

The Effect of Health Education Simulation on First Aid on Students' Knowledge Level

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ABSTRACT

Purpose of the study: The aim of this study was to analyze the influence of health education simulations about first aid on students' level of knowledge.

Methodology: This study used a pre-experimental research design with a one-group pre-post test design. The population was 11th-grade Science students. The sampling technique used was a total sampling of 45 students. A questionnaire was used to measure the students' knowledge levels.

Main Findings: Based on the Wilcoxon test, the p-value was 0.001 ($p < 0.05$). This indicates that the health education simulation on first aid has an effect on students' knowledge levels.

Novelty/Originality of this study: This research can be used as a development of knowledge for junior high school students so that they know and are able to apply and simulate first aid at school.

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1. INTRODUCTION

Accidents and minor injuries frequently occur in schools, whether during teaching and learning activities, sports, or extracurricular activities [1], [2]. These conditions require basic first aid skills across all school components, including students. Prompt and appropriate first aid can prevent deterioration of the victim's condition, facilitate early stabilization, and even save lives. Therefore, it is crucial to improve students' understanding and skills related to first aid through various forms of effective education [3], [4].

The World Health Organization (WHO) emphasizes that first aid education should begin at school age because adolescence is a developmental phase with high physical activity and a greater risk of injury [5], [6]. Field research shows that most students lack adequate knowledge of first aid procedures, such as treating wounds, fainting, bleeding, and injuries resulting from accidents [7], [8]. Low student health literacy often results in incorrect or non-compliant actions that do not adhere to basic safety principles.

Efforts to improve students' first aid knowledge are typically conducted through health education methods [9], [10]. However, conventional lectures are considered ineffective because they do not encourage active student involvement [11], [12]. Previous research has shown that students are better able to remember and apply health material when the learning process involves direct experience and practical exercises [13], [14]. Therefore, choosing the right learning method is an important aspect to improve student understanding.

One method considered effective is health education simulation [15], [16]. Simulations provide students with the opportunity to experience realistic situations, practice first aid steps, and develop rapid decision-making skills [17]-[19]. This approach not only enhances cognitive knowledge but also strengthens students'

psychomotor skills and confidence in dealing with emergencies. Therefore, simulations have the potential to be a superior educational intervention compared to theoretical delivery alone [20], [21].

Previous research has shown that the use of simulations in health education can lead to significant improvements in first aid knowledge and skills across various age groups [22], [23]. However, some studies have also revealed that the effectiveness of simulations can be influenced by activity design, duration, and participant readiness [24], [25]. Furthermore, research specifically evaluating the impact of health education simulations on school students is still limited, particularly in the Indonesian educational context.

In the school context, providing simulation-based first aid education is highly relevant to helping students understand emergency procedures holistically [26], [27]. This intervention also aligns with schools' efforts to build a culture of safety (school safety) and increase student preparedness for accidents [28], [29]. Therefore, it is important to evaluate how health education simulations can impact students' first aid knowledge.

Based on this background, this study was conducted to analyze the effect of a health education simulation on first aid on students' knowledge levels. The results are expected to contribute to the development of more interactive and effective health learning strategies in schools. Furthermore, this research can serve as a reference for teachers, healthcare workers, and policymakers in designing educational programs that better prepare students for emergencies.

2. RESEARCH METHOD

2.1. Research Design

Experimental research designs are designed to assess how well an intervention can produce changes in a defined outcome [30], [31]. There are several types of experimental research designs, including pre-experimental, pure experiments, quasi-experimental, and single-subject designs. In a pre-experimental design, the research involves only one group that receives a treatment throughout the research process [32], [33]. This design does not provide a comparison group, so the results of the experimental group cannot be compared with those of other groups. One form of pre-experimental design is a single-group pre-test and post-test design [34], [35], in which measurements are taken before the treatment is administered and repeated after the treatment to assess any changes.

In this study, the authors implemented a pre-experimental design with a single-group pre-test and post-test model. This design was used to assess the effect of health education regarding first aid through a simulation method on the knowledge level of students at YP Binaguna Private High School.

Table 1. One group pretest-posttest research design

| | O ₁ | X ₁₋₃ | O ₂ |
|--------------|--|------------------|----------------|
| Description: | | | |
| X | : Intervention | | |
| O | : Observation or Measurement of the Dependent Variable | | |

2.2. Population and Sample

A population is the entirety of the individuals or cases targeted by the research [36], [37]. In this study, the population used was all eleventh-grade science students at Binaguna Private High School, totaling forty-five. The sample is a subset of individuals drawn from the population to represent the entire population. This study used a total sampling technique, where all members of the population were used as samples [38], [39]. Therefore, the sample size for this study was forty-five individuals.

2.3. Research Instruments

Research instruments are tools used to collect data so that the entire research process can proceed systematically and purposefully [40], [41]. In this study, the instrument used was a questionnaire. The researchers used a questionnaire prepared by another party and obtained permission to use and distribute it to respondents. The instruments in this study consisted of a health education instrument delivered through a simulation method, as well as a knowledge instrument in the form of a questionnaire. Simulation learning was used to provide health education to students regarding first aid, allowing interventions to be implemented using a hands-on approach.

