# High and low fidelity simulation for clinical skill in paramedic students in resource limited settings

SYSTEMATIC REVIEW

**ORIGINAL ARTICLE BY**

Nantawan Tippayanate; Kiattisak Chaiprom; Ajchara Kamya; Chlollada Thornsao; Wipada Wijakkanalan; Nattida Aopasi; Kawisara Treemaneerat; Patthraporn Philatha

Mahasarakham University, Thailand

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**Correspondence to:** Nantawan Tippayanate; nokeworld@gmail.com

## ABSTRACT

### OBJECTIVE

To investigate and compare the effectiveness of high-fidelity simulation and low fidelity simulation.

### METHODS

34 second-year paramedic students were randomly divided into eight groups: 17 students to the four experimental groups and the other 17 to the four control groups. Each group was assigned four scenarios of emergency from the same lecturer and the same instructor. The experimental groups received a high-fidelity simulator, a more advanced manikin that mimicked body mechanisms including pulse rates, a respiratory system, and a beating heart. They also had video-assisted instructor-facilitated debriefing. Meanwhile, the control groups received an evaluation during the training and then instructor-facilitated debriefing. Both experimental and control groups received their operation evaluation using a primary survey.

### RESULTS

Thirtyfour paramedic students participated in the study (low fidelity, n=16; high fidelity, n=18). There was a significant improvement in posttest practice scores in assessment of the airway, disability and exposure. However, there was no statistically significant difference in score between low fidelity and high fidelity simulation sessions. Student opinions indicated that the experiential simulator sessions were more satisfying.

### CONCLUSION

Both low fidelity and high fidelity simulation of faculty- facilitated educational offer a valuable learning experience. Future research is needed that address the long term effects of experiential learning in retention of knowledge and acquisition skills.

## INTRODUCTION

Fidelity simulation training for paramedic students has had an increasingly important role for more than 20 years intending to develop their clinical skills to be effective for urgent situation with a limitation of training time and to give them relevant advice.[1,2] Fidelity simulation training is employed to instruct various medical practices including clinical examination, illness diagnoses, medical treatment procedures, and medical equipment use so students can perform those practices properly.[3] Advancement of hardware and software, simulation has become more realistic. Manikins used in a simulation have life-like body mechanisms such as pulse, respiratory system, and functioning pupils. They also have a basic ability to communicate. These sophisticated manikins are called high fidelity simulators.[4] Meanwhile, the less sophisticated manikins with limited simulated body mechanisms are called low fidelity simulators. When the latter is used, training is required to be evaluated with other criteria. Theoretically, the more realistic the simulation is, the better the learning outcome. However, it is found in various studies that gained knowledge and skills from high fidelity are not significantly different from that of low fidelity simulators.[5-7] However, most of the information is exclusively from the western countries while the evidence is relatively scarce in the resource- limited setting. The objective of this study was to compare the effectiveness of clinical learning outcome, self-confidence and satisfaction between the low fidelity simulation vs high fidelity simulation.

## METHODS

### STUDY DESIGN AND OVERSIGHT

This study employed quasi-experimental design with non-randomized intervention-control posttest only design to compare the results from the group trained with high fidelity simulation and the other group trained with low fidelity simulation. Both groups were given debriefing after the simulations. The low fidelity simulation took place in the skill lab, the faculty of Medicine, Mahasarakham University, Thailand and the high-fidelity simulation took place in the simulation unit, the faculty of nursing, Mahasarakham University, Thailand. The study period was from June 1, 2020 through July 31, 2020. The study was approved by the ethics committee of Mahasarakham University.

### PARTICIPANTS

The participants were 34 second-year paramedic students of the academic year 2019 of Mahasarakham University, Thailand. They were divided into four groups regarding the students' preference. In each of these four groups; it was later divided into two small groups with a matched pretest score. At this stage, we had 8 small groups with 4-5 students per small group. These 8 small groups were assigned using block randomization with a block size of 2 to either high and low fidelity groups using.

