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Creating Meaningful Connections: The Role of Simultaneous Multi-Situational Learning in Knowledge Contextualization and Application

Chih-Yen CHEN[a], Su-Hang YANG[b], Meng-Xuan XIE[a], Yi-Chuan FAN[c], Jen-Hang WANG[c*] & Gwo-Dong CHEN[a]

[a] Department of Computer Science and Information Engineering, National Central University, Taiwan
[b] Department of Hospitality Management, Chien Hsin University of Science and Technology, Taiwan
[c] Research Center for Science and Technology for Learning, National Central University, Taiwan
*harry@cl.ncu.edu.tw

Abstract: This study investigates the effectiveness of a simultaneous multi-situational learning system with embodied recognition to enhance learners' outcomes. Traditional situational learning systems provide a single situation for knowledge explanation or application, which limits learners' ability to fully immerse themselves in the learning environment and receive immediate feedback. To address this, a simultaneous multi-situational learning system was proposed to create a digital space with multiple situations, allowing learners to immerse themselves in different scenarios simultaneously and facilitating reflective learning. An experimental study with 60 undergraduate students in a Hospitality Japanese course compared a control group using the traditional situational learning system with an experimental group using the proposed simultaneous multi-situational learning system. Results showed the proposed system significantly improved learning outcomes, understanding, and interest in learning. It enables the prompt creation of situational learning environments, contextualizes knowledge, and fosters reflective learning with real-time feedback. Overall, this study contributes to the field of education by providing a more effective approach to situational learning that can be easily implemented in classroom settings.

Keywords: Situational learning, embodied cognition, Simultaneous multi-situation

1. Introduction

1.1 Background

Situational learning is an approach that allows learners to immerse themselves in situations where knowledge may be applied, thereby strengthening the connection between knowledge and its practical applications in real-world situations. Brown, Collins, and Duguid (1989) emphasized the importance of learning in an environment that corresponds to its situations and showed that knowledge can be contextualized. Consequently, researchers explored how to design a situational learning environment to enhance learners' learning outcomes, and they showed that situational learning is an effective method helping learners to acquire knowledge (Herrington & Oliver, 2000). On the other hand, creating an appropriate situational environment in the real world can be time-consuming and complicated, making situational learning rarely be applied in traditional classrooms (Dede, 2009).

However, with the development of technologies, virtual environments can be constructed more easily, leading the provision of situational learning methods in virtual environments. Wu et al. (2015) have proposed an approach in which real human images are combined with virtual scenes to enable learners to not only immerse themselves in the situation but also see their own appearance and inspect performance in the virtual environment. This approach can be particularly useful in establishing a situational learning environment promptly in classrooms and facilitating reflective learning.

In addition, embodied cognition theory shows that learners can acquire knowledge through the interaction between their bodies and the environment (Wilson, 2002). Furthermore, some research suggested that embodied interaction in virtual space can improve user engagement (Lindgren et al., 2016). Recently, Wang et al. (2020) demonstrated that the integration of body recognition services in digital learning environments allows for learners to interact using embodied behaviors, Furthermore, computers can function as personal instructors, identifying inadequate aspects of posture and emotional expression during the learning process, and guiding learners to adopt correct behaviors (Xie et al., 2022).

However, during a learning process, the context is not limited to only one situation. The Mantle of the Expert (MoE) theory, proposed by Heathcote and Bolton (1994), suggests that when learners are asked to present a professional role by the instructor, they must learn relevant knowledge and imagine a situation to achieve their goal. As a result, they will need to play a variety of different roles when they face different events that change at the same time. Additionally, the Legitimate Peripheral Participation (LPP) theory (Lave & Wenger, 1991) states that the best way to learn complex skills is to become a member of a problem-solving team. Therefore, it is necessary to understand the status of different roles in different situations. As demonstrated, multiple scenarios are essential to explain various situations during situational learning.

1.2 Motivation

As aforementioned, it is evident that current studies typically restrict learners' learning to a single situation in which they only witness the application of knowledge but do not fully grasp how it is contextualized. However, with the advancements in technology, particularly in the fields of AI, GPU, memory, and related technologies, situational learning systems can now be combined with recognition services. This integration facilitates the provision of situational feedback by detecting learners' embodied behavior while simultaneously presenting multiple situations. Consequently, learners can immerse themselves in multiple scenarios simultaneously, enabling them to contextualize and apply their knowledge in various contexts.