The knowledge instrument was compiled in the form of a questionnaire containing thirty-five questions using the Guttman scale. Each question had two answer options: "yes" was scored one and "no" was scored zero. However, for several negative questions, the scoring was reversed, with "no" being scored one and "yes" being scored zero. Negative questions were found in items seven, thirteen, twenty-two, and thirty-five. Based on the total score obtained, knowledge levels were categorized into three groups: good (24 to 35), adequate (12 to 23), and poor (0 to 11). The instrument has undergone a reliability test and demonstrated excellent results, declaring

it suitable for use without the need for retesting its validity. The instrument framework used in this study is as follows:

Table 2. Instrument Grid

| Variable | Indicator | Category | Score |
|------------------------|----------------------------------|----------|---------|
| Knowledge of first aid | First aid and legal requirements | | |
| | Fainting victims | Good | 24 – 35 |
| | Bites and stings | Enough | 12 – 23 |
| | Poisoning | Poor | 0 - 11 |
| | Choking | | |
| | Wounds and bleeding | | |
| | Fractures | | |

2.4. Research Procedures

This research procedure was implemented through three main stages: the preparation stage, the intervention implementation stage, and the final evaluation stage. During the preparation stage, the researcher obtained permission from the school, prepared research instruments in the form of questionnaires [42], [43], and prepared health education materials to be delivered using the simulation method. The researcher also scheduled activities with the school to ensure the entire intervention process ran smoothly.

The next stage was the implementation of the intervention. Before the intervention began, the researcher administered a pre-test to all students as a preliminary step to determine their level of knowledge regarding first aid before administering the treatment [44], [45]. After the pre-test was completed, the researcher provided health education through a simulation method for three days. Two sessions were presented each day, each lasting fifteen minutes. The sessions covered the management of fainting, bites and stings, poisoning, choking, wounds and bleeding, and broken bones. During the simulation, the researcher guided the students through the practical steps systematically.

The final stage was the post-intervention evaluation. At the end of the session, the researcher conducted a question-and-answer session to ensure student understanding and provided a demonstration to reinforce the material. This evaluation lasted thirty minutes [46], [47]. Afterward, the researcher distributed a post-test questionnaire to assess changes in knowledge levels following the intervention. The post-test took fifteen minutes to complete. All collected data was then processed and analyzed to determine the impact of health education through simulation methods on improving student knowledge.

2.5. Data Collection Techniques

The data collection technique in this study was carried out through several structured stages. In the intervention phase, researchers provided health education on first aid using a simulation method. The simulation was conducted over three days, with two sessions delivered each day. The materials covered the management of unconscious victims, bites and stings, poisoning, choking, wounds and bleeding, and broken bones, with each session lasting approximately fifteen minutes. During the simulation, researchers ensured that students followed the practical steps to obtain comprehensive data related to the learning process [17], [48].

After all simulation materials were presented, researchers entered the next phase, post-intervention data collection [49]. In the final session, researchers evaluated students' understanding by giving them the opportunity to ask questions about the material. Researchers also conducted a re-demonstration to reinforce students' memory and ensure that all material was conveyed accurately. This evaluation session lasted thirty minutes. Next, researchers distributed a questionnaire as a post-test to measure students' level of knowledge after the intervention [50], [51]. The questionnaire took fifteen minutes to complete. After completing the entire data collection process, researchers continued the data processing process to achieve the stated research objectives.

2.6. Data Analysis

Data analysis in this study was conducted in two stages: univariate analysis and bivariate analysis [52], [53]. Univariate analysis was used to describe the characteristics of each variable studied. At this stage, data were presented in the form of frequency distributions to provide a general overview of the study variables. Univariate analysis included a description of respondents' demographic data, such as initials, age, and gender. Furthermore, this analysis was used to describe the level of student knowledge before and after health education through simulation.

Next, bivariate analysis was conducted to assess the relationship or influence between two variables: the health education intervention through simulation as the treatment variable and the level of student knowledge as the outcome variable [54], [55]. This analysis aimed to determine whether there was a change in knowledge level after the intervention. In this study, statistical testing was performed using the Wilcoxon test. This test is a nonparametric analysis method used to assess differences in pre- and post-treatment values in non-normally

distributed data. The results of this analysis serve as the basis for determining whether or not the health education simulation on first aid had an effect on improving student knowledge.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Respondents at Binaguna Private High School

Table 3. Characteristics of Respondents at Binaguna Private High Schools (n=45)

| No | Characteristics | Frequency | Percentage (%) |
|----|-----------------|-----------|----------------|
| 1. | Gender | | |
| | a. Male | 10 | 22.2 |
| | b. Female | 35 | 77.8 |
| | Total | 45 | 100 |
| 2. | Age | | |
| | a. 15 Years | 2 | 4.4 |
| | b. 16 Years | 31 | 68.9 |
| | c. 17 Years | 10 | 22.3 |
| | d. 18 Years | 2 | 4.4 |
| | Total | 45 | 100 |
| | Religion | | |
| 3. | a. Protestant | 34 | 75.6 |
| | b. Catholic | 5 | 11.1 |
| | c. Islam | 6 | 13.3 |
| | Total | 45 | 100 |
| | Ethnic group | | |
| 4. | a. Batak Toba | 42 | 93.3 |
| | b. Javanese | 3 | 6.7 |
| | Total | 45 | 100 |

