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Simulation effect on medical sciences students' motivation: A systematic review study

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Abstract:

Simulation is an educational technology that can facilitate learning, improve performance, and develop critical thinking and self-confidence in students. Motivation is an effective factor in the level of efficiency and the use of individual talent, ability, and satisfaction. The aim of this study was to determine the effect of simulation on students' motivation based on existing studies. This systematic review was conducted using a full systematic search strategy based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for the identification of relevant literature in Cochrane, PubMed, Embase, Scopus, Web of Science, and ERIC electronic databases up to April 2023, utilizing search terms in the titles and abstracts. Finally, 21 articles were selected after being screened in accordance with our inclusion and exclusion criteria. Of 21 articles related to the study's aim, 19 articles (91%) were interventional studies (three randomized controlled trials (RCTs) and 16 non-RCTs) and two articles (9%) were noninterventional studies (cohort and cross-sectional). The results revealed that in 17 studies (77%), simulation studies had a positive effect on motivation, and in 19% of studies, simulation had no significant effect on motivation. Most of the studies improved students' learning motivation using different simulation methods. Simulation methods require appropriateness in three areas: comprehensiveness, the subjects of training, and the allocation of appropriate facilities.

Keywords:

Education, motivation, simulation, student

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Background

Today, the use of traditional teaching methods alone is no longer sufficient for efficient education, and other complementary methods should be employed for appropriate and effective education to boost learning.[1] Although ability and skill are crucial in learning, they are not enough for success in education, and motivation and learning strategies also play significant roles.[2] Lack of available clinical learning space for the education of medical students, limited exposure of learners to patients with different diagnoses, and issues related to patient safety are factors that have affected clinical education in medical science[3] and choosing a suitable method to implement educational programs is one of the most significant measures in the course of educational design.[1]

Education is one of the key elements in preparing students for the purposeful application of knowledge in different fields of learning.[4] Recent technological advances have created new tools to enhance learning, especially in higher education.[5]

Simulation is an educational technology that can facilitate learning, improve performance, and develop critical thinking and self-confidence in students. Additionally, students gain the ability to

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develop high levels of critical thinking by repeating and practicing in an observed environment.[6]

The effects of simulation are very important on learners' knowledge and skills; hoverer, since factors such as motivation also affect the education quality, an educational technique can lead to changes in people and be presented as a successful method that affects crucial factors such as motivation in addition to knowledge and skills.[3]

Motivation is an important factor in learning that can cause movement in humans[7] and increases individual efficiency, talent, ability, and satisfaction.[8] Motivation and interest play a major role in the learning process and have various influences on learning and behavior,[7] academic performance, adaptation, and students' health.[9]

The best way to motivate students is to improve learning conditions and increase the quality of educational methods. Therefore, the teaching method can be a motivating factor.[10]

Koh *et al*.[11] (2010) study indicated that students trained with simulation-based learning (SBL) reached high levels of motivation and achieved high average performance test scores. Another study on simulation in nursing education found that simulation leads to a change in the learner's attitude and readiness to learn, as well as the creation of critical thinking processes in the learner.[12]

Although most studies have focused on strengthening the learning of students, to our knowledge, no systematic review has examined the effect of these interventions on the motivation of medical science students. According to the studies conducted in this field and given the significance of motivation in the learning of medical science students, this structured review aimed to investigate the impact of simulation on the motivation of medical sciences students to determine the most effective simulation method for improving the motivation of these students.

Materials and Methods

This systematic review study analyzed the studies conducted on the effect of simulation on students' motivation. All related articles published between 1990 and April 2023, based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, in four stages of identification, screening, eligibility, and inclusion were selected according to the main question of this study: "What is the effect of 'simulation' on the motivation of medical students based on existing studies?"