1.3 Research Objectives

This study aims to build a learning system that can identify users' embodied behavior and provide them with the situation of knowledge explanation, the situation of knowledge application, and the situation of post-problem-solving. The main goal is to verify whether this system can improve learners learning performance by allowing them to immerse in simultaneous multi-situational scenarios.

1.4 Research Question

This study investigates whether the proposed simultaneous multi-situational learning system, which generates different situations for the needs of knowledge learning and service and enables the coexistence of various situations in a digital space, can lead to better learning achievement compared to traditional single-situation learning systems. Therefore, the research question is: "Could the simultaneous multi-situational learning system outperform traditional single-situation learning systems in terms of learning achievement?"

2. Related Work

2.1 Situational Learning

Situational learning is a valuable approach that emphasizes the interaction between learners and the environment to acquire knowledge. Brown et al. (1989) emphasized that knowledge is acquired through interaction with contexts of the environment, making situational learning a valuable approach to strengthen the connection between knowledge and practical application. Gagne et al. (2005) also argued that learning is most effective when it is applied to real-life situations. To improve learners' thinking, exploration, and problem-solving abilities, situational learning aims to immerse learners in various situations for exploration and reflection. Scholars have proposed various methods of situational learning, including authentic learning and drama-based learning. Authentic learning combines learning content with real-world issues, allowing learners to learn and practice at the same time, which has shown to improve learning outcomes (Ornellas et al., 2018). Drama-based learning involves learners collaborating to perform a drama, which can increase learner engagement and promote active learning (Dawson & Lee, 2018).

Additionally, previous research on situational learning has used different approaches, such as situational classrooms and simulated environments. The English Village is an example of a situational classroom that transforms a traditional classroom into a foreign language learning environment (Kelch, 2011). Similarly, the Clinical Skills Center of the National Taiwan University Hospital has created simulated spaces for performing surgeries and medical examinations to allow learners to become familiar with the process of seeing a doctor. With advances in technology, situational learning has been combined with multimedia technology to simulate learning situations in real environments. For instance, Chou et al. (2012) developed a computer game that combines game-based learning with situational learning, enabling elementary school students to learn how to react during earthquakes. Moreover, digital spaces built in the classroom based on drama-based learning enable learners to perform dramas and learn in the situation (Wu, 2015). All of the above confirm the feasibility of digital learning platforms for situational learning.

2.2 Embodied cognition

Recent technological advancements have made it possible to create realistic environments in a digital way. Studies have indicated that situational learning in digital reality can improve learning outcomes (Giasiranis & Sofos, 2016). In recent years, human-machine interaction has become more diverse, with additional sensors or recognition systems detecting users' embodied behaviors. Linden Lab's Second Life, for instance, uses Windows, Icon, Menu, and Pointer (WIMP) for interaction, allowing learners to control virtual avatars through devices and interact with the virtual world through WIMP. With the development of VR and AR, users can experience more immersive interactive experiences (Buttussi & Chittaro, 2017). Research suggests that using VR in education can enhance learners' learning motivation and improve their performance, outperforming observation and exploration (Kavanagh et al., 2017; Kwon, 2019).

Situational learning combined with embodied interaction can be advantageous for educational applications. However, in most embodied interaction situations, users enter the digital world as a virtual avatar, which makes it difficult for them to observe their own performance in the digital world and engage in reflective learning. To address this limitation, Wu et al. (2015) developed the Digital Learning Theater (DLT), a drama-based digital reality system that allows learners to immerse themselves in the digital environment through a mirror image, enabling them to see their own performance during the drama and engage in reflective learning.

3. Implementation

3.1 Design Concept

In this study, we designed a simultaneous multi-situational learning system that aims to enhance learners' connection between situations and knowledge. The system consists of four situations: the "situation of knowledge presentation," "situation of knowledge explanation," "situation of knowledge application," and "situation of post-problem-solving." The "situation of knowledge presentation" provides learners with the necessary concepts and knowledge through textbooks and lectures. The "situation of knowledge explanation" is an interactive mechanism that allows learners to select specific contents for more in-depth learning. The "situation of knowledge application" provides learners with scenarios that allow them to apply what they have learned to real-world situations. Finally, the "situation of post-problem-solving" provides a feedback mechanism that allows learners to reflect on and incorporate the knowledge and experience gained from the previous situations into their own learning process. To implement the system, learners will access the different situations through a digital platform, and each situation will be designed to provide a unique learning experience. The system will evaluate learners' performance by monitoring their embodied behavior during each situation and providing feedback in the "situation of post-problem-solving." The feedback will be designed to help learners reflect on their performance and incorporate their learning into future situations, thereby improving their learning outcomes.