Based on Table 3 shows that the characteristics of respondents based on gender, age, religion, and ethnicity. The characteristics of respondents based on gender are female as many as 35 people (77.8%). For age characteristics, the most aged 16 years as many as 31 people (68.9%), while the characteristics of respondents for religion are Protestant as many as 34 people (75.6%) and the characteristics for ethnicity are Batak Toba as many as 42 people (93.3%).

3.2. Students' Knowledge Before Being Given Health Education Intervention Using Simulation Methods at Binaguna Private High School

Table 4. Respondents' knowledge before being given health education using the simulation method at Binaguna Private High School (n=45)

| No | Knowledge | Pre-Intervention | |
|----|------------|------------------|------|
| | | F | % |
| 1. | Good | 2 | 4.4 |
| 2. | Enough | 15 | 33.4 |
| 3. | Not Enough | 28 | 62.2 |
| | Total | 45 | 100 |

Based on Table 4, data shows that before the health education intervention, the characteristics of respondents' knowledge were lacking, namely 28 people (62.2%), and respondents who had sufficient knowledge were 15 people (33.3%) and respondents who had good knowledge were 2 people (4.4%).

3.3. Knowledge of male and female students after being given health education intervention using the simulation method at Binaguna Private High School

Table 5. Respondents' knowledge after being given health education intervention using the simulation method at Binaguna Private High School (n=45)

| No | Knowledge | Post Intervention | |
|----|-----------|-------------------|------|
| | | f | % |
| 1. | Good | 36 | 80.0 |
| 2. | Enough | 7 | 15.6 |

| | | | |
|----|------------|----|-----|
| 3. | Not enough | 2 | 4.4 |
| | Total | 45 | 100 |

After the intervention, data was obtained that 36 respondents (80.0%) had good knowledge, 7 respondents (15.6%) had sufficient knowledge, while 2 respondents (4.4%) had insufficient knowledge.

3.4. The Influence of Health Education Simulation on First Aid on the Level of Knowledge of Students at Binaguna Private High Schools

Table 6. The Effect of Health Education Simulation on First Aid on the Level of Knowledge of Students at Binaguna Private High Schools

| Knowledge | F | Mean | Std. Deviation | Sig. (2-tailed) |
|---------------------|----|-------|----------------|-----------------|
| Before Intervention | 45 | 11.44 | 5.255 | P = 0.001 |
| After Intervention | 45 | 27.33 | 6.571 | |

Based on Table 6, the average knowledge of respondents before the health education intervention was 11.44 (poor), with the categorization of knowledge levels ranging from 0-11 (poor), 12-23 (sufficient), and 24-35 (good), while after the intervention it was 27.33 (good). The standard deviation before the intervention was 5.255 and the standard deviation after the intervention was 6.571, with a p-value of 0.001. This indicates that respondents' knowledge before and after the health education intervention with simulations for students at Binaguna Tanah Jawa Private High School increased, with a good criterion. Therefore, there was a significant influence between the pre-intervention and post-intervention health education simulation intervention on first aid.

Factors influencing knowledge include education, occupation, experience, age, culture, interests, exposure to information, and mass media. A person's education influences their perspective on the environment and the learning process to acquire knowledge [56], [57]. Work is a means of acquiring true knowledge. Another factor that influences a person's ability to acquire knowledge is internal factors, which include physical and spiritual factors. Internal factors include the physical and spiritual. Physical factors refer to the person's own body, while spiritual factors include psychological, intellectual, psychomotor, and affective and cognitive states [58], [59]. Extrinsic factors include rewards, a conducive environment, and engaging learning activities.

Prior to this first aid health education intervention, many respondents (62.2%) lacked knowledge, particularly regarding first aid for poisoning. This was because the majority of respondents had never received direct first aid health education and also lacked information about first aid. Respondents only acquired knowledge from print and electronic media, and respondents had never read about first aid repeatedly. This resulted in respondents not remembering what first aid actually was. Therefore, to improve respondents' knowledge, the researchers provided a first aid health education intervention using a simulation method aimed at increasing respondents' knowledge.

Education influences responses to external sources. Highly educated individuals respond more rationally to incoming information. Higher education makes a person more likely to obtain information, both from others and from the mass media. Knowledge is closely related to education, and it is expected that someone with a higher education will have a broader knowledge base [60], [61]. Characteristics are closely related to education, where it is expected that someone with higher education will have broader knowledge. Learning motivation based on Uno's opinion (2008) can be classified as follows: the existence of desire and wish to succeed, the existence of encouragement and need in learning, the existence of hopes and ideals for the future, the existence of appreciation in learning, the existence of interesting activities in learning, the existence of a conducive learning environment.