Articles were searched in Cochrane, PubMed, EMBASE, Scopus, Web of Science, and ERIC databases using the following keywords alone or in combination: "Motivation" or "Disincentive" or "Expectation" or "Incentive"; "Simulation" or "High Fidelity Simulation" or "Patient Simulation"; "Medical Student" and "Education" or "Training" or "Teaching." The criteria for continuing to review the articles included being written in English, containing original research, having access to the full text, being relevant to the education of medical sciences students, and reporting the impact of simulation training on students' motivation as the outcome variables. Studies in which outcomes of interest were not measured, or not reported, were ineligible. Table 1 shows the search strategy in electronic databases.

After the removal of duplicate articles using X8 software, the titles and abstracts of the studies were independently reviewed by three researchers who removed irrelevant studies based on the exclusion criteria, and any disagreements were resolved through discussion. To evaluate the quality of the articles, an eight-question checklist (two questions about purpose, three sampling questions, two data collection questions, and one analysis question) was used.[13] The qualitative evaluation of the articles was performed by two researchers separately, and in case of disagreement, the opinions of a third researcher were used to summarize and make decisions.

The data collected from the final studies were extracted based on the designed form and the name(s) of the author(s) and year of publication, place of publication, type of study, sample or research community, sample size, training content, duration of sessions, and total training. The simulation method, control group intervention (if any), motivation measurement tool, and results are presented in a separate table.

This study was approved by the Research Ethics Committee of Jahrom University of Medical Sciences, Iran, with the ethics code IR.JUMS.REC.1401.079.

Table 1: Search strategy in the electronic database

Database	Date	Variable search term	Total kept
Cochrane	2015–2023	"Simulation" OR "Student" OR "Motivation"	T: 3 K: 1
PubMed	1966–2023	"Simulation" OR "Student" OR "Motivation"	T: 56 K: 5
EMBASE	1987–2023	"Simulation Method" OR "Medical" OR "Education" OR "Motivation"	T: 28 K: 3
Scopus	1988–2022	"Simulation" OR "Medical Student" OR "Education"	T: 97 K: 6
WOS	1989–2023	"Simulation" OR "Nursing" OR "Education"	T: 24 K: 4
ERIC	1995–2023	"Simulation" OR "Education" OR "Education"	T: 34 K: 2

Authenticity was taken into account in the use of different sources and materials. Furthermore, all the issues related to research ethics were taken into consideration when conducting and publishing the materials, as well as the standards required in the review studies.

Results

From a total of 2135 studies in the primary search, 656 articles were selected according to the relevance of the titles to the subject of the study. After screening the abstracts, 210 articles remained. After that, by removing duplicates using Endnote X8 software, 71 articles were finally selected. In the next stage, 17 cases were excluded from the review process due to their qualitative nature, 13 cases due to noninterventional factors, seven cases due to the lack of relevance to the intervention, 13 cases due to the lack of evaluation of the outcome variable with tools, and three cases due to presentation in a seminar. After reading the full text of 71 articles, 21 papers that were related to the purpose of the research were selected. Figure 1, shows the stages of studies selection.

After searching, screening, and evaluating, 21 articles related to the purpose of the study were chosen. The characteristics of the 21 articles included in the systematic review are summarized in Table 2. The countries of Vietnam, Taiwan, Spain, Portugal, France, Jordan, the Netherlands, and the United States had one article each; Korea, Sweden, and Australia had two articles each; Germany and Denmark had three articles; and one article was shared by France and Sweden.

From the 21 final studies, 19 articles (90%) were interventional studies (three randomized controlled trials (RCTs) and 16 non-RCTs) and two articles (10%) were noninterventional studies (cohort and cross-sectional). Moreover, 74% of the motivation studies used the word motivation and 26% of the studies used the subclasses of motivation including feedback, involvement, interest, competence, and effort. Among these studies, 12 were conducted on medical students, four on nursing students, one study on students in each of the fields of physiotherapy, exercise physiology, radiography, and dentistry, and one on joint interdisciplinary study. Additionally, in 17 studies (81%), the simulation had a positive effect on motivation, and in 19% of the cases, the simulation did not significantly affect motivation. One study found that there was no positive effect for strong and medium students and no significant effect for weak students.