### PROCEDURES

All students were lectured regarding history taking and physical examination for 8 weeks at the Faculty of Medicine, Mahasarakham University. Later, they

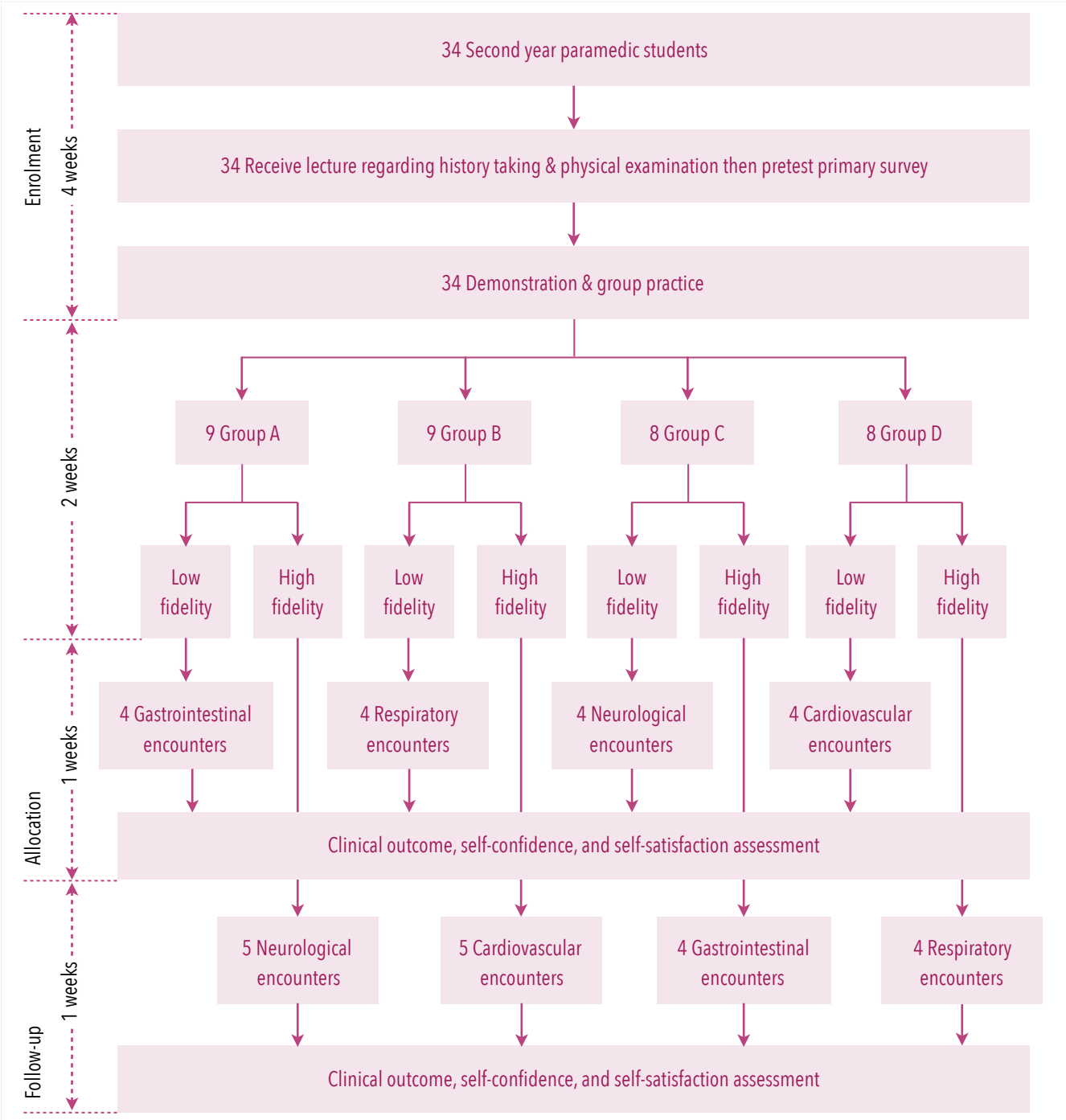


**Figure 1. Study flow**

**Table 1. Primary survey score**

| Primary survey group score | Low fidelity (4 groups) | High fidelity (4 groups) | P-value |
|---|---|---|---|
| Total pretest score | | | 0.69 |
| Median | 27.3 | 27.5 | |
| IQR | 27.3-27.4 | 27.2-27.6 | |
| Range | 27.3-27.4 | 27.0-27.7 | |
| Posttest score | | | |
| Airway | | | 0.88 |
| Median | 7.5 | 8.0 | |
| IQR | 6.5-8.5 | 4.0-10.0 | |
| Range | 6.0-10.0 | 2.0-10.0 | |
| Breathing | | | >0.99 |
| Median | 8.0 | 7.5 | |
| IQR | 6.5-9.5 | 6.5-9.0 | |
| Range | 6.0-8.0 | 7.0-10.0 | |
| Circulation | | | >0.99 |
| Median | 13.5 | 13.5 | |
| IQR | 13.0-14.5 | 10.0-17.5 | |
| Range | 13.0-15.0 | 10.0-18.0 | |
| Disability | | | 0.14 |
| Median | 6.5 | 9.5 | |
| IQR | 4.5-8.5 | 8.5-10.0 | |
| Range | 4.0-10.0 | 8.0-10.0 | |

