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Comparison of Students' Attitudes about the Effectiveness of Algorithm-based Education with Lecture-based Education

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Abstract

Background: Training is a complex process, especially when the students are being prepared for patient's management. Therefore, the development of effective teaching methods is critical for to improvement of learning and communication between the content and concepts. In algorithm-based education, more focus is placed on more involvement of students in the subject, thereby providing a better understanding of the concept. In this study, we compared students' attitudes about the effectiveness of algorithm-based education (education based on the patient's complaints and symptoms) with lecture-based education in the learning ability of the medical students presented in the clinical course of the orthopedic group.

Methods: This research is a single-group quasi-experimental study; we assessed the students' attitudes on a five-point Likert scale questionnaire with confirmed validity and reliability. The scores of two teaching methods were assessed after the training course, which was presented using the algorithmic method for selective titles and lectures for the other titles. Data were analyzed on SPSS software using a paired t-test.

Results: A total of 220 internship medical students, including 58.7% of girls with a mean age of 22.9 ± 1.19 years, participated in the study. The mean score of the questions was 3.92±0.54 and 2.17±0.58 in the algorithmic and the lecture training, respectively. After comparing the results with a paired t-test, there was a significant difference between students' attitudes toward the two teaching methods ($p < 0.001$), so the students' attitude was more positive toward the algorithm-based method.

Conclusion: For the education of medical students, algorithm-based training is more efficacious compared to traditional methods such as lecture-based training.

Keywords: Clinical Teaching, Algorithm-based education, Clinical course, Orthopedics

Conflicts of Interest: *None declared*
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Introduction

Education is a complicated process. This complication is even more prominent when the training recipient is getting prepared for the patients' management, as small mistakes may risk someone's life (1, 2). With the advancement of technology, medical education has also evolved, and traditional methods, such as lecture-based training, have been substituted with new training methods such as e-learning, simulation, and virtual patients (3). While the traditional

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↑What is "already known" in this topic:
In algorithm-based education, more focus is placed on more involvement of students in the subject, thereby providing a better understanding of the concept.

→What this article adds:
For the education of medical students, algorithm-based training is more efficacious compared to traditional methods such as lecture-based training. Algorithm-based learning is effective in improving clinical decision-making and using algorithms along with other educational methods can be effective in improving students' clinical decision-making skills, especially orthopedic students.

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methods were centered on memorizing information inactively, the new trend in education is focused on the active involvement of students in understanding the concept, thereby assuring more efficient and durable learning (2, 4). Musculoskeletal disorders are one of the most frequent and debilitating medical problems. According to the 2017 report, musculoskeletal disorders have been the main cause of disability in four out of six WHO regions. Although these disorders are generally attributed to old age, musculoskeletal injuries of young individuals are prevalent, as well (5). Therefore, medical education systems should provide a strong background for the diagnosis and treatment of such disorders (6, 7). A cross-sectional study performed at Harvard University revealed that medical graduate lacks enough capability in clinical encounter with disorders of the musculoskeletal system (8). In another study performed at Isfahan University of Medical Sciences, the proficiency of 40 interns in orthopedics was investigated with A 14-item questionnaire. The results revealed that the interns were not adequately qualified in casting and splinting, doing different bandages, suturing open wounds, and doing intra-articular injections. They concluded that a complete revision is necessary for the educational systems for training orthopedic interns (9). Emergent revision of the orthopedic education systems for training medical students was highlighted in other investigations, as well (6, 7, 10). Clinical algorithms, also known as “protocols’, provide a clear-cut explanation regarding the appropriate action in the management of patients with a specific problem and include proper history taking, clinical and Para clinical evaluations leading to the optimum diagnosis and selection of best therapeutic approach (11). In the algorithmic approach, the consecutive steps to diagnosis and treatment are demonstrated in an algorithm, thereby facilitating clinical decision-making by reducing the mental challenge (12). Considering the importance of musculoskeletal knowledge for medical students, the implication of algorithm-based training, whenever possible, would result in a better conceptualization of the contents (13). In this study, we compared students' attitudes towards the effectiveness of algorithm-based education (based on the patients’ complaints and symptoms) in comparison with the lecture-based algorithm in the training of medical interns in the clinical course of orthopedics.

Methods

Research Design and Setting

This research is a single-group quasi-experimental study. Educational contents and headlines were taught to the interns of the orthopedic group using either a lecture-based system or an algorithm-based system. At the end of the experiment, the students' attitude toward each training system was evaluated using a predesigned questionnaire.