3.2 System structure

The system design of this study consists of three modules: the drama-based simultaneous multi-situational display system, the simultaneous multi-situational editor, and the database, as shown in Figure 1. Instructors and learners can use the simultaneous multi-situational editor to manage materials and edit the script stored in the database. When learners perform in a drama, the simultaneous multi-situational display system retrieves the relevant data from the database and overlays multiple scenes, changes scenes, and dresses focus situations. Finally, the learners can observe their appearance and performance in the digital space via the displayed video.

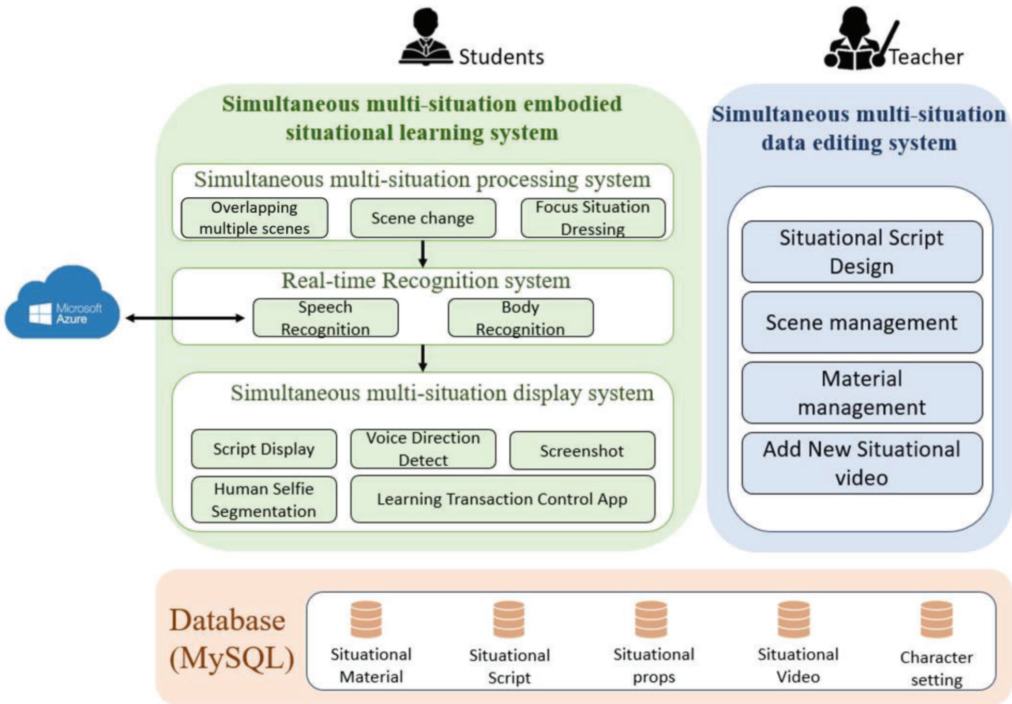

Figure 1. System structure

The simultaneous multi-situational learning system comprises three parts. The first part, shown in Figure 2, is the data editing system, which allows editors to add events, materials, scenes, props, and costumes that occur when the event is triggered. The second part is the embodied situational learning system, which processes the events set in the database according to the previous editing system. This system mainly involves overlapping multiple scenes, scene changes, and focus situation dressing. Additionally, the system recognizes and processes the generated scene and the original situational scene according to the learner's action response. The third part is the database, which stores the learning materials and scripts based on the Hospitality Japanese textbooks. The teaching content includes the complete reception process of the waiters, starting from the reception, menu introduction to the checkout. These materials are discussed with the instructors of the Hospitality Japanese course to help learners learn Hospitality Japanese and the response actions during the reception process.