Various interventions, such as games, role-playing, simulation environments, mannequins, and Standard Patients (SPs), were used as reported in Table 2.

In these studies, different simulation methods were used. These methods included role-playing in three studies by Roze (2016), Codeço (2020), and Zorn (2018); simulation games in four studies by Su C-H and Cheng C-H (2013), Dennis (2017), Dankbaar *et al*. (2016), and Nguyen TN (2015); SPs in three studies by Yoon (2016), Riber (2009), and Hecimovich and Volet (2014); SBL environments in one study by Makransky (2016); films containing simulated scenarios (videotaped simulation scenarios) in three studies by Hallin *et al*. (2016), Sorenson *et al*. (2015), and Fawaz *et al*. (2016); simulation sessions in three studies by Roh and Kim (2015), Brock *et al*. (2013), and Guerrero-Martínez *et al*. (2020); simulation-based team training (SBTT) in one study by Escher *et al*. (2017); virtual simulator (VS) in two studies by Klienert *et al*. (2016) and Nilsson *et al*. (2016); and simulation devices in one study by Holling *et al*. (2015).

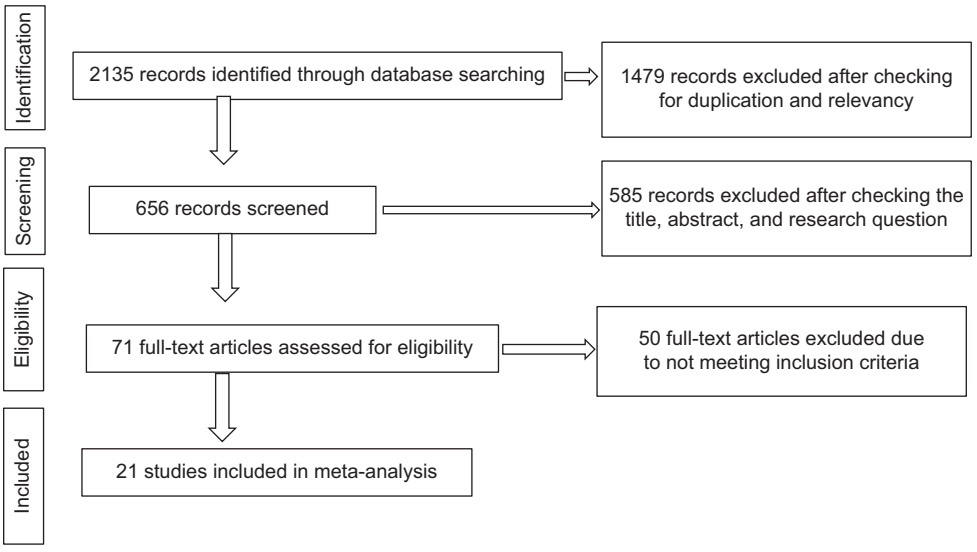

Figure 1: Flow chart of studies selection

Table 2: List of articles included in this study

	Author (year)	Country	Design	Sample/grade	Sample size	Class (content)	Intervention		Control	Measurement	Outcome (results)/ effect
							Duration/no. of session/ intervention	Total time			
1	Roze *et al.* (2016)	France	Non-RCT (post-only)	Medical students and their teachers/3rd years	(1 group) student: 223/ teacher: unclear	Neurological semiology	14 weeks/ mime-based role-playing	3 h	Unclear	Anonymous self-administrated questionnaire	Motivation to learning (+)/ Students: 78% increased motivation Teachers: 90% increased motivation
2	Su C-H and Cheng C-H (2013)	Taiwan	Quasi-experimental (pre–post)	College students/3rd years	E: 33 C: 30	System analysis course	22 weeks/3D game-based learning	1100 min	Traditional face-to-face learning	Designed questionnaire	Motivation to learning (+) F=5.782, P<0.010
3	Yoon *et al.* (2016)	Korea	Cohort study	Preclinical medical students/2nd years	99	Kidney and urinary tract and endocrine system and clinical nutrition	2 weeks/ standardized patients	105 min	Video case	A Likert scale questionnaire	Motivation (+) t=13.25, P<0.001, d=2.05
4	Makransky *et al.* (2016)	Denmark	Non-RCT (pre–post)	Undergraduate medical student/ first year	(1 group) 300	Medicine and molecular biomedicine	Half-semester/ simulation-based learning environment	2 h	Unclear	5-point Likert scale	Motivation (+) 93% more motivation t=3.49, P=0.001, d=0.31
5	Hallin *et al.* (2016)	Sweden	Cross-sectional	Nursing students/3rd year	173	A, B, C, D, E scenarios	Unclear/ videotaped complex nursing simulation scenarios	50–75 min	Unclear	Productivity Environmental Preference Survey for Adults (PEPS)	Motivation (-) 16.2% high
6	Roh & Kim (2015)	Korea	Repeated-measures design	Nursing students/2rd year	83	CPR	6 weeks/ simulation-based learning	2 h	PBL	Motivation Strategies for Learning Questionnaire (MSLQ)/Life Style Questionnaire	Motivation (+) F=6.62, P=0.003