Based on the results obtained, respondents' knowledge after the intervention was categorized as poor (2 respondents, 4.4%), and sufficient (7 respondents, 15.6%). This was due to a lack of curiosity, evident when respondents were not serious and focused during the activity and were still playing around during the first aid simulation. However, respondents' knowledge was generally good, and there was an increase after receiving health education using the simulation method [62], [63]. This was due to the respondents' sensory process of understanding an object, of which first aid education was the object. Another factor that increased respondents' knowledge was that first aid education was new and attracted respondents to participate [64], [65]. This was evident during the activity, where respondents were enthusiastic and asked many questions about first aid. Therefore, first aid education using the simulation method can be used as an intervention to increase knowledge.

In this study, first aid education was delivered to respondents using the simulation method. This allows first aid material to be acquired through the sensory process, which is the process of becoming aware. This is obtained through this method, resulting in respondents' knowledge of first aid increasing after the health education. A study conducted with 45 students at the Binaguna Tanah Jawa Private High School found an

increase in first aid skills after health education interventions. These results indicate a significant impact of health education and simulation methods on the knowledge of students at the Binaguna Private High School.

Health knowledge influences behavior as a medium-term outcome of health education [66], [67]. Health behavior, in turn, influences improvements in public health indicators as an outcome of health education. The focus of the counseling concept is on changing the behavior of the target population to achieve health, especially in cognitive aspects that are in line with expectations (knowledge and understanding of the target population). Therefore, the knowledge of the target population is aligned with expectations.

This is also in accordance with the factors that influence knowledge, where education is one of the factors that influence education, where the respondent's education is high school, and work is also a factor that influences knowledge, where the results obtained show that Binaguna High School students only focus on working as students. Age also influences the knowledge factor, where the average age of respondents is 15-18 years old, so their age is classified as an age that is easy to remember and understand an object or lesson. Interest and experience are also factors that influence knowledge according to the results obtained that students' interest and experience in first aid simulations are very high, where there is a significant change in the level of knowledge from before and after the intervention of health education interventions, and the surrounding culture is a plantation culture area so that students really need lessons or simulations on first aid handling.

In a study that has been conducted on class XI science students at Binaguna Private High School regarding health education using the simulation method on knowledge, the results showed that there was an increase in respondents' knowledge, indicated by an increase in average scores after the health education simulation intervention on first aid and compared to the scores before the intervention. This is also supported by the methods and tools used when conducting health education with the simulation method, where researchers use power point in delivering material where the power point material is made with clear image and color designs so that students are serious in following the health education simulation, accompanied by simulations that are directly practiced by researchers so that it is very interesting to see and practice first aid methods in certain situations. And when the practice is carried out directly, students are very enthusiastic about practicing the actions carried out by researchers, so that the health education simulation runs very smoothly.

The results of this study have important practical implications for the development of health education in school settings. The significant increase in student knowledge after the intervention indicates that the simulation method is effective as an active learning strategy that can enhance student preparedness in emergency situations. The short-term impact of this study is an increase in students' cognitive understanding of first aid, which has the potential to encourage more appropriate and safe emergency response behaviors in the school environment. More broadly, the implementation of simulation-based health education can support efforts to establish a school safety culture and improve student health literacy as part of injury prevention and initial accident response.

However, this study has several limitations that require consideration when interpreting the results. First, the pre-experimental design with a single group without a control group limits the study's ability to draw strong causal conclusions, as increased knowledge cannot be fully separated from the influence of other external factors. Second, the relatively small sample size, limited to a single private school with homogeneous respondent characteristics, limits the generalizability of the study results to a broader student population. Third, the measurements focused only on knowledge and were conducted over a relatively short period of time, thus failing to reflect the sustainability of knowledge or long-term changes in first aid behavior and skills.

4. CONCLUSION

Based on the results of a study of forty-five respondents regarding the effect of health education simulations on first aid on the level of knowledge of students at Binaguna Private Senior High School, several important findings were obtained. Before the intervention was given, the majority of students, namely sixty-two point two percent, had a level of knowledge that was still classified as poor. After being given health education through the simulation method, almost all students, namely eighty percent, showed an increase so that they were in the good knowledge category. The results of the analysis using the Wilcoxon test showed a p-value of zero point zero zero one which was below the significance limit of zero point zero five. This finding indicates that there is a significant effect of health education simulations on first aid on increasing the level of knowledge of students at YP Binaguna Private Senior High School, Tanah Jawa, Simalungun Regency. Therefore, further research is recommended using a quasi-experimental or experimental design with a comparison group, a larger sample size, and further evaluation to assess knowledge retention and the impact on students' practical skills.