Attitude assessment tool

A questionnaire with a five-point Likert item (Strongly agree; agree; neither agree nor disagree; disagree; strongly disagree) was designed by the authors, in which the strongly disagree scored 1 point and the strongly agree scored 5 points. The questionnaire was composed of two sections. The first section was related to the general information and included four questions. The second section was designed to assess the students' attitude toward the education system and included 22 questions. The questionnaire had two dimensions with indistinctive distribution. Nine questions (questions 1, 4, 5, 6, 14, 17, 18, 19, 20) were attributed to the positive attitude towards algorithm-based education method (first category) , while the remaining questions implied the opposite attitude (second category). The reliability of the questionnaire was confirmed by five specialists and the validity of the questionnaire was checked by internal consistency or homogeneity using Cronbach's coefficient alpha. The Cronbach's coefficient alpha for the questionnaire was 0.88. The Cronbach's coefficient alpha was 0.77 for the first category. All the questions of this category, except number 17, revealed a significant positive correlation of 0.49 to 0.74 with the sum of this category and a significant positive correlation of 0.44 to 0.65 with the total sum ($p < 0.001$). The Cronbach's coefficient alpha for the second category of questions was 0.85. All the questions of this category revealed a significant positive correlation of 0.49 to 0.73 with the sum of this category and a significant positive correlation of 0.43 to 0.7 with the total sum following the recode ($p < 0.001$).

Study population

The study population included 220 interns who received orthopedic training in the orthopedic group of Rasul-e Akram Hospital between 2017 and 2018. Convenience sampling was used.

One-Group Posttest-Only Design

In a one-group posttest-only design, a treatment is implemented (or an independent variable is manipulated) and then a dependent variable is measured once after the treatment is implemented. The one-group posttest-only design (a.k.a. one-shot case study) is a type of quasi-experiment in which the outcome of interest is measured only once after exposing a non-random group of participants to a certain intervention.

The Figure 1 shows that the group of participants who receive the intervention is selected in a non-random way

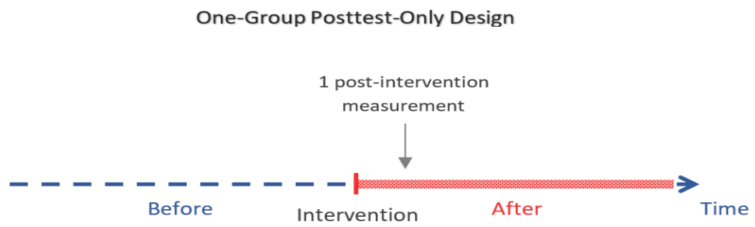

Fig. 1. The one-group posttest-only design

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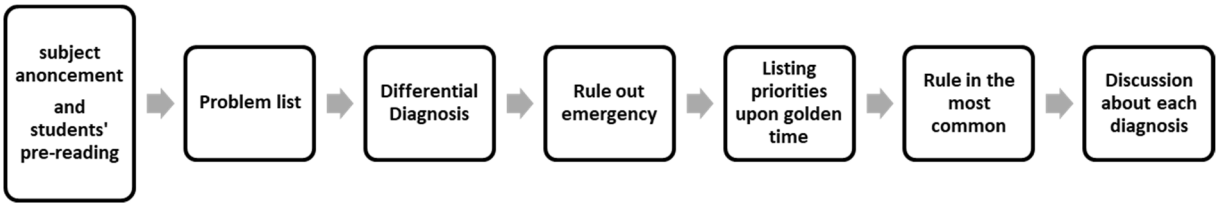

Fig. 2. Education process used for algorithm-based training

(for example, according to their choice or that of the researcher) (14-16).

Education system

Two education strategies were used for teaching orthopedic headlines. For orthopedic fractures, a lecture-based education system was employed. For subjects other than fractures, an algorithm-based training system was implemented. So the professor used to complete the subject's algorithm from step-to-step questioning and completing the algorithm by directing the students' answers (Fig. 2). All sample students received different materials during 6 months of education in both lecture and algorithm methods.

Statistical analysis

The statistical evaluation of the results was done by using SPSS for Windows (version 16). Descriptive data were provided as mean ± SD and number & percentage for quantitative and qualitative variables, respectively. The normal distribution of the parametric data was tested by a Kolmogorov-Smirnov test. As all of the participants received both education and completed the total questionnaire (two sections), paired t-test was used to compare the mean values. The evaluation of the statistical association between categorical variables was done using a chi-square test. A p-value of fewer than 0.05 was considered significant.

