Development of Academic Achievement by Learning Activity using Safety Case Study of University Students in China

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ABSTRACT
The purpose of this research was to compare the academic achievement of Sichuan University of Science and Engineering students in China before and after receiving learning activities using safety case studies. A pre-experimental research methodology was employed. The sample for this research consisted of one class of 30 first-year students from Sichuan University of Science and Engineering in China during the first semester of the academic year 2025. The sample group was selected using cluster sampling technique. The research instruments included safety case study lesson plans and an academic achievement test. The statistics used in data analysis were mean, standard deviation, and t-test. The research results showed that the academic achievement in learning activities using safety case studies of university students after receiving learning activities using safety case studies was significantly higher than before learning at the significance level of .05. It can be concluded that learning activities using safety case study methods significantly improve students' academic achievement, confirming their effectiveness in the field of safety education.
Keywords: academic achievement, case study, learning activity, safety education

INTRODUCTION

The importance of safety in educational institutions is paramount and self-evident. Creating a safe, harmonious, and healthy learning environment for teachers and students requires comprehensive strengthening of safety education and management practices. Campus facility safety directly impacts the daily activities and well-being of the academic community, encompassing structural integrity, equipment maintenance, and unobstructed safety passages in teaching buildings, laboratories, sports venues, dormitories, and other facilities (Díaz-Vicario, 2017; Taleghani et al., 2018). Regular inspection and maintenance of campus infrastructure, coupled with timely identification and elimination of safety hazards, are crucial measures for ensuring the safety of all stakeholders.

Fire safety remains a critical concern that educational institutions cannot overlook. These institutions must develop comprehensive fire emergency plans, conduct regular fire drills, and enhance fire safety awareness along with self-rescue and mutual assistance capabilities among teachers and students. Additionally, maintaining and inspecting firefighting facilities and equipment is essential to ensure their effective operation during emergencies (Daramola et al., 2024; Onyekwere et al., 2024; Waryoba & Mung'ong'o, 2023).

With the widespread adoption of internet technologies, cybersecurity has emerged as a new challenge for educational institutions. Institutions must establish and enhance network security protection systems, strengthen supervision of online behavior, and prevent incidents of cyber fraud, cyberbullying, and the dissemination of harmful content. Concurrent emphasis should be placed on cybersecurity education to enhance awareness and prevention strategies among teachers and students (Bashaeva et al., 2024; Kumar et al., 2024).

The popularization of safety education is fundamental to improving awareness and preventing accidents. Educational institutions should integrate safety education into their daily teaching plans through various methods, including safety courses, knowledge lectures, and practical drills. This integration helps develop safety literacy and emergency response capabilities among teachers and students. Furthermore, strengthening communication and collaboration with parents and the community creates a supportive atmosphere for institutional safety initiatives

(Wang, 2010).

Campus traffic safety management constitutes a critical component of comprehensive university safety protocols. The optimization of campus traffic safety management requires careful consideration due to its complexity and significance. University transportation systems present unique challenges owing to their distinctive characteristics and operational demands. Campus traffic safety management must address increased traffic volumes and pedestrian safety. Therefore, it is necessary to have a systematic approach to effectively prevent accidents that may occur. This optimization framework considers institutional contexts, practical constraints, and implementation requirements. Successful implementation depends on governmental support through appropriate legislation and enforcement mechanisms, coupled with broad societal engagement. Such collaborative efforts are essential for enhancing the effectiveness of campus traffic safety initiatives (Luo, 2024; Mostafa, 2022).

Traditional safety education approaches exhibit significant limitations in practicality and relevance, often reducing the educational process to mere procedural compliance. Current university safety education predominantly relies on conventional classroom-based instruction, where subject matter experts deliver content through direct textbook recitation. This pedagogical approach suffers from minimal teacher-student interaction and outdated content, compromising its effectiveness and timeliness. The rigid instructional methodology frequently results in student disengagement, manifested through behaviors such as mobile phone distraction during lectures and superficial compliance during assessments. Despite the abundance of modern communication technologies, safety education remains confined to limited spatial, temporal, and methodological frameworks, lacking diverse pedagogical approaches such as student-led narratives, experiential learning, and role-playing exercises.