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REFERENCES

- [1] J. Navrátilová and M. Fico, "When they are not at school: the involvement of socially disadvantaged pupils in extracurricular activities through a Bourdieusian lens," *Int. Stud. Sociol. Educ.*, vol. 34, no. 4, pp. 505–525, 2025, doi: 10.1080/09620214.2025.2466547.
- [2] V. Beranek, P. Stastny, and V. Novacek, "School injuries and their prevention from the present perspective," *Balt. J. Heal. Phys. Act.*, vol. 13, no. 1, pp. 45–53, 2021, doi: 10.29359/BJHPA.13.1.06.
- [3] P. León-Guereño, L. Cid-Aldama, H. Galindo-Domínguez, and A. Amezu-Urrutia, "Effectiveness of an Intervention to Enhance First Aid Knowledge among Early Childhood Education Students: A Pilot Study," *Children*, vol. 10, no. 7, pp. 1–11, 2023, doi: 10.3390/children10071252.
- [4] U. B.-A. Ordu, "The Role of Teaching and Learning Aids/Methods in a Changing World," *Bulg. Comp. Educ. Soc.*, vol. 9, pp. 210–216, 2021.
- [5] J. M. Parada-Espinosa, S. Ortega-Gómez, M. Ruiz-Muñoz, and J. González-Silva, "Teaching Methodologies for First Aid in Physical Education in Secondary Schools: A Systematic Review," *Healthc.*, vol. 13, no. 10, pp. 1–19, 2025, doi: 10.3390/healthcare13101112.
- [6] J. Á. García-Blaya, J. A. Abraldes, and R. Vaquero-Cristóbal, "Assessment of First Aid Knowledge at Different Stages of Education," *Healthc.*, vol. 13, no. 13, pp. 1–28, 2025, doi: 10.3390/healthcare13131507.
- [7] A. Aljawfi, R. Hassanen, and S. Sharkawy, "Knowledge and Practices of Engineering Students about First Aid at Assiut University," *Assiut Sci. Nurs. J.*, vol. 10, no. 33, pp. 205–214, 2022, doi: 10.21608/asnj.2023.179439.1468.
- [8] E. M. Shaker, "Assessment of the First Aid Knowledge of Students at the Mosul Technical Medical Institute," *Int. J. Med. All Body Heal. Res.*, vol. 5, no. 4, pp. 104–107, 2024, doi: 10.54660/ijmbhr.2024.5.4.104-107.
- [9] K. Krishnamurthy *et al.*, "Benefits of gamification in medical education," *Clin. Anat.*, vol. 35, no. 6, pp. 795–807, 2022, doi: 10.1002/ca.23916.
- [10] B. R. Harris, B. M. Maher, and L. Wentworth, "Optimizing Efforts to Promote Mental Health on College and University Campuses: Recommendations to Facilitate Usage of Services, Resources, and Supports," *J. Behav. Health Serv. Res.*, vol. 49, no. 2, pp. 252–258, Apr. 2022, doi: 10.1007/s11414-021-09780-2.
- [11] K. Klein *et al.*, "Evaluating Active Lecture and Traditional Lecture in Higher Education," *J. Empower. Teach. Excell.*, vol. 7, no. 2, pp. 9–10, 2023.
- [12] D. A. Tholibon *et al.*, "The factors of students' involvement on student-centered learning method," *Int. J. Eval. Res. Educ.*, vol. 11, no. 4, pp. 1637–1646, 2022, doi: 10.11591/ijere.v11i4.22314.
- [13] M. I. Baig and E. Yadegaridehkordi, "Flipped classroom in higher education: a systematic literature review and research challenges," *Int. J. Educ. Technol. High. Educ.*, vol. 20, no. 1, pp. 1–26, 2023, doi: 10.1186/s41239-023-00430-5.
- [14] K. Ali, N. Barhom, F. Tamimi, and M. Duggal, "ChatGPT—A double-edged sword for healthcare education? Implications for assessments of dental students," *Eur. J. Dent. Educ.*, vol. 28, no. 1, pp. 206–211, 2024, doi: 10.1111/eje.12937.
- [15] M. Saleem and Z. Khan, "Healthcare Simulation: An effective way of learning in health care," *J. Healthc. Simul.*, vol. 39, no. 4, pp. 1185–1190, 2023.
- [16] M. Xu, Y. Luo, Y. Zhang, R. Xia, H. Qian, and X. Zou, "Game-based learning in medical education," *Front. Public Heal.*, vol. 11, no. 1, pp. 01–09, 2023, doi: 10.3389/fpubh.2023.1113682.
- [17] C. Elendu *et al.*, "The impact of simulation-based training in medical education," *Medicine (Baltimore)*, vol. 103, no. 27, pp. 1–14, 2024.
- [18] M. A. Hazrat, N. M. S. Hassan, A. A. Chowdhury, M. G. Rasul, and B. A. Taylor, "Developing a Skilled Workforce for Future Industry Demand: The Potential of Digital Twin-Based Teaching and Learning Practices in Engineering Education," *Sustainability*, vol. 15, no. 16433, pp. 1–27, 2023.
- [19] A. Cirneanu and C.-E. Moldoveanu, "Use of Digital Technology in Integrated Mathematics Education," *Appl. Syst. Innov.*, vol. 7, no. 66, pp. 1–26, 2024, doi: 10.3390/asi7040066.
- [20] A. Romancenco, I. Saratila, I. Ababii, and G. Rojnovanu, "Bridging theory and practice : enhancing medical education through simulation-based training methods," *Mold J Heal. Sci.*, vol. 11, no. 2, pp. 68–73, 2024, doi: 10.52645/MJHS.2024.2.09.
- [21] M. Zhang, H. Ding, M. Naumceska, and Y. Zhang, "behavioral sciences Virtual Reality Technology as an Educational and Intervention Tool for Children with Autism Spectrum Disorder: Current Perspectives and Future Directions," *Behav. Sci.*, vol. 12, no. 138, pp. 1–33, 2022, doi: 10.3390/bs12050138.
- [22] B. Avau, A. Vanhove, K. Lauwers, P. Vandekerckhove, and E. De Buck, "Impact of the Use of Simulated Patients in Basic First Aid Training on Laypeople Knowledge , Skills , and Self-efficacy A Controlled Experimental Study," *Empir. Investig.*, vol. 17, no. 4, pp. 213–219, 2022, doi: 10.1097/SIH.0000000000000657.
- [23] M. Peng, N. Su, R. Hou, and H. Geng, "Evaluation of teaching effect of first-aid comprehensive simulation-based education in clinical medical students," *Front. Public Heal.*, vol. 10, no. 909889, pp. 1–8, 2022, doi: 10.3389/fpubh.2022.909889.
- [24] C. Dai, F. Ke, Z. Dai, and M. Pachman, "Improving teaching practices via virtual reality-supported simulation-based learning : Scenario design and the duration of implementation," *Br. J. Educ. Technol.*, vol. 54, no. December 2022, pp. 836–856, 2023, doi: 10.1111/bjet.13296.