As all of the participants received both two education and completed the total questions (two sections), paired t-test was used to compare the mean values.

Results

A number of 220 medical interns, including 128 (58.7%) females and 90 (41.3%) males, were evaluated in this study. The mean age of participants was 22.9±1.19 (range 20-32). One hundred and ninety-seven (89.5%) interns were present in all the educational sessions. The students' response to the study questions is demonstrated in detail in Table 1. Gender and absence had no significant effect on the answers.

The sum of the questions in the first category (positive attitude toward algorithm-based education) was 35.27±4.9 (72.98±13.55 after scaling to 100). In this category, the mean score of each question was 3.92±0.54. The sum of the questions in the second category (positive attitude toward algorithm-based education) was 28.24±7.5 (29.32±14.49 after scaling to 100), and the mean score of each question was 2.18±0.58. The mean difference between the total score of the first and second categories was statistically significant ($p < 0.001$) (Table 2).

Discussion

In the present study, we compared the medical interns'

Table 1. The frequency of the participants' answers to each five-point Likert item showing their attitude toward the education system (algorithm-based versus lecture-based)

Question	Proportion (%)					Median	Mean ± SD
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree		
1. Algorithm-based education could be a decent substitute for traditional education	.9	5.9	6.8	45.5	40.9	4.00	4.2±.87
2. I feel the traditional education system is Irreplaceable	42.0	42.5	11.4	3.7	.5	2.00	1.78±.82
3. The education system does not matter if the education content is appropriate	27.4	42.9	18.3	10.0	1.4	2.00	2.15±.98
4. Algorithm-based education helps me better understand clinical skills.	0	2.3	7.3	51.4	39.1	4.00	4.27±.69
5. I like to learn lots of lessons by algorithm-based method	.9	6.4	9.5	47.7	35.5	4.00	4.10±.88
6. I enjoy being involved with the teacher	3.2	3.7	12.4	48.6	32.1	4.00	4.03±.94
7. I learn less in algorithm-based method	36.1	45.7	13.2	4.1	.9	2.00	1.88±.85
8. Algorithm-based education is harder than traditional education	23.3	43.8	19.2	12.3	1.4	2.00	2.25±.99
9. I feel uncomfortable and anxious in algorithm-based education	30.5	45.0	15.9	7.7	.9	2.00	2.04±.92
10. If the educator is appropriate, the education system does not matter.	15.5	36.8	22.3	20.9	4.5	2.00	2.62±1.11

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Table 1. Continued

Question	Proportion (%)					Median	Mean ± SD
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree		
11. Algorithm-based education is of no use in medical sciences	49.1	40.9	6.8	2.7	.5	2.00	1.65±.76
12. Algorithm-based education is useless	55.0	32.7	6.8	5.0	.5	1.00	1.63±.85
13. Algorithm-based education needs lots of facilities	19.1	44.1	20.0	12.3	4.5	2.00	2.39±1.06
14. The accuracy and validity of the education are more in the algorithm-based method	3.6	15.0	25.0	40.9	15.5	4.00	3.50±1.04
15. Algorithm-based education is just an imitation of the new education methods that are common in other parts of the world	16.4	32.4	40.2	9.6	1.4	3.00	2.47±.92
16. Algorithm-based education waste more time than traditional education	26.4	41.8	13.6	16.8	1.4	2.00	2.25±1.06
17. I better understand the educational content in the algorithm-based system	9.1	29.1	17.3	32.7	11.8	3.00	3.09±1.20
18. I believe algorithm-based education leads to active learning	.5	5.5	16.8	51.8	25.5	4.00	3.96±.82
19. Algorithm-based education improves the students thinking skills	.9	5.0	10.5	49.5	34.1	4.00	4.11±.84
20. I think the development of algorithm-based education is necessary for better learning	.5	2.7	15.5	54.1	27.3	4.00	4.05±.76
21. Algorithm-based education seems complicated	15.5	47.7	23.6	12.3	.9	2.00	2.35±.91
22. Algorithm-based education is not qualified for national tests evaluations	20.0	23.2	23.6	20.0	13.2	3.00	2.83±1.31

Table 2. Comparison of the mean total score of the first and second categories of questions

		Paired Differences					t	df	*P*-value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair	Sum of Algorithm – Sum of Traditional	43.66	24.43	1.64	40.41	46.91	26.51	219	<0.001
Pair	Mean of Algorithm – Mean of Traditional	1.75	.98	.066	1.62	1.88	26.42	219	<0.001

* Paired t-test

attitudes toward lecture-based and algorithm-based education. According to our results, the student had a significantly positive attitude toward the algorithm-based education system. This positive attitude was not affected by the students' gender. These results were in line with the results of earlier investigations.

