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The Efficiency of Well-Written Manuals Aided-Hand Knotting Skills Acquisition for Undergraduates

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Abstract

Introduction. Standard procedural skills training methods include a tutorial, workshop, and feedback. Written manuals might add value to those standard methods; nevertheless, it depends on how well they are composed. This research aimed to evaluate the efficiency of well-written manuals of hand-knotting skills to improve students' procedural skills learning and competency.

Method. This research was conducted through a preliminary study to identify the assessor reliability and main study to evaluate the students' scores for reef and surgeon's knots using an objective structured assessment of technical skills (OSATS). Subjects' preparedness and perception of the quality of the manuals were evaluated through a survey. Students were randomly divided into two groups. The treatment group received written manuals a day before the workshop. Both groups experienced the same five steps procedural skills teaching methods. The results were analyzed by SPSS 17.0 through the Pearson Chi-square test and independent t-test.

Results. A preliminary study showed that the assessors had no difference in evaluating students' skills. The main study included 31 subjects in the treatment group and 34 subjects in the control group. The OSATS scores were statistically significantly different between the groups. Students in the treatment group had higher mean scores (43.42 ± 7.98) than those in the control group (27.21 ± 5.64); $p < 0.05$. None of the control group students felt prepared, and most students (77%) considered the manuals to be well written.

Conclusion: Well-written manuals of hand-knotting skills given before skills training improve students' skills acquisition and the standard teaching methods.

Keywords: education, medical; general surgery; feedback; sutures

Introduction

Continuing medical education is directed toward maximum skill competency a doctor could achieve with efficient time. Improvisation of procedural and surgical skills could be achieved in several ways. The current standard method of education includes the tutorial, workshop, and feedback. Wanzel KR et al., Velmahos GC et al., and Reznick RK et al. highlighted the importance of practical sessions and feedback.¹⁻³

Although these current methods seem to be promising, there are still rooms to expand. Written manuals, conventional education tools should not be forgotten as important material for procedural skill learning.⁴ The use of written manuals before the workshop has been studied in some skills training.^{5,6} Surprisingly, there were no significant differences in skill acquisition or final results despite distinct learning methods, including written manuals, instructional video, and hands-on instructions by a tutor.^{5,6} All in all, literature regarding the efficiency of written manuals are still insufficient. One fundamental concern was raised to question whether the manuals were well-written to improve students' learning and help them study skills better and faster during the workshop. Therefore, this research aimed to evaluate the efficiency of well-written manuals given before the workshop to improve surgical skills learning.

The hand-knotting skill was chosen for this research because it bears a high complexity level that cannot be imitated easily by the novice in surgery.⁷ In addition, neither expensive phantom nor fancy instruments are needed.

Method

This research was conducted through two stages, namely preliminary and main study. The preliminary study aimed to identify the assessors' reliability, while the main study was performed to evaluate the student's scores for making reef knots and surgeon's knots. A survey (Appendix A) was distributed to the subjects who were given the written manuals to assess the manuals' quality. The main study compared two groups of students. The treatment group received written manuals (Appendices B to E) a day before the workshop, while the control group did not. A survey was conducted for both groups to determine their preparedness for the workshop (Appendix F). Informed consent was obtained before the research.

Preliminary Study

Three senior surgeons, performed as assessors, were given an introduction on evaluating the knotting skills performed by 30 medical students. The assessors assessed time in motion, flow, final product, and overall performance using Objective Structured Assessment of Technical Skills (OSATS). The knotting process was video recorded by showing up only the hand and distal forearm area without access to the subjects' face and body attire to avoid the subjectivity of the assessors. Each assessor evaluated 30 videos randomly extracted from students' performance showing the knotting skills, either surgeon's knot or reef knot based on one-handed index finger domination, two-handed index finger domination, and two-handed middle finger domination

techniques. The OSATS scores were analyzed for reliability using the intra-class correlation coefficient (Table 1).

Table 1. The objective structured assessment of technical skills (OSATS)

Categories	Score 3	Score 2	Score 1
Time in motion	Clear economy of movement and maximum efficiency	Efficient time and motion, but some unnecessary moves	Many unnecessary moves
Flow	Obviously planned maneuver	Demonstrated some forward planning and reasonable progression of procedure	Frequently stopped maneuvering