- [25] P. W. C. Lau, J. J. Wang, and L. L. Ransdell, "The effectiveness of Facebook as a social network intervention to increase physical activity in Chinese young adults," *Front. Public Heal.*, vol. 10, no. 912327, pp. 1–14, 2022, doi: 10.3389/fpubh.2022.912327.
- [26] G. D. Collins and N. D. Ekumah, "Current State of Global Disasters and Development of Global Nursing Professionals Designing and delivering effective simulation-based education for global nursing emergency disaster preparedness and humanitarian practice," *Heal. Emerg. Disaster Nurs.*, vol. 12, pp. 21–28, 2025, doi: 10.24298/hedn.2025-SP03.
- [27] A. Hamdi and A. Al Thobaity, "Enhancing Disaster Triage Competencies through Simulation-Based Training: An Interventional Study among Undergraduate Nursing Students," *Sustainability*, vol. 15, no. 15513, pp. 1–13, 2023, doi: 10.3390/su152115513.
- [28] G. C. Osegbue, I. N. Ohamobi, C. O. Alordiah, A. State, and D. State, "Enhancing School Safety and Security: Developing and Implementing Effective Protocols For A Secured Learning Environment," *African J. Soc. Behav. Sci.*, vol. 15, no. 2, pp. 1023–1038, 2025.
- [29] E. Widowati, H. Koesyanto, W. Istiono, and A. H. Sutomo, "Disaster Preparedness and Safety School as a Conceptual Framework of Comprehensive School Safety," *Sage*, no. December, pp. 1–11, 2023, doi: 10.1177/21582440231211209.
- [30] K. Skivington *et al.*, "A new framework for developing and evaluating complex interventions: Update of Medical Research Council guidance," *BMJ*, vol. 374, no. 2018, pp. 1–11, 2021, doi: 10.1136/bmj.n2061.
- [31] A. Ghanad, "An Overview of Quantitative Research Methods," *Int. J. Multidiscip. Res. Anal.*, vol. 06, no. 08, pp. 3794–3803, 2023, doi: 10.47191/ijmra/v6-i8-52.
- [32] W. Purnomo, A. Ardayati, and A. Fiani, "Teaching Reading Comprehension: A Pre-experimental Research of Story Mapping Strategy," *Dharma Acariya Nusantara. J. Pendidikan, Bhs. dan Budaya*, vol. 2, no. 2, pp. 37–48, 2024, doi: 10.47861/jdan.v2i2.1152.
- [33] A. Yilmaz and S. Duygulu, "Developing Psychological Empowerment and Patient Safety Culture: A Pre-experimental Study," *J. Basic Clin. Heal. Sci.*, vol. 5, no. 2, pp. 94–103, 2021, doi: 10.30621/jbachs.907526.
- [34] P. S. Anand, P. K. Mohiudheen, M. Ali, and P. P. Sekar, "Effectiveness of Structured Instructional Teaching on Internet Usage in Reducing Academic Stress Among Nursing Students: A Pre-Experimental Study," *Vasc. Endovasc. Rev.*, vol. 8, no. 9s, pp. 115–119, 2025.
- [35] A. K. Abadi, H. T. Oktavia, K. Mada Setiadi, G. B. Wicaksono, and I. Hayuningtyas, "Comparison of Arm and Leg Muscle Fatigue During a 3X3 Basketball Game: a Pre- Experimental Study," *Malaysian J. Sport Sci. Recreat.*, vol. 21, no. 1, pp. 1–8, 2025, doi: 10.24191/mjssr.v21i1.5664.
- [36] J. E. Rudolph, Y. Zhong, P. Duggal, S. H. Mehta, and B. Lau, "Defining representativeness of study samples in medical and population health research," *BMJ Med.*, vol. 2, no. 1, pp. 1–7, 2023, doi: 10.1136/bmjmed-2022-000399.
- [37] M. M. Willie, "Defining the Population and Target Population in Clinical Studies: Clarifying Terminology and Enhancing Study Validity," *J. Med. Clin. Nurs. Stud.*, vol. 1, pp. 1–3, 2023, doi: 10.61440/jmcns.2023.v1.03.