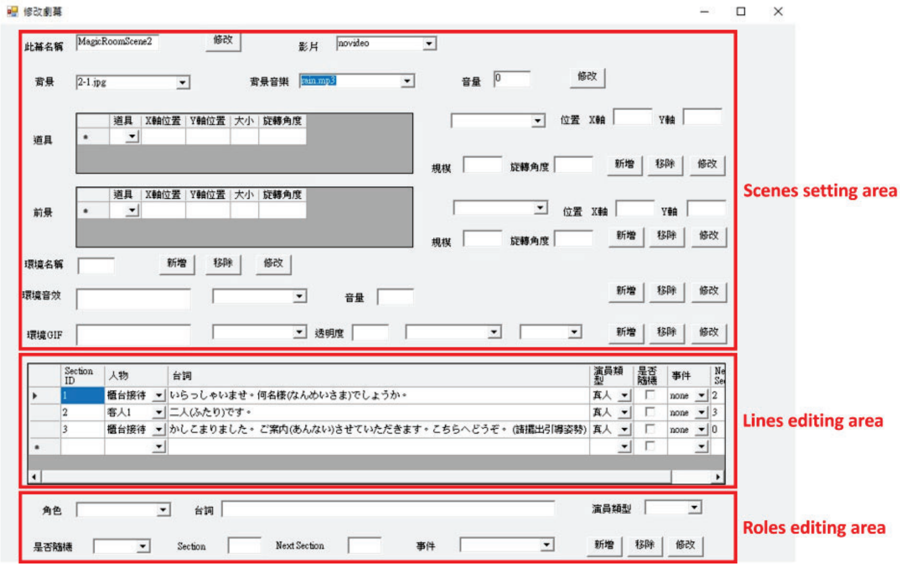

Figure 2. Simultaneous multi-situational editor interface

3.3 Real-time embodied cognitive system

The real-time recognition cognitive system consists of two parts, including speech recognition and body recognition. Figures 3 and 4 illustrate the flowchart of the system.

Speech recognition is the first part of the system, which is processed through the speech recognition service in Microsoft Azure. The Speech-to-Text API converts audio into Japanese text, and punctuation processing is performed to minimize errors during content comparison. The processed results are then compared with the lines, enabling the system to make a corresponding situational change to the background and props based on the recognized results.

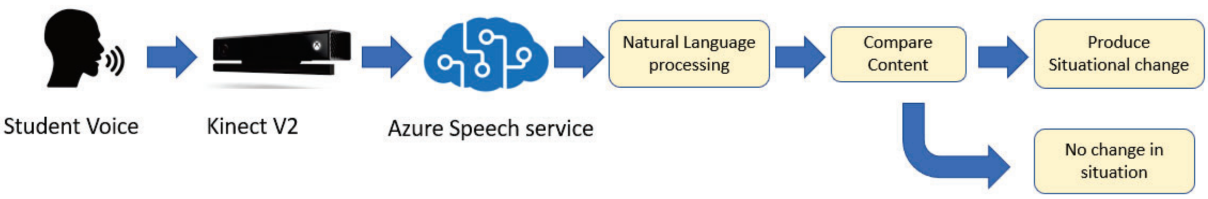

Figure 3. Speech recognition flowchart

The second part of the system is body recognition, which involves training the recognition model using TensorFlow and the Long-term Recurrent Convolutional Networks (LRCN) method. This model combines CNN and LSTM, where Convolutional layers extract features from each video frame, and these features are sent to the LSTM layers to process the time relationship between each frame and improve recognition of continuous actions. This model solves the issue that traditional CNN models can only recognize a single frame and simulates the impact of the user's performance on the situation. After identifying the body recognition results, the system makes a corresponding situational change to the background and props based on the recognition results.

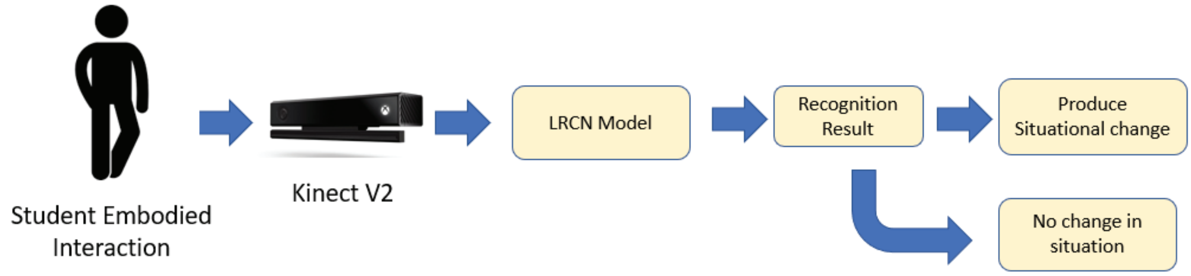

Figure 4. Body recognition flowchart

4. Method

4.1 Experimental Hypothesis

To evaluate the effectiveness of the proposed system, the present study tests the following hypothesis: The use of a simultaneous multi-situational learning system that provides immediate feedback based on learners' embodied interactions and simultaneously presents multiple situations is more effective in terms of learning achievement than a traditional situational learning system that only provides a single situation. The study aims to compare the learning outcomes of the two systems to determine whether the proposed simultaneous multi-situational learning system outperforms traditional situational learning systems in terms of learning achievement.