Analysis of current university safety education practices reveals persistent challenges, including recurring accidents and safety hazards, despite ongoing educational efforts. This pattern indicates fundamental issues in the educational approach, including an imbalanced emphasis on theoretical training, insufficient case study integration, inadequate warning education, and limited instructional diversity. Moreover, the prevalence of traditional lecture formats, supplemented by passive materials and rote learning methods, has resulted in predominantly theoretical instruction with limited practical application and unclear learning outcomes (Li, 2007).

Case study is an effective approach to education, helping to link theoretical and applied knowledge by engaging students with real-world situations. It promotes critical thinking, problem-solving, and decision-making skills, especially in the context of safety cases, by using insight-based discussions from various studies to enhance understanding and enable effective application in real situations. This approach is particularly suitable for higher education contexts. The instructor facilitates learning and encourages students to participate enthusiastically in activities while thinking critically about the presented cases. The learning management process using case studies encourages students to achieve good learning outcomes and develop problem-solving skills (Hall et al., 2016).

Therefore, learning activities using safety case studies are very suitable for developing students' safety awareness because this method connects theory to practice through content presentation. Using case studies along with questioning and activities that encourage group discussion and problem-solving helps improve learning by shifting focus from memorization to analysis, assessment, and application. Case studies are based on real-life situations, helping learners connect emotions to topics, increase risk awareness, and raise safety consciousness in a safe, risk-free, and effective learning environment (Fixen, 2024; Roell, 2019).

Contemporary safety education in higher education institutions faces significant challenges stemming from traditional pedagogical limitations. Current instructional methods predominantly emphasize theoretical knowledge transmission over practical application, resulting in diminished student engagement and insufficient skill development. The persistent occurrence of safety incidents, despite established educational programs, indicates the necessity for innovative instructional approaches. Case study methodology enables students to engage with authentic safety scenarios, develop critical thinking capabilities, and acquire practical safety competencies while enhancing academic achievement. The aim of this study is to implement and evaluate the effectiveness of case analysis in improving the academic achievement of students at Sichuan University of Science and Engineering in China, and to establish a more effective model for safety education in higher education institutions.

LITERATURE REVIEW

This section presents a comprehensive review of literature related to learning activities using safety case studies and their potential to enhance the academic achievement of Sichuan University of Science and Engineering students in China. The literature review is as follows:

Safety Education in Higher Education

In the United States, safety education in primary and secondary schools is strongly supported by laws and regulations, including national legislation, state-level strategic decisions, and school-level security measures. In addition, the campus safety management mechanism in the United States is both advanced and comprehensive, laying the foundation for implementing effective safety education. Furthermore, the United States has established a systematic safety education system, encouraging teachers and students to participate together, adopting diverse educational methods, and ensuring that educational content is both rich and relevant to real life (Kim, 2022).

Schools are important places for implementing safety education in China. In 2007, the "Guidelines for Public Safety Education in Primary and Secondary Schools" were promulgated, becoming the guiding outline for school safety education, mainly involving life safety and health. After 2018, the "Implementation Opinions of the Ministry of Education on Strengthening National Security Education in Primary, Secondary, and Tertiary Schools" and the "Guidelines for National Security Education in Primary, Secondary, and Tertiary Schools" were successively issued, which put forward specific requirements for the implementation of national security education at the school level and expanded the content of school safety education.

Integrating safety education into subject curriculum is an important way for schools to implement safety education. The latest "General High School Curriculum Plan" and "Compulsory Education Curriculum Plan" issued by China emphasize the integration of national security, life safety, and other education into the curriculum in the principle section of content determination. Campus safety in educational institutions and the development of strategies to enhance safety measures, including prevention strategies and working with parents, communities, and law enforcement agencies, also highlight the need for student involvement in safety initiatives and reporting of incidents and accidents that occurred (Li, 2023).

In India, research found that road safety knowledge, attitudes, and risk perceptions in schools need to be developed. Therefore, traffic safety education is required to be included in the school curriculum (Borakanavar, 2024).

At present, the safety education model in domestic universities mainly adopts methods such as centralized lectures and poster displays, which have played an important role over a long period of history. However, when facing the "Internet generation" who have "read all the headlines," the previous education model has become "powerless." This inadequacy is mainly reflected in three aspects.