- [38] D. Hossan, Z. Dato' Mansor, and N. S. Jaharuddin, "Research Population and Sampling in Quantitative Study," *Int. J. Bus. Technopreneursh.*, vol. 13, no. 3, pp. 209–222, 2023.
- [39] F. Mulisa, "Sampling techniques involving human subjects: Applications, pitfalls, and suggestions for further studies," *Int. J. Acad. Res. Educ.*, vol. 8, no. 1, pp. 74–83, 2022, doi: 10.17985/ijare.1225214.
- [40] C. B. Uwamusi and A. Ajisebiyawo, "Participant Observation as Research Methodology: Assessing the Defects of Qualitative Observational Data as Research Tools," *Asian J. Soc. Sci. Manag. Technol.*, vol. 5, no. 3, pp. 1–14, 2022.
- [41] N. K. Sharma, "Instruments Used in the Collection of Data in Research," *SSRN Electron. J.*, vol. 1, no. 1, pp. 1–8, 2022, doi: 10.2139/ssrn.4138751.
- [42] A. I. Oben, "Research Instruments: a Questionnaire and an Interview Guide Used To Investigate the Implementation of Higher Education Objectives and the Attainment of Cameroon'S Vision 2035," *Eur. J. Educ. Stud.*, vol. 8, no. 7, pp. 113–130, 2021, doi: 10.46827/ejes.v8i7.3808.
- [43] J. B. Torratio, S. E. Aguja, and M. S. Prudente, "Using web video conferencing to conduct a program as a proposed model toward teacher leadership and academic vitality in the Philippines," *Educ. Sci.*, vol. 11, no. 11, pp. 1–30, 2021, doi: 10.3390/educsci11110658.
- [44] D. R and D. R, "A Study to Assess the Knowledge Regarding Consanguineous Marriages and its Genetic Effects among Young Adults with a View to Develop an Information Booklet at Selected Degree Colleges in Tumkur, Karnataka," *Int. J. Nurs. Care*, vol. 12, no. December, pp. 17–35, 2024.
- [45] I. Afrianti, N. Wahyuni, and M. Y. A. Putra, "The Effect of Implementation Project-Based Learning (Pjbl) on Students' English Learning Outcomes," *IJEAL (International J. English Appl. Linguist.)*, vol. 5, no. 3, pp. 289–302, 2025.
- [46] R. Alfiani and D. Sulisworo, "Leveraging ChatGPT for Developing Learning Object Material: A Multi-representation Approach to Teaching Water Pollution," *Form. J. Ilm. Pendidik. MIPA*, vol. 13, no. 2, pp. 167–178, 2023, doi: 10.30998/formatif.v13i2.19472.
- [47] Z. Zen, Reflianto, Syamsuar, and F. Ariani, "Academic achievement: the effect of project-based online learning method and student engagement," *Heliyon*, vol. 8, no. 11, pp. 1–13, 2022, doi: 10.1016/j.heliyon.2022.e11509.
- [48] D. Duchatelet and V. Donche, "Assessing student learning during simulations in education: Methodological opportunities and challenges when applying a longitudinal case study design," *Stud. Educ. Eval.*, vol. 72, p. 101129, 2022, doi: 10.1016/j.stueduc.2022.101129.
- [49] Q. Huang, S. Y. Yan, J. Huang, Y. Guo, X. T. Zeng, and Y. H. Jin, "Effectiveness of simulation-based clinical research curriculum for undergraduate medical students - a pre-post intervention study with external control," *BMC Med. Educ.*, vol. 24, no. 1, pp. 1–12, 2024, doi: 10.1186/s12909-024-05455-6.
- [50] A. Vandendriessche, B. Deforche, K. Dhondt, T. M. Altenburg, and M. Verloigne, "Combining participatory action research with intervention mapping to develop and plan the implementation and evaluation of a healthy sleep intervention for adolescents," *Heal. Promot. Perspect.*, vol. 13, no. 4, pp. 316–329, 2023, doi: 10.34172/hpp.2023.37.