Table 1. Continue

| Primary survey group score | Low fidelity (4 groups) | High fidelity (4 groups) | P-value |
|---|---|---|---|
| Exposure | | | 0.32 |
| Median | 2.50 | 3.0 | |
| IQR | 2.0-3.0 | 3.0-3.5 | |
| Range | 2.0-3.0 | 3.0-4.0 | |
| Total | | | 0.01 |
| Median | 38.0 | 39.0 | |
| IQR | 33.5-41.5 | 34.5-45.0 | |
| Range | 32.0-42.0 | 31.0-50.0 | |

were subjected to pretests using 40 multiple-choice questions. Then the instructor demonstrated how to do a primary survey in an emergency patient and allowed the students to do a return demonstration and a group practice for another week. The members of each subgroup were practiced by assigning the role to be the first-order as a paramedic or head of the group, the second-order as an advanced emergency medical technician (EMT), the third-order as a basic EMT and the fourth-order as an emergency medical rescuer. If there were the fifth-orders in some groups, they were assigned as a driver. A week later, the low fidelity group was practiced as a posttest with random clinical encounters of emergency conditions consisting of the cardiovascular problem, respiratory problem, gastrointestinal problem, and neurovascular problem (Figure 1). The students in the high fidelity group were allowed to observe their peers. In the last week, the high fidelity groups practiced as a post-tested with random clinical encounters for the same various emergency conditions with a different diagnosis. The students in the low fidelity groups were also allowed to observe.

For each clinical encounter, it comprised, first, 10-minute-long pre-briefing by the same instructor that gave the students details of fidelity simulation and instructions and let them familiarize with the tools such as emergency medical kit and the manikin; second, a 20-minute-long practice session with the instructor giving simulated scenarios and evaluating the students' clinical skills, third, a 20-minute-long session for debriefing by the instructor team.

### *SIMULATIONS*

Each group of the students was given a 30-minute-long session. In the low fidelity group, the instructor indicated the clinical symptoms such as

pale, dyspnea, restless, tachycardia, cyanosis to recognize any illness. Meanwhile, the training of the high fidelity group was conducted in the high-fidelity simulation, the manikin with life-like body mechanisms such as functioning pupils, a respiratory rate, a blood pressure, a pulse rate, and EKG monitor that could be assessed. The same instructor provided simulated scenarios of emergency which had been presented using a computer-based. In both groups, a deterioration in the condition of the patient changed according to how well the students gave medical care in an emergency. The high-fidelity simulation was also being recorded on video from the beginning to the end of the session for reviewing during the debriefing.

### *DEBRIEFING*

The debriefing was done in every group after finishing the clinical encounter session, the same instructor encouraged students to reflect their performance by exploring the process of simulation, the outcome achieved, and the application of the scenario to clinical practice with non judgemental feedback by welcoming all comments and correcting the misunderstanding. However, video-assisted instructor-facilitated debriefing using the recorded video was done only in the high fidelity group.

### *OUTCOME MEASURES*

The three measures in the present study included outcome-based clinical skills, self-confidence, and student satisfaction. The clinical skills were assessed by a practical scenario simulated assessment using the non-trauma primary survey.[8] The scores were given regarding group (group score) using a 26-question with a three-point global rating scale, the high score showed the appropriate assessment and decision making consisting of lists for assessment and management of airway, breathing, circulation, disability, and exposure (ABCDE). After being provided with call-out information by the instructor, participants entered a room carrying a standardized medical kit to find a manikin awaiting diagnosis, stabilization, and to be made ready for transport. Score 0 meant undo or wrong which requires development; score 1 meant incomplete or required supervision' and score 2 meant complete or competent. The total score then could be ranged from 0 to 52.

To measure participants' level of confidence and satisfaction level, we adopted the checklist of the students' self-confidence and satisfaction using the National League for Nursing.[9,10] To measure the students' confidence, we used 8-item questions with a four-point Likert scale while the students' satisfaction was measured using 5-item questions with the same four-point Likert scale; very satisfied, satisfied, unsatisfied, and very unsatisfied. The instrument has a high reliability with a Cronbach's alpha of 0.90 for the presence of features and 0.96 for its importance.[11] Its content validity was scored by the expert opinions of the three instructors yielding 0.86, 1, and 1. The students' confidence and satisfaction was determined to be structurally valid.[12]

## STATISTICAL ANALYSIS

The present study was using the Mann-Whitney U test for non-normally distributed continuous data and the chi-square test for categorical data. The clinical assessment scores, the level of confidence and the participants' satisfaction from the low and high-fidelity simulation were analysed.