First, poor linkage and weak strength characterize current approaches. The content of safety education involves all aspects of college students' growth and success. At present, the task of safety education in domestic colleges and universities is often undertaken by a single department within the security office, with a single staff structure and limited resource integration, which directly leads to the "inherent inadequacy" of safety education effectiveness. Second, the form is monotonous and lacks novelty. A single topic-based teaching model is difficult to stimulate students' enthusiasm for participation. Students generally learn safety knowledge to cope with examinations and forget it after examinations, without achieving the purpose of real education and learning.

Third, the content is outdated with poor practical performance. New forms of crime and security issues continue to emerge, but the lack of timely updates and supplements to security education content has resulted in weak practicality of security education (Li, 2007).

Learning Activity Using Safety Case Study

Traffic safety education is an important matter that should be cultivated and experienced by individuals both as vehicle users and as people involved in traffic situations. In organizing teaching and learning activities, safety education can significantly affect traffic safety attitudes. Using case studies to organize traffic safety learning activities helps students engage with real-world situations and develop practical skills. Students can analyze and learn from these cases, making abstract concepts more concrete and applicable.

For example, in South Australia, a road safety scene was created titled "Crash Scene Investigation - The Science of Motion," developed for 10th graders. It uses accident scenario creation software and driving simulators to teach students about the science of movement and its application to vehicle accidents. By investigating actual collision situations, students can understand the consequences of risky behavior and the importance of safe driving practices (Illingworth, 2015).

In higher education, case studies can be used to explore more complex issues in traffic safety. For example, the Young Offender Program in Australia uses case studies and scenarios to help participants explore situations similar to their own experiences. It promotes an environment that challenges existing beliefs and encourages safer

behaviors. The use of case studies not only enhances students' knowledge of traffic safety but also helps students take responsibility for their own actions and decisions (Waller et al., 2016).

Hall, Magee, and Clapp (2016) developed a case-based learning model in the classroom featuring four steps to strengthen students' problem-solving skills by engaging them in real situations. This model emphasizes critical thinking and the application of knowledge rather than memorization, and it can be used by instructors at all levels of education. The effectiveness of the model depends on the instructor's ability to serve as a facilitator in selecting and preparing case studies that stimulate inquiry and critical analysis on various issues.

The elements of the four-step model are: 1) Define the Unknown, which is the first step in identifying gaps in available knowledge and what remains unknown. Instructors encourage students to ask questions and seek information to achieve a true understanding of the learning objectives or subject content. 2) Establish the Timeline: Students need to sequence the events or processes involved in the case study. This step helps learners organize their thoughts and understand the problem situation. 3) Identify the Systems Involved: Students must analyze the systems or elements involved in the case study. 4) Determine What is Unique: Students must identify unique or specific aspects of the case study that differentiate it from other cases.

When implementing case study learning, several considerations should be addressed: the instructor must demonstrate the role of facilitator by encouraging student discussion without directly providing answers to students. Instructors must be well-prepared and have genuine understanding of the subject material. The complexity of the case study must be appropriately challenging, and the problem must be solvable within the specified time frame. Instructors should include both relevant and irrelevant information in the case study to teach students how to distinguish important details from extraneous information. The case studies developed must be consistent with the intended learning objectives.

In addition, Khammani (2016) has defined teaching using case studies as a process in which the instructor helps learners achieve learning according to set objectives by having learners study fictional stories that arise from reality and answer questions about them. After that, the answers and the reasons for the answers are used as information in discussions, so that learners can learn according to the learning objectives.

The five important steps of teaching and learning management using case studies are: 1) The instructor or learner presents a case study; 2) The learner studies the case study; 3) The learner discusses questions to find answers; 4) The instructor and the learner discuss the answers; 5) The instructor and learner discuss the learner's problems and solutions and summarize the learning results obtained.

The advantages of teaching using case studies include helping to develop critical thinking skills and problem-solving abilities while helping learners develop broader perspectives. This method allows learners to face real-life situations and practice solving problems without risking actual consequences, helping learners become ready to solve problems in the future. This method also helps learners engage in high-level academic activities and encourages interaction between learners, allowing them to know more about each other. This teaching method works particularly well when learners have diverse experiences because it allows for discussions from different perspectives.

Academic Achievement

Academic achievement refers to the measurable outcomes of students' educational progress, encompassing both quantitative metrics (e.g., grades, standardized test scores) and qualitative growth in skills such as critical thinking, problem-solving, and socio-emotional competencies. It is not confined to rote memorization but extends to the application of knowledge in real-world contexts, reflecting a dynamic continuum of learning rather than a fixed endpoint. For instance, Tian and Sun (2018) emphasize that academic achievement assessment must integrate cognitive, behavioral, and emotional dimensions to holistically evaluate students' capabilities.