7	Sorenson *et al.* (2015)	Denmark	Investigator-initiated single-center randomized trial	Midwives/ specialized midwives/ auxiliary nurses/nurse anesthetists/ operating theater nurses/ consultant doctors	ISS: 48 OSS: 49	Management of emergency cesarean section after cord prolapse and postpartum hemorrhage	Unclear/ multiprofessional simulation scenario	50–60 min	*In situ* versus out-site simulation-based multiprofessional training	Multiple choice question (MCQ)/ Safety Attitudes Questionnaire (SAQ)/Stress-Trait Anxiety Inventory (STAI)/cognitive appraisal (CA)/ Intrinsic Motivation Inventory (IMI)	Motivation (-) P=0.72, P=0.24, P=0 0.15, P=0.65
8	Riber *et al.* (2009)	Germany	Non-RCT (pre–post)	Medical student/3–5 years	(1 group) 44	Medical history taking training	Unclear/ standardized patients	Unclear	Baseline values	Questionnaire on Current Motivation (QCM)	Motivation (+) F=5.42, P<0.05

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Table 2: Contd...

	Author (year)	Country	Design	Sample/grade	Sample size	Class (content)	Intervention		Control	Measurement	Outcome (results)/ effect
							Duration/no. of session/ intervention	Total time			
9	Escher *et al.* (2017)	Sweden	Prospective cohort study	Medical students/7–8 semester	(1 group) 56	Patient safety	Unclear/ simulation-based team training (SBTT)	Unclear	Unclear	Situational Motivation Scale (SIMS)/ Attitudes to Patient Safety Questionnaire (APSQ)	Motivation (+) $P<0.001$
10	Dankbaar *et al.* (2016)	Netherlands	Post-test-only design	Pre-clerkship (4th-year) medical students	In total, 79 student games (n=30), cases (n=30), and control group (n=19)	Emergency care skills	4 weeks/ simulation game with the same cases ("high-fidelity condition")	2–4 h	Access from home to an instructional e-module on emergency care, followed by a knowledge test	The 9-item questionnaire consisted of two constructs: engagement (six items) and feedback (3 items); 5-point Likert scale	Motivation: engagement: Game (+) Case (-) Control (-) Feedback: Game (+) Case (+) Control (-) Motivation: Game (+) Case (-) Control (-)
11	Dennis *et al.* (2017)	Australia	Non-RCT	Physiotherapy students	140	"Communication in physiotherapy"	1 session/a new SBL (simulation-based learning) activity	40 min	No control group	Instructional Materials Motivation Scale (IMMS) questionnaire	The median of the total IMMS score for all students was 149, which was well above the median of the scale (108). Subscales: "attention, relevance, confidence, and satisfaction"
12	Kleinert *et al.* (2016)	Germany	Post-only	Third-year students	360	Esophageal cancer	6 lectures/ custom-made three-dimensional (3D) virtual patient simulator (VPS)	3 semesters	No control group	5-point Likert scale: 1—very reasonable, 2—mainly reasonable, 3—reasonable, 4—partially reasonable, and 5—not reasonable	Motivation (+)

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Table 2: Contd...