- [51] P. A. Nasita and T. Purnama, "Snowball Throwing Method as an Effort to Improve Dental Health Knowledge in Elementary School Students," *J. Cent. Excell. Heal. Assist. Technol.*, vol. 3, no. 2, pp. 58–63, 2025, doi: 10.36082/jchat.v3i2.2608.
- [52] M. Taniguchi, T. Ikezoe, T. Tsuboyama, Y. Tabara, F. Matsuda, and N. Ichihashi, "Prevalence and physical characteristics of locomotive syndrome stages as classified by the new criteria 2020 in older Japanese people: results from the Nagahama study," *BMC Geriatr.*, vol. 21, no. 1, pp. 1–10, 2021, doi: 10.1186/s12877-021-02440-2.
- [53] T. Piratvisuth *et al.*, "Multimarker Panels for Detection of Early Stage Hepatocellular Carcinoma: A Prospective, Multicenter, Case-Control Study," *Hepatol. Commun.*, vol. 6, no. 4, pp. 679–691, 2022, doi: 10.1002/hep4.1847.
- [54] D. J. E. Berdida and R. A. N. Grande, "Academic stress, COVID-19 anxiety, and quality of life among nursing students: The mediating role of resilience," *Int. Nurs. Rev.*, vol. 70, no. 1, pp. 34–42, 2023, doi: 10.1111/inr.12774.
- [55] C. Yan, A. B. Siddik, L. Yong, Q. Dong, G. W. Zheng, and M. N. Rahman, "A Two-Stage SEM-Artificial Neural Network Approach to Analyze the Impact of FinTech Adoption on the Sustainability Performance of Banking Firms: The Mediating Effect of Green Finance and Innovation," *Systems*, vol. 10, no. 5, 2022, doi: 10.3390/systems10050148.
- [56] M. Qorib, "Analysis Of Differentiated Instruction As A Learning Solution In Student Diversity In Inclusive And Moderate Education," *IJRS Int. J. Reglem. Soc. Anal. Differ. Instr. As A Learn. Solut. ...*, vol. 5, no. 1, pp. 43–55, 2024.
- [57] D. Abidin, M. S. Aminudin, E. Supriatna, K. K. Alvinuri, and I. Ramadhan, "Between Potential and Environmental Influences for Individual Success: A Review from An Educational Perspective," *EDUKASIA J. Pendidik. dan Pembelajaran*, vol. 5, no. 1, pp. 95–104, 2024, doi: 10.62775/edukasia.v5i1.718.
- [58] G. Gunawan, P. R. Yanti, and N. Nelson, "Methods for Achieving Cognitive, Affective, and Psychomotor Aspects in Islamic Religious Education Learning: A study at Senior High School in Rejang Lebong," *AL-ISHLAH J. Pendidik.*, vol. 15, no. 1, pp. 981–991, 2023, doi: 10.35445/alishlah.v15i1.2793.
- [59] A. Aprizal and P. A. Dewi, "The Effect of Learning Independence on Learning Outcomes in Fiqih Subjects of Class X MAN 3 Inhil," *Int. J. Educ. Inf. Technol. Others*, vol. 8, no. 2, pp. 96–109, 2025.
- [60] M. Akour and M. Alenezi, "Higher Education Future in the Era of Digital Transformation," *Educ. Sci.*, vol. 12, no. 784, pp. 1–13, 2022, [Online]. Available: <https://doi.org/10.3390/%0Aeducsci13121166>
- [61] M. A. M. Hashim, I. Tlemsani, and R. Matthews, "Higher education strategy in digital transformation," *Educ. Inf. Technol.*, vol. 27, no. June 2021, pp. 3171–3195, 2022, doi: 10.1007/s10639-021-10739-1.
- [62] I. AlBalawi *et al.*, "Health Sciences Students' Attitude, Perception, and Experience of Using Educational Simulation in Saudi Arabia: A Cross-Sectional Study," *Nurs. Reports*, vol. 12, no. 3, pp. 620–628, 2022, doi: 10.3390/nursrep12030061.
- [63] B. A. Alhassan, M. Diebieri, A. A. Anliengmene, and S. Issah, "A survey of knowledge and practice of simulation among health tutors in selected health training institutions," *Nurs. Open*, vol. 10, no. 9, pp. 6390–6397, 2023, doi: 10.1002/nop2.1887.
- [64] A. L. Adere, T. B. Abicho, H. H. Seid, B. S. Workneh, and E. Getaneh Mekonen, "Determinants of knowledge and attitude toward first aid among final year students at technical and vocational schools in Addis Ababa, Ethiopia," *SAGE Open Med.*, vol. 10, pp. 1–9, 2022, doi: 10.1177/20503121221107479.
- [65] I. Budin-Ljosne *et al.*, "Public perceptions of brain health: an international, online cross-sectional survey," *BMJ Open*, vol. 12, no. 4, pp. 1–15, 2022, doi: 10.1136/bmjopen-2021-057999.
- [66] T. Tajima, K. Harada, Y. Oguma, and S. S. Sawada, "Does health literacy moderate the psychological pathways of physical activity from guideline awareness to behavior? A multi-group structural equation modeling," *BMC Public Health*, vol. 23, no. 1, pp. 1–13, 2023, doi: 10.1186/s12889-023-15012-3.
- [67] A. I. Roşioară *et al.*, "Status of Healthy Choices, Attitudes and Health Education of Children and Young People in Romania—A Literature Review," *Med.*, vol. 60, no. 5, pp. 1–32, 2024, doi: 10.3390/medicina60050725.