Students' academic achievement is influenced by various factors, some of which come from their own characteristics, while others come from the external environment. At present, research on the factors affecting students' academic achievement can be roughly summarized into three categories. The first category studies the individual influencing factors of students, such as learning quality and self-efficacy. The second category studies the influencing factors of families, such as parental involvement, family socioeconomic status, and extracurricular tutoring. The third category studies the influencing factors of schools, such as school environment, teacher teaching methods, and teacher-student relationships.

Overall, previous scholars often used a horizontal research approach to explore the impact of factors such as

students, families, or schools on students' academic achievement, while neglecting the key variable of students' admission scores. Some scholars also use the socioeconomic status of schools and families as indicators to measure the source of students in schools and explore the impact of this factor on academic achievement (Lestari & Lidyasari, 2024; Noeryanti et al., 2018; Vitoria et al., 2024).

Traditional academic achievement assessments are the foundation of academic assessment in higher education. These assessment methods may be used as tests, which are written exams recognized as measures of students' ability to use their knowledge to answer questions or solve problems in given situations. The nature of these exams has a clear structure. The standard of traditional methods involves standardized tests with a high degree of consistency and fairness in assessing students. These tests can be verified and are reliable, ensuring that all students are assessed according to the same criteria. This makes it possible to compare the abilities of learners across different groups (Davidovitch et al., 2024).

METHODOLOGY

Research Objective

To compare the academic achievement of Sichuan University of Science and Engineering students in China before and after receiving learning activities using safety case studies.

Research Hypothesis

The academic achievement of Sichuan University of Science and Engineering students in China after receiving learning activities using safety case studies will be significantly higher than before receiving learning activities using safety case studies.

Conceptual Framework

This research will use a pre-experimental design. The framework below will serve as the researcher's guide in conducting the study:

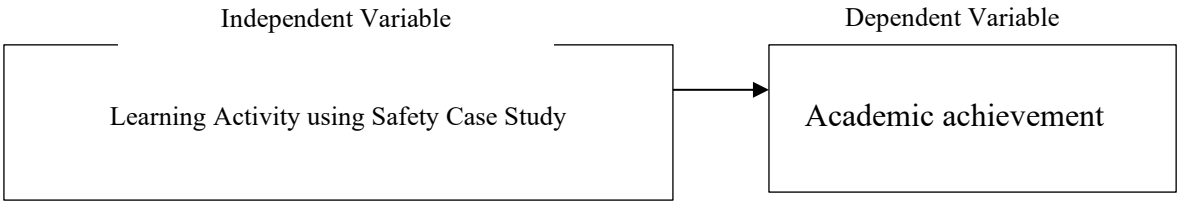

Figure 1 Conceptual framework of learning activities using safety case studies to enhance academic achievement of Sichuan University of Science and Engineering students in China

Research Methodology

Research Design

The design of the research is pre-experimental: one-group pretest-posttest design (Best & Kahn, 2003).

Table 1: One-Group Pretest-Posttest Design

Pretest	Experimental	Posttest
O1	X	O2

Symbols used in experimental design.
O1 = Pretest
O2 = Posttest
X = Learning Activity using Case Study

Population and Sample

The population consists of 200 first-year students in the College of Education at Sichuan University of Science and Engineering in China. The sample scope consists of one cohort of first-year undergraduate students enrolled in the College of Education at Sichuan University of Science and Engineering in China in the first semester of the academic year 2025. Through cluster sampling methodology, one group of 30 students was selected.

Research Instrument

The research instruments were classified into two types: those used in the experiment and those used for data collection. The details are as follows:

The experimental instrument consists of learning activities using case study lesson plans composed of 3 lesson plans, with 2 hours for each lesson plan, totaling 6 hours. The instrument used for data collection is an academic achievement test that serves as a comprehensive assessment instrument designed to measure students' cognitive understanding and knowledge retention of safety concepts. Comprising 30 multiple-choice items, the test evaluates various cognitive domains, including knowledge, comprehension, application, analysis, and creation levels of safety principles.

