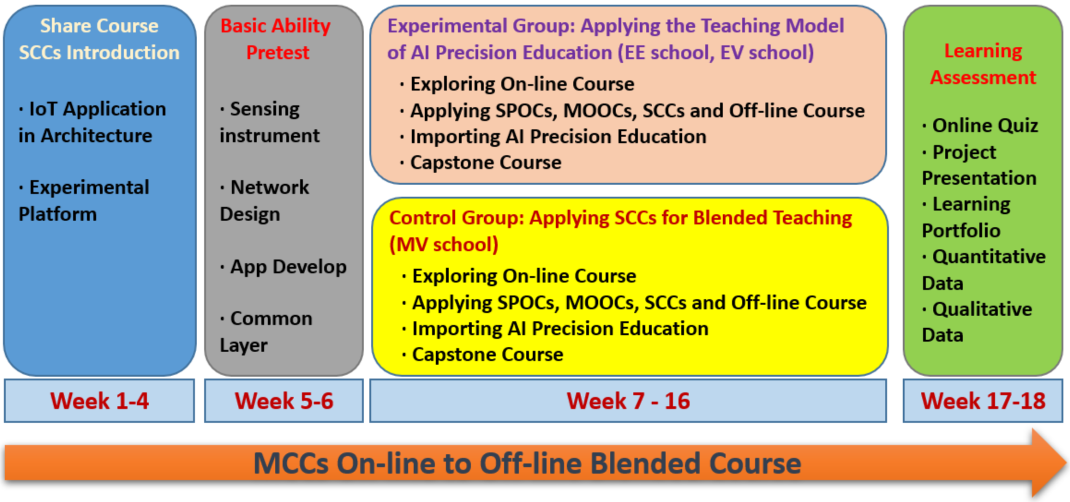

Figure 2. Pipeline of AI based education model

Table 1. Average score of the questionnaire survey

Items	EE	EnvE	MEE
(1) Learning satisfaction			
1. I think the learning effect is better than the general physical class.	4.61	4.56	4.34
2. Teacher-student interaction is good in the courses taught, and there is guided learning.	4.56	4.61	4.71
3. Teachers respond appropriately and constructively to students' questions or assignments.	4.34	4.12	4.32
4. Teachers are enthusiastic yet serious while teaching.	4.66	4.56	4.38
5. Teachers express, explain, and demonstrate clearly.	4.23	4.15	4.36
6. This course enhances my ability in this field.	4.91	4.33	4.12
7. I am willing to continue to take other online and physical combination courses.	4.87	4.55	4.31
8. I would like to recommend others to take online and physical combination courses.	4.77	4.22	4.45
9. Overall, I am satisfied with the experience of this course.	4.67	4.81	4.59
(2) Readiness for online learning			
1. I can plan my time, location, and learning tools according to the weekly learning progress requirements arranged by the teacher.	3.91	3.27	3.77
2. I can effectively use my time to watch teaching videos before class to achieve the learning progress specified by the teacher.	3.89	3.91	4.25
3. I can connect the new concepts learned from watching instructional videos before class with the learning tasks arranged by the teacher during class.	3.78	3.56	4.04
4. When I encounter problems while watching the instructional videos specified by the teacher before class, I can try to seek for help (e.g., finding solutions from the internet).	4.08	4.17	4.39

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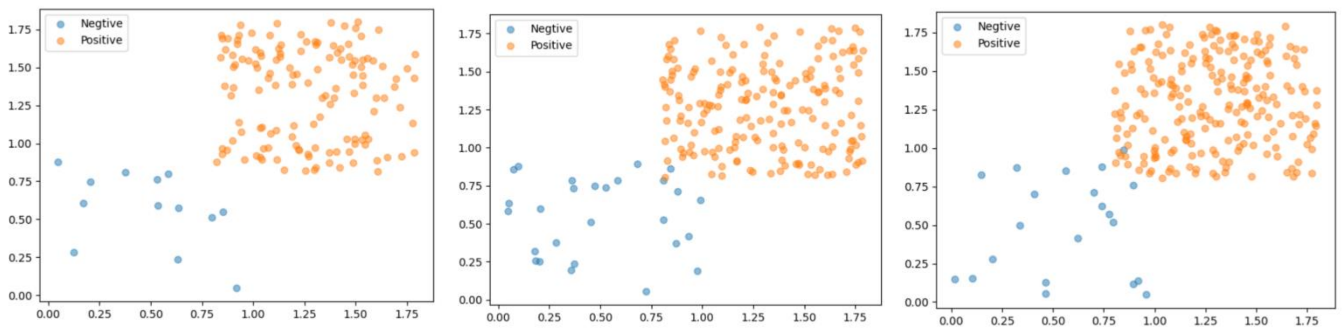
Items	EE	EnvE	MEE
(3) Self-study evaluation			
1. I think I have a good learning attitude.	4.13	4.25	4.27
2. I think I have a good understanding of the concepts of this course.	4.63	4.56	4.77
3. I have high willingness to learn.	4.83	4.36	4.57
4. I have a high degree of confidence in learning.	4.12	4.29	4.39
(4) Learner/teacher positivity			
1. In general, the students are actively involved in this course.	4.37	4.58	4.51
2. The teacher actively participates in the course.	4.51	4.35	4.72
3. The teacher can flexibly adjust the teaching content according to students' individual differences.	4.76	4.83	4.72
(5) Learning activities			
1. I can accept the learning mode of hands-on practice and interactive discussion in class.	4.66	4.57	4.81
2. The practical activities in offline experimental courses allowed me to learn the basics of the internet.	4.65	4.31	4.72
3. The practical activities in offline experimental courses allowed me to experience system development.	4.22	4.34	4.27
(6) Comprehensive issues			
1. I think the teaching videos are of good quality.	4.51	4.89	4.67
2. I think the quality of online and offline interaction is good.	4.78	4.85	4.91
3. I think the teaching mode combining online and physical courses is suitable.	4.67	4.14	4.21

3.4. Precision education model

Relevant learning data records were acquired from the SCCs platform, which contains all learning history and activity information. The data were used as the training set to construct precision-learning auxiliary modules. Decision trees, random forests, neural networks, and support vector machines were employed as learning methods, and SVM was finally selected as the classifier due to data scale constraints. For a better AI-based education model, an attachment guidance was provided to the students to improve their effectiveness and outcomes. Both of these factors help to improve the final education and outcomes in a specific setting, and students will be able to gain better satisfaction with the course design.

4. Results and discussion

The SCCs protocol is evaluated by the proposed AI based education model. The results revealed that the teaching videos in SCCs enable students to learn basic information before the offline course, and there is more flexibility in the connection and communication between offline and online courses. The SVM model classified the students into two groups, one positive and the other negative, which represent the positive and negative responses from the students, respectively. The results are shown in **Figure 3**. Furthermore, the discussion in class and the interaction between teachers and students improved as a result of watching teaching videos before class, thus allowing students to learn more and teachers to teach more. This is a virtuous circle in action. As information courses emphasize on students' hands-on operations, offline thematic practice enables students to apply the acquired knowledge to real-world situations.



(A) (B) (C)

Figure 3. The impact of AI precision education on different students; (**A**) 1:10; (**B**) 1:15; (**C**) 1:20

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