	Author (year)	Country	Design	Sample/grade	Sample size	Class (content)	Intervention		Control	Measurement	Outcome (results)/ effect
							Duration/no. of session/ intervention	Total time			
13	Brock *et al.* (2013)	USA	Pre–post	Fourth-year medical, third-year nursing, second-year pharmacy and second-year physician assistant students	306	Adult acute care, pediatric, obstetric cases	1 session/ simulation-based interprofessional team STEPPS	4 h	No control group	Attitudes, Motivation, Utility and Self-Efficacy (AMUSE)	Motivation (+) Pre: 3.64 (3.55 to 3.73) Post: 4.01 (3.90 to 4.11) Paired t-test: 0.000 Effect size (d): 0.4
14	Nguyen, TN (2015)	Viet Nam	Quasi-experimental	Medical students	53	Operations Management course	7 days/game group played a Web-based simulation game lasting 7 days	Unclear	The no-game group was assigned problem textbooks and in-class exercises	A 5-point Likert scale Intrinsic motivation is composed of three dimensions: competence (four items), interest in study (four items), and efforts (four items)	Interest (-) Competence (-) Effort (-)
15	Hecimovich and Volet 2014	Australia	RCT pre–post	3rd-year university exercise physiology students	43	Musculoskeletal assessment and rehabilitation	2 sessions/actors as standardized patients	4×2 h	Peer-based learning	3-item scale	Motivation (engagement):(-) Both groups (F=10 0.05 (1,40), P=0.003)
16	Nilsson *et al.* 2016	Denmark	RCT	Medical student in the fourth, fifth, or sixth semester	36 participants	Laparoscopic surgery	Intervention 1: virtual reality simulation training: Camera group, using a 30 Intervention 2: angled laparoscope (procedure group) practiced a simulated laparoscopic cholecystectomy	120 min	No one receive any training	Transfer test and Intrinsic Motivation Inventory (IMI)	Motivation (+) (P=0.030)

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Table 2: Contd...

	Author (year)	Country	Design	Sample/grade	Sample size	Class (content)	Intervention		Control	Measurement	Outcome (results)/ effect
							Duration/no. of session/ intervention	Total time			
17	Holling *et al.* 2015	Germany	RCT	Fourth-year medical students	120 45 intervention 56 control	Diagnosis of brain death	1 session/new high-fidelity simulation device	1 hour	Received no intervention	The students were asked to evaluate eight statements	Motivated to engage (-) (i=4.18, c=4.16) has no issue with evaluating (-) (i=2.58, c=3.48; *P*=0.001) Instruction was effective (+) (i=4.60, c=3.60; *P*=0.001) Instruction was fun (+) (i=4.42, c=3.48; *P*=0.001) The instruction changed my attitude (+) (i=4.30, c=2.63, *P*=0.001) "I am motivated to engage with the topic: evaluation of brain death" (-) (i=4.18, c=4.16) "this training course was strong motivation for me (-) (i=2.62, c=2.38)
18	Fawaz *et al.* (2016)	Jordan	A post-test, quasi-experimental design	First-year nursing students	56 (26 simulation-30 traditional)	Presentation of a simulation scenario of clinical cases of acute CHF	Unknown	Unknown	Traditional classroom instruction	The Motivated Strategies for Learning Questionnaire (MLSQ)	There was a significant difference post-HFS between intervention (198.6±10.5) and control groups (161.6±20) in motivation for academic achievement (*t*=−6.71, P b 0.001)
19	Guerrero-Martínez *et al.* (2020)	Spain	Quasi-experimental design	Fourth-year nursing students	51	Care of multiple victims	2 sessions with 1 h and 30 min	4 months	Descriptive documentation	A specific questionnaire for perception of learning	There were favorable significant differences in the set of global responses, with *P*<0.0069 for motivation" dimension

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Table 2: Contd...