Instrument Development

Learning activity using safety case study lesson plans: Design a 6-hour classroom teaching program with traffic safety as the theme, focusing on traffic safety case studies. The steps in creation were as follows:

1) Content analysis: The development process begins with a comprehensive analysis of safety curriculum standards and learning objectives. Key real-world safety case studies are identified and structured into a 3-week instructional framework, ensuring alignment with educational goals and student learning outcomes.

2) Design phase: Detailed lesson plans are created, incorporating learning activities using case study principles and integrating safety concepts with real-world applications. Each plan includes learning activities, materials, assessment tasks, and cross-disciplinary connections. The plans are structured to promote student engagement and critical thinking in safety practices.

3) Expert validation: Learning activity lesson plans using case studies are submitted to experts. The IOC (Index of Item-Objective Congruence) consistency index in the teaching management plan is verified to be greater than or equal to 0.5. Three experts evaluated the lesson plans, including a curriculum and instruction specialist, an occupational safety expert, and an assessment and evaluation expert, and provided improvements. The evaluation experts rated and calculated the qualification IOC as 0.67-1.00, which is considered effective.

4) Quality assurance: Following expert validation, necessary revisions are made based on feedback to ensure instructional effectiveness. The revised lesson plans are tested among students who do not belong to the classroom sample group and are then used to improve the teaching management plan and collect actual data before the experiment.

Academic Achievement Test: The process of creating and ensuring the quality of academic achievement tests is as follows:

1) Study curriculum content: Study the safety curriculum at Sichuan University of Science and Engineering in China and learn about the content used in learning safety management.

2) Analyze learning objectives: Analyze the learning objectives of the content used in test design to measure academic achievement.

3) Determine test structure: Determine the number of items in the academic achievement test and use objective multiple-choice questions to test 45 items. Each multiple-choice question has 4 options.

4) Expert validation: The created academic achievement test was submitted to five experts to verify the accuracy of the language used and the effectiveness of the IOC obtained from the evaluation of the academic achievement test. Expert scores were taken and the qualification index was calculated. The evaluation experts rated and calculated the qualification IOC as 0.80-1.00, which is considered effective.

5) Pilot testing: A pilot test was conducted to measure academic achievement. A revised trial was conducted on 24 students who were not part of the sample. The test results from the pilot study were used to check the quality of the testing. The researcher analyzed the discrimination index and then analyzed the difficulty index and reliability. Items with difficulty values between 0.29-0.79 and discriminative power between 0.20-0.50 were selected.

6) Reliability testing: A test was conducted to measure academic achievement, and 30 out of 45 selected questions were used to check reliability with Cronbach's alpha coefficient of 0.71.

7) Implementation: Conduct the experiment using the academic achievement test.

Data Collection

Research data was collected by the researchers in the following sequence:

1) Preparation steps: Contact was made to obtain official documents from Sichuan University of Science and Engineering. The assistance and cooperation of the university administration was requested for permission to collect data. One group of 30 students from first-year student cohorts was selected using the cluster sampling technique.

2) Experimental steps: At the beginning of the experiment, participants completed a pre-test using the academic achievement test to assess their initial academic achievement, establishing baseline measurements for later comparison. During the three-week implementation period, learning activities using safety case study lesson plans were conducted. Following the implementation phase, participants completed a post-test to measure academic achievement, enabling analysis of learning outcomes and comparison between pre-test and post-test results.

3) Analysis steps: The scores obtained from academic achievement tests were analyzed through statistical methods to test the research hypotheses.

Data analysis

In the data analysis, the researchers used statistical software to analyze the data, following this data analysis process:

1) Statistics for quality testing of instruments: Basic descriptive statistics, such as mean and standard deviation, were used by the researcher to analyze the data gathered from the experiment. For analysis of instrument quality, the IOC method was used to check the validity of the lesson plan content and academic achievement test.

2) Statistics used in hypothesis testing: In order to compare academic achievement before and after the implementation of learning activities using case studies, data was analyzed using a t-test for dependent samples.

Results

The data was analyzed to compare the academic achievement of Sichuan University of Science and Engineering students in China in learning activities using safety case studies before and after learning, using a dependent t-test. The results of the analysis are presented in Table 2.