A clinical trial study performed by Costaet al. revealed that interactive teaching methods in orthopedic education are more popular than lecture-based methods and provide more durable learning (17) .Schwarz et al. used a problem-based algorithm in medical and nursing education. According to their survey, the students expressed interactive algorithms as an easy-to-understand and efficient education method, which leads to the improvement of learning in emergency medicine (3). Saeidiborojeni et al. evaluated the efficacy of an algorithm-based system in educating brain surgery. According to their report, algorithm-based education resulted in learning improvement and more active presentation of medical students at the patients' bedside. They concluded that algorithm-based education could be considered a more efficient education system in comparison with other methods (18).

Although we compared the patients' attitudes toward the algorithm-based and lecture-based education, the effect of these methods on the students' performance was not assessed. However, this comparison was made in several studies. Asayesh et al., in a randomized experimental study, evaluated the ability of 25 medical emergency students in the diagnosis and treatment of emergency problems. The students were either educated by a lecture-based education system or an algorithm-based method. The decision-making capability of the students was measured by clinical scenarios and the clinical self-efficacy scale. Accordingly, the mean scores of the students in the algorithm-based method were significantly more than those in the lecture-based group (12). The experimental study of Mirzatoloei also revealed that medical student participation in the orthopedic operating room based on small group learning scheme not only elevates their scores on ward exams but also has positive effects on their comprehensive examination (19).

Jung Hwa Lee et al. in the study (Effects of an Algorithm-based Education Program on Nursing Care for Children with Epilepsy by Hospital Nurses) concluded. Nurses' knowledge and self-efficacy showed a statistically significant improvement after participation in the education program on nursing care for children with epilepsy (20). Yong-Min Kim et al., in the study "The effects of algorithm-based software education using micro:bit on elementary school

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students' creativity, concluded that the software education program developed in this study had a positive effect on the creativity of elementary school students (21). Corey Heerschap et al. in the study (Algorithmic approaches to ostomy management: An integrative review) concluded Current literature demonstrates the potential benefit of ostomy management algorithms to standardize and improve ostomy patient care (22). Xiaofang Wu et al. in the study "Application of the Improved Clustering Algorithm in Operating Room Nursing Recommendation under the Background of Medical Big Data," concluded data mining technology based on the improved clustering algorithm could effectively improve the quality of care during the nursing period in the operating room, obviously can stabilize the various indicators of the patient during the operation, greatly improve the negative emotions of the patient, and increase the satisfaction of nursing work (23, 24).

Limitations of the Study

Altogether, the results of the present study, in line with the results of earlier investigations, reveal that an algorithm-based method could improve the learning quality in the medical intern of the clinical orthopedic course. However, this study was not without limitations. As the main limitation of the study, we did not evaluate the students' performance in two education systems. Therefore, we suggest performing future complementary comparing the effect of lecture-based education with algorithm-based education on the performance of the students.

Conclusion

According to the results of the present study, algorithm-based education of orthopedic content is superior to the traditional education systems, such as lecture-based methods, and could be considered in the improvement of learning quality as well as in increasing the durability of learning. Algorithm-based learning is effective in improving the clinical decision-making situation, and using algorithms along with other educational methods can be effective in improving the clinical decision-making skills of students, especially orthopedic students.

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Authors Contributions

Study concept and design, Akram Hashemi & Ali Yeganeh; Analysis and interpretation of data, Ghobad Ramezani; Drafting of the manuscript, Mehdi Moghtadaei; Akram Hashemi & Ali Yeganeh ,Critical revision of the manuscript for important intellectual content, Soodabeh Hoveidamanesh and Ghobad Ramezani.

Ethical approval

This study was approved by the Ethical Board of Iran University of Medical Sciences (registration code: IR.IUMS.REC 1396. 29518). Verbal informed consent was obtained from all participants.

Conflict of Interests

The authors declare that they have no competing interests.

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