Author (year)	Country	Design	Sample/grade	Sample size	Class (content)	Intervention		Control	Measurement	Outcome (results)/effect
						Duration/no. of session/intervention	Total time			
20 Codeço (2020)	Portugal	A quantitative and descriptive study	Undergraduate dentistry degree students (5th year)	51	Establish useful strategies to change patients' behavior concerning oral health	2 sessions in 2 hr Role-plays with standardized patients	2 days	No control group	Researcher questionnaire	Students believe that clinical simulation contributes to the active participation of learners in their learning process, promoting the development of skills and decision-making
21 Zorn *et al.* (2018)	French (two) and Swiss (one) simulation centers	A qualitative approach	3rd- and 4th-year student radiographers	7	Osteoarticular radiographic examinations	Three role-play simulation sessions	Unknown	No control group	Interview and observation	Students said that such simulation sessions are effective to develop high motivational dynamics for students

Discussion

In this study, 21 articles were investigated with the aim of evaluating the effect of different types of simulation on student motivation. Simulation interventions were performed using demonstrations, mannequins, games, SPs, simulated environments, scenarios, video texts, real patients, computers, and 3D images. The results indicated that in 17 studies, the effect of simulation training on students' motivation was positive.

Most of the simulation techniques in the selected studies (eight cases) used SPs. Using SPs is an effective method of teaching by simulation. The advantages of this simulation type are deeper thinking, development of communication skills, improvement of perspective, and an increase in motivation.[14] The study by Roh *et al*.[15] (2015) showed that using the SP method increases the motivation of nursing students in learning Cardio-Pulmonary Resuscitation (CPR). The results of the study by Yoon *et al*.[16] (2016) revealed that using the SP method in teaching about the kidney and urinary tract, the endocrine system, and clinical nutrition increased the motivation of medical students. In another study, SP simulation motivated medical students in the process of taking patients' medical history.[17] In the study by Dennis *et al*.[18] (2017) conducted in Australia, teaching communication skills based on simulation (SBL) using the SP method for undergraduate students of physiotherapy had a positive effect on the motivation of learners. Codeço *et al*.[19] (2020) reported that the use of SP increased dental students' motivation in using the appropriate methods to improve the performance of patients with conditions related to oral hygiene.[19] The use of SP increases students' self-confidence in the field of learning and performance, problem-solving, and self-directed learning.[16]

However, in Hecimovich and Volet's study (2014), which used SP simulation to teach physiology students in Australia about the assessment of the musculoskeletal system and rehabilitation, the students' educational motivation declined.[20] The reason for students' lack of motivation in using the SP method can be their unfamiliarity with this method, which consequently affected their communication skills and self-confidence, or not providing a suitable environment for the correct presentation of the SP method.[21,22]

In two studies, SP simulation was used as a team training method (SBTT). In the study by Cecilia Escher *et al*.[23] (2017) in Sweden, this method was used to teach medical students about safety, and the result showed that there is a positive relationship between student's attitude about patient safety and their self-report of motivation to participate in SBTT. In addition to the simulation method benefits, group activity skills are also

improved in SBTT, and all team members benefit from the training process.[24]

In another study conducted in the United States, SBTT was used interprofessionally in medical, nursing, pharmacy, and medical assistant students. In this study, adult acute care and common topics of pediatrics and midwifery were taught. The findings indicated that the creation of a considerable logistical challenge along with the change in students' attitudes and beliefs during training increased students' educational motivation.[25]

In Denmark, a study was conducted on the SP training method for nursing and midwifery students, regarding the clinical management of emergency cesarean sections and postpartum hemorrhage. In this method, a simulated patient, who was a faculty instructor, was presented to students in two situations: *in situ* simulation (ISS), that is, simulation inside the hospital but outside the delivery room, and off-site simulation (OSS). The results showed that although the students' learning motivation improved in both situations, there was no difference between the two situations in this regard.[26]