Table 2: Comparative analysis of the academic achievement of Sichuan University of Science and Engineering students in China in learning activities using safety case studies before and after learning

Academic achievement	n	M	SD	$\bar{D}$	Sd	t	p
before learning	30	16.67	2.25	3.77	2.68	7.68*	.000
after learning	30	20.43	2.24				

* $p < .05$

Analysis of data from Table 2 revealed significant differences in the t-test ($t = 7.68$, $p < .05$). When considering the average academic achievement in learning activities using safety case studies of Sichuan University of Science and Engineering students, it was found that students had statistically significantly higher academic achievement after learning ($M = 20.43$, $SD = 2.24$) than before learning ($M = 16.67$, $SD = 2.25$) at the .05 significance level.

Conclusions and Discussion

Conclusions

Learning activities using safety case studies for first-year students at Sichuan University of Science and Engineering in China enhance academic achievement. The research hypothesis that the academic achievement of Sichuan University of Science and Engineering students in China after receiving learning activities using safety case studies will be significantly higher than before receiving learning activities using safety case studies was confirmed. The results showed that post-intervention academic achievement was significantly higher than pre-intervention achievement at the .05 significance level.

Discussion

The results showed that case studies significantly increased academic achievement ($p < .05$) through organizing learning activities in the classroom using case studies on traffic safety. It was found that defining case studies that are close to learners and can occur in real life makes learners alert in learning.

The five-step process was implemented as follows: Step 1: Instructor presents case study. The instructor asked questions so that each student could think of their own answers first. Step 2: Students study the case example. Each student goes through the details of the case study based on the questions provided by the teacher to prepare to discuss the information with the group. Step 3: Students discuss questions to find answers. The instructor divides the students into groups of 4-5 so that everyone has the opportunity to express their opinions thoroughly. The instructor helps by asking questions, allowing students to exchange ideas and learn more, or may provide additional information to the student groups. Step 4: Instructor and students discuss the answers. The instructor has each group of students present a summary of the group discussion, which allows students to broaden their range of ideas and helps to correct misunderstandings. Step 5: Summarize the learning from case studies. Students record their learning outcomes on at least 3 important safety rules and complete "Safety Commitment Letters" while highlighting connections to future lessons.

This approach can be seen in the use of examples that are close to the learners. It provides an indirect experience where students do not have to risk real accidents. This allows students to visualize potential future situations or behaviors that could lead to accidents and the violence or loss that may occur. Through the exchange of learning from various perspectives among classmates, learners have developed cognition and understanding, enhancing students' critical thinking and awareness of the importance of traffic safety.

The use of case studies in organizing learning activities gives students a deeper understanding and leads to higher academic achievement. It helps increase students' motivation to participate in class activities, which promotes learning, critical thinking, and engagement in other activities. Case studies are a learning management tool that promotes proactive learning and makes learners' learning more accessible (Bonney, 2015; Toogood, 2023).

Learning management using safety case studies focuses on using real-life examples relevant to learners. It helps make the student learning experience more meaningful, useful, and memorable while emphasizing the importance of using risk management methods. This enables students to increase their understanding of safety practices and decision-making processes in real-life situations (Bocwinski et al., 2021).

In addition, group work and presentation of group discussions help improve communication and collaboration skills. By collaborating to analyze case studies, students learn to share ideas and draw conclusions that are accepted by the group (Hall et al., 2016).

The Study Reached the Following Findings

Findings from learning activities using safety case studies revealed that: 1) Case studies are effective in significantly improving academic achievement. 2) Case studies are a highly flexible learning management method. 3) Case studies increase students' motivation to participate in class activities, leading to better learning and improved thinking skills and communication through participation in group discussions at the class level. 4) Case studies can present risky scenarios to students, allowing them to practice thinking, analyzing, and finding prevention strategies without experiencing dangerous situations themselves. 5) Having learners write records of their learning results and safety practice commitments helps students recognize the importance of traffic safety.

Recommendations

Recommendations for Implementation

Based on the conclusions and discussion of the study, the researcher has several suggestions as follows: 1) Those who want to use learning activities using safety case studies should study and understand each step thoroughly. 2) The instructor must help facilitate each group comprehensively, noting which groups need assistance or which skills are lacking. 3) The instructor should introduce the group process, explain how to work effectively within groups, and clarify the roles and duties of group members.

Recommendations for Future Research

1) Apply learning activities using case studies to other courses to verify their effectiveness in enhancing academic achievement or learning outcomes, and 2) Compare learning activities using safety case studies between two groups: experimental and control groups.

Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this work, the authors used Claude AI to correct grammatical errors and improve readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Credit Authorship Contribution Statement

All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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