4.2 Experimental Subject

This study was conducted in collaboration with a local university of science and technology located. The sample consisted of 60 participants from two classes in the Department of Hospitality Management. The two classes were randomly assigned to either the experimental group (30 participants) or the control group (30 participants). To ensure comparability between groups, participants within each class were divided into small groups of six based on their pre-test scores. The experimental group was exposed to a simultaneous multi-situational learning system that provided additional situational changes based on learners' embodied behaviors during learning activities, while the control group received a traditional single-situation learning system where the instructor changed the situations on the screen according to learners' embodied behaviors during the rehearsal of the drama.

4.3 Experimental Process

This study employed a six-week experimental process, with one class session per week and two hours per class session, which is depicted in Figure 5. The instructor for the two groups was the same.

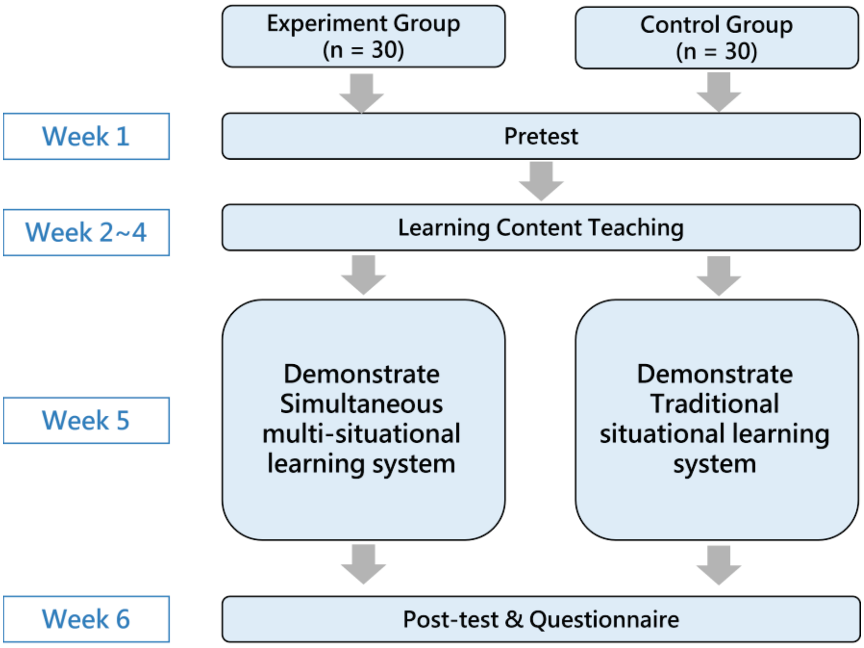

Figure 5. Experimental Process

During the first week, the learners took a pre-test and received an introduction to the system. Over the next two to four weeks, the course content was taught, and group practice sessions were conducted. In the fifth week, the learners performed in a formal setting, and a post-test and questionnaire were administered during the final week. To enhance the learning experience, the system was also accessible online, providing learners with the opportunity to practice on their own time and increase their familiarity with the system.

The environmental design of curriculum is shown in Figure 6, where the classroom is divided into an actor area and an audience area. The screenplay in the casting area differs between control group and experimental group, where the experimental group used the simultaneous multi-situational learning system, while the control group used a traditional single-situation learning system. The control group only depicts the knowledge application situation in the restaurant scene, while the experimental group presents a multi-situational screenplay combining two situations: the situation of knowledge explanation for the description of ingredients and the situation of knowledge application for the description of the restaurant scene.