In two selected studies, virtual patient simulation was used. In the study by Kleinert *et al*.[27] (2015) in Germany, the real patient simulation method combined with a network (Web-based virtual patient simulation) was used to teach the different stages of diagnosis and treatment of esophageal cancer to medical students and improved the learning motivation of the learners.[27] In the study by Nilsson *et al*.[28] (2017), using a simulation method, a real patient with a camera (simulation-based camera) (SBC) was employed in laparoscopic surgery training in Denmark, which boosted learners' motivation.[28] The available evidence shows that the use of simulation methods in conjunction with the real patient improves learners' real motivation and learning success;[29] however, the degree of integration and use of the real patient are influenced by various factors, and all students cannot be placed in the same position.[30]

In five studies, simulation games were used in two ways: 3D or digital games and Web-based simulation games. Dankbaar *et al*.[31] (2016) conducted their study in the form of a simulated game in emergency care training of medical students in the Netherlands and reported a positive effect on the learners' motivation. In Nguyen's (2015) study, the educational motivation of students increased in the training of operation management in the online simulation form.[32] Using a 3D or digital game, a study in Taiwan in the field of teaching system analysis and topics related to energy showed that students' motivation was improved.[33]

The use of simulated games in the education process is increasing, while the design of these games requires deep insight.[34] A simulated game places learners in a real and enjoyable computer environment so that the learner observes the results of his training and decision-making simultaneously during the training.[35] In fact, the interplay of games with simulation is actually a part of the process of transitioning from traditional education to a new learning-center model in which the learner plays an active, challenging, and enjoyable role in his education.[33,36] Obtaining suitable results from simulated games is dependent on the correct understanding of the cognitive and psychomotor skills of learners and the correct choice of educational subjects.[37,38]

In two studies, the role-playing simulation method was used. In the study by Roze *et al*. (2016), the simulation method in the role-playing form in a comedy show (mime-based role-playing) was used to teach neurology to medical students at a French university. In this method, by overcoming the fear of neurophobia, students' motivation to learn was increased.[39] In the study by Zorn *et al*.[40] (2018), adopting the simulated role-playing approach for radiography students led to an increase in their motivation. The use of the simulated role-playing strategy leads to the management of the learning process, which improves students' knowledge and awareness and their educational experience.[39]

In other studies, different simulation methods were used, which have different results on students' motivation. In the study by Makransky *et al*.[41] (2016), the simulation-based virtual learning environment was used to teach genetics to medical students in Denmark. This method affects the knowledge and self-confidence of students and consequently increases their motivation to learn.

In the study by Hallin *et al*. (2016), videotaped simulation scenarios were used to teach various curriculum items to undergraduate nursing students, including cardiopulmonary resuscitation. In this study, students' motivation to learn declined. The use of simulation methods requires the provision of appropriate fields of knowledge and comprehensive structural and psychomotor fields.[42]

In Germany, a high-fidelity simulation device was employed to teach the diagnosis and evaluation of brain death to medical students. According to the findings of this study, this method had an effect on students' motivation.[43]

In the study by Fawaz and Hamdan-Mansour[44] (2016), the scenario simulation method increased nursing

students' motivation in learning to care for acute Congestive Heart Failure (CHF) patients.

In Guerrero-Martinez *et al*.'s[45] (2020) study, the use of virtual learning platform in the form of teaching the care of multiple victims, for fourth-year nursing students, has led to an improvement of motivation.

Enhancing students' motivation is dependent on improving their self-confidence in science inquiry, creating interest in science, changing the science identity, and inducing an implicit conception of ability.[46]

Conclusion

Most examples of using different simulation methods have been reported to improve students' learning motivation; however, more studies in this field are required. Applying the simulation method requires the suitability of the conditions in three areas: comprehensiveness, the subject of training, and the allocation of appropriate facilities. Therefore, it is recommended to use different simulation methods as an effective educational strategy to boost learners' motivation, taking into account the appropriateness of inclusivity, the subject of education, and facilities.

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Conflicts of interest

There are no conflicts of interest.

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