**Table 2. Self-confidence rating scale**

| | Low fidelity (N=16) | | | | High fidelity (N=18) | | | | P Value |
|---|---|---|---|---|---|---|---|---|---|
| I am confident that | Strongly disagree | Disagree | Agree | Strongly agree | Strongly disagree | Disagree | Agree | Strongly agree | |
| | *no. (%)* | | | | | | | | |
| I am mastering the content of the simulation activity that my instructors presented to me. | 0 | 9 (56) | 7 (44) | 0 | 0 | 3 (17) | 12 (66) | 3 (17) | 0.03 |
| This simulation covered critical content necessary for the mastery of paramedic curriculum. | 0 | 7 (44) | 9 (56) | 0 | 0 | 3 (17) | 12 (66) | 3 (17) | 0.09 |
| I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a scene | 0 | 8 (50) | 7 (44) | 1 (6) | 1 (5) | 1 (5) | 12 (67) | 4 (23) | 0.02 |
| My instructors used helpful resources to teach the simulation. | 0 | 7 (44) | 6 (38) | 3 (18) | 0 | 1 (5) | 11 (61) | 6 (34) | 0.03 |
| It is my responsibility as the student to learn what I need to know from this simulation activity. | 0 | 0 | 13 (82) | 3 (18) | 0 | 0 | 12 (67) | 6 (33) | 0.34 |
| I know how to get help when I do not understand the concepts covered in the simulation. | 0 | 6 (38) | 8 (50) | 2 (12) | 0 | 4 (22) | 8 (44) | 6 (33) | 0.32 |
| I know how to use simulation activities to learn critical aspects of these skills. | 0 | 3 (19) | 9 (56) | 4 (25) | 0 | 0 | 9 (50) | 9 (50) | 0.09 |
| It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time. | 0 | 4 (25) | 10 (62) | 2 (13) | 0 | 1 (5) | 8 (44) | 9 (50) | 0.04 |

## RESULTS

Thirty-four second-year paramedic students participated in the present study. Most of them were female. The pretest scores between the two groups were similar (P=0.69). For the posttest score, there were also no significant differences between the two groups concerning all process of the primary survey; airway (P=0.88), breathing (P>0.99), circulation (P>0.99), disability (P=0.14), exposure (P=0.32). The total posttest score of the high fidelity group, however, was significantly higher than that of the low fidelity group (P=0.01) (Table. 1).

From Table 2, we found that the high fidelity group tended to have higher confidence compared with that of the low fidelity group in relation to class mastery (P<0.05); knowledge to perform necessary task (P<0.05); helpful resources (P<0.05) and get what need to learn from simulation activity (P<0.05).

For Table 3, we also found that the high fidelity group tended to have higher satisfaction compared with that of the low fidelity group in relation to effective teaching method (P<0.005); variety of learning materials and activities (P<0.005); motivated and helpful materials to learn (P<0.005) and suitable to their way of learning (P<0.005).

## DISCUSSION

### SUMMARY

The thirty-four second year students who received the lecture and then pretest before the primary survey practice using the low fidelity compared to the high fidelity simulation did not show a significant difference in pretest score and also the clinical assessment score in each process of primary survey. However, in the high fidelity group, they felt more confidence in group relation to class mastery, knowledge to perform necessary tasks, helpful resources, and have got what they need to learn from simulation activity. In the self-satisfaction outcome, there were found that the students were more satisfied in groups of high fidelity in relation to effective teaching methods, variety of learning materials and activities, motivated materials to learn and suitable to their way of learning.

### COMPARISON WITH OTHER STUDIES

The result indicated that the clinical assessment outcome of the group practice with the higher fidelity was not significantly different to the low fidelity group practice when focus each step from A to E in the primary survey. It was the result same as many studies [14-16] which indicated that no difference in knowledge at course conclusion or no difference in skill performance. It may be due to the fact that the fidelity plays an important role in the choice of an appropriate simulation for a specific task, while the clinical assessment outcomes depend on the type of task and learner's level. The comparisons made between high and low fidelity simulations mainly investigated the educational impact. The psychometric advantages and disadvantages were evidently not elaborated.[17]