Figure 6. The environmental design of curriculum

4.4 Experimental Measurement Tools

To evaluate the effectiveness of the proposed simultaneous multi-situational learning system, pre-tests and post-tests were conducted to assess the learners' academic knowledge in hospitality situations, their proficiency in Japanese oral communication, and their familiarity with Japanese culture. These tests were based on the Hospitality Japanese textbook used in the course and were designed in consultation with the course instructor. The tests included true/false, multiple-choice, and fill-in-the-blank questions, with a maximum score of 100 for each test. Analysis of Covariance (ANCOVA) was employed on the test scores to analyze the impact of the learning system on the learners' academic performance. Additionally, a questionnaire was administered using a Likert five-point scale to understand the learners' perceptions on the system's impact on their motivation and confidence. The questionnaire was designed based on the ARCS model (Keller, 1987) and was validated by expert professors, with a Cronbach's alpha of 0.972, indicating high reliability.

5. Result

5.1 Pre-Test and Post-Test Result

To evaluate the normality of the data, Shapiro-Wilk test was employed for both the experimental and control groups as the sample size for each group was less than fifty. The results showed that the experimental group pre-test ($p = .120 > .05$), control group pre-test ($p = .145 > .05$), experimental group post-test ($p = .111 > .05$), and control group post-test ($p = .432 > .05$) all fulfilled the assumption of normal distribution. To further test the assumption of homogeneity of regression coefficients, the results showed that the assumption was met. ($F = .015$, $p = .902 > .05$). Moreover, the assumption of the equality of variances was also supported by the result of Levene's test ($p = .470 > .05$).

Based on the above results, ANCOVA was performed. The result shows that the average and the adjusted mean of the experimental group post-test were 73.673 and 72.293, respectively; while those of the control group were 65.507 and 66.257, respectively. Furthermore, there is a significant difference between the two groups ($F = 4.303$, $p = .043 < .05$). The partial eta square value was .07, with a range from .06 to .14, which indicates the effect size is at a medium level (Cohen, 1992). The data indicate that the simultaneous multi-situational learning system was significantly more effective than the traditional situational learning system with a single situation in terms of learning performance.

Therefore, the results of this study support the hypothesis that the use of a simultaneous multi-situational learning system is more effective than using a traditional situational learning system with a single situation.

5.2 Questionnaire Result

The results of the questionnaire indicated that there were no significant differences in the mean scores of the user's system experience, learning motivation, and building confidence between the experimental and control groups. Nonetheless, both groups provided positive feedback on the experimental content, demonstrating that multimedia tools can effectively engage and motivate learners' interest, as well as align with the principles of situational learning and enhance their motivation to learn.

5.3 Interviews

In order to gain a deeper understanding of the experimental group's experience, interviews were conducted with four learners and the instructor who participated in the experiment. In terms of system control, the participants expressed that the simultaneous multi-situational learning system provided a novel control method. Compared to using mobile phones or computers, this method provided a more immersive experience. Some learners also expressed a desire for the system to point out their errors during learning, which could improve their long-term learning performance.

Regarding situational changes, learners indicated that the application of the situation, explanation of the situation, and the resulting situation after the change can effectively link them to the knowledge they want to express. The learning model allowed them to have a deeper understanding of what they were learning and a better understanding of the textbook knowledge. Furthermore, the learning model increased their motivation to learn. Some participants stated that the system had made them eager to express more diverse knowledge while others hoped for stronger audio or visual effects.

6. Conclusion

The aim of this study was to investigate the effectiveness of a simultaneous multi-situational learning system on learners' learning achievement. The proposed system created a digital space with multiple situations, allowing learners to perform and reflect on their behavior in real-time. This approach addressed the limitations of traditional single-situation learning, such as the difficulty of immersing learners in a single situation and the lack of real-time assessment. The experimental results demonstrated that the performance of the experimental group was significantly better than that of the control group in the post-test.

Furthermore, the questionnaire and interview results indicated that the digital space with multiple situations enhanced learners' understanding and connection to the knowledge and increased their interest in learning. Therefore, the contribution of this study is the proposal of a new type of simultaneous multi-situational learning system and the validation of the hypothesis that a simultaneous multi-situational learning system is more effective than a traditional situational learning system.

Based on the feedback from the experimental group's interviews, students expressed that some variations in situations were not engaging enough, future research could focus on exploring the incorporation of sound effects to enhance the overall attractiveness and effectiveness of the learning experience. Furthermore, with advancements in Augmented Reality (AR) and Mixed Reality (MR) technologies, such as the Mixed Reality Toolkit (MRTK) offered by Microsoft, visual effects could be enhanced to create more realistic multi-situational environments. Moreover, adding error guidance could further enhance the learning process, allowing learners to instantly correct their posture, pronunciation, facial expressions, and other aspects of knowledge that are not typically expressed through traditional paper-based learning.

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