The high fidelity group practice tended to have higher confidence than the low fidelity group. The use of high-fidelity allows learners to engage physically with the simulated patient, assess physical findings, make clinical decisions, and can

**Table 3. Student-satisfaction rating scale**

| Item of satisfaction | Low fidelity (N=16) | | | | High fidelity (N=18) | | | | P Value |
|---|---|---|---|---|---|---|---|---|---|
| | Very unsatisfied | Unsatisfied | Satisfied | Very satisfied | Very unsatisfied | Unsatisfied | Satisfied | Very satisfied | |
| | *no. (%)* | | | | | | | | |
| The teaching methods used in this simulation were helpful and effective. | 0 | 2 (12) | 10 (62) | 4 (26) | 0 | 0 | 3 (17) | 15 (83) | 0.002 |
| The simulation provided me with a variety of learning materials and activities to promote my learning of the medical surgical curriculum. | 0 | 4 (24) | 6 (38) | 6 (38) | 0 | 0 | 1 (5) | 17 (95) | 0.002 |
| I enjoyed how my instructor taught the simulation. | 0 | 2 (12) | 5 (31) | 9 (57) | 0 | 0 | 2 (11) | 16 (89) | 0.08 |
| The teaching materials used in this simulation were motivating and helped me to learn. | 0 | 3 (18) | 10 (62) | 3 (20) | 0 | 0 | 4 (22) | 14 (78) | 0.002 |
| It is my responsibility as the student to learn what I need to know from this simulation activity. | 0 | 0 | 13 (82) | 3 (18) | 0 | 0 | 12 (67) | 6 (33) | 0.34 |
| I know how to get help when I do not understand the concepts covered in the simulation. | 0 | 6 (38) | 8 (50) | 2 (12) | 0 | 4 (22) | 8 (44) | 6 (33) | 0.32 |
| I know how to use simulation activities to learn critical aspects of these skills. | 0 | 3 (19) | 9 (56) | 4 (25) | 0 | 0 | 9 (50) | 9 (50) | 0.09 |
| It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time. | 0 | 4 (25) | 10 (62) | 2 (13) | 0 | 1 (5) | 8 (44) | 9 (50) | 0.04 |

increase realism of interactions with other healthcare professionals in team-based that closely clinical practice[18], therefore the confidence in domain; mastering content, developing skill, helpful resources were higher compare to the low fidelity using basic manikin and then response the abnormality of signs and symptoms by instructor only.

Higher fidelity group practice tended to have more satisfaction than low fidelity group practice, this finding deviates from a study conducted by Zulkosky[19] who were found that the different degree of complexity in the methods of high fidelity may have influenced the students' perceptions and the students seemed to prefer learning strategies that they were accustomed to.[20]

## STRENGTH AND LIMITATION

In the present study, we used the self- confidence and self-satisfaction with high reliability; the Cronbach's alpha of 0.90 for the presence of features and 0.96 for its importance. However it was a subjective rating scale and may have a different rate from another examiner therefore the overall self-confidence and overall self-satisfaction should be asked to finalize the total score.

Each item of self-confidence not meaning confidence in skill, because of the fidelity simulations is regarding the environment and context of learning and application. Therefore, the self- confidences in clinical assessment skills were not clearly described.

The high fidelity practice after the observation of Low fidelity group practice may affect better clinical outcome and self-confidence. In the present study may bias the findings because the training was carried out on the low fidelity prior with allocation of students to observe then the next week was practice with the high fidelity group, therefore it may bias more confidence when practice after complete observation in the low fidelity group.

All participants were second-year paramedic students but have good experience on multiple tasks and complication tasks to improve decision making. As an essential part of professional development and education, the students were trained under safe conditions in order to practice in complex situations, as manifested by clinical practice.[21] Meanwhile, the mean score of satisfactions in high fidelity were significantly higher compared to low fidelity due to the video-assisted instructor-facilitated debriefing in high fidelity simulation is more reassurance of intentions and essential to create a safe emotional environment that is conducive to learning.

## CONCLUSION AND IMPLICATION

The findings support the fact that from the clinical assessment outcome, simulation methods using low to high fidelity could be used in paramedic education at second year- level. However, the level of fidelity should be appropriate to the type of task and training stage. A novice can achieve similar or higher skills transfer with a simple simulator, than with a complex training aid such as a simulated environment. In the future study, the balancing fidelity and breadth of sampling as this will affect reliability, validity, educational impact, feasibility, and acceptability of the assessment method. Concerning the impact of high fidelity manikins, we need to define the best means of structuring debriefing to facilitate meaningful learning that will impact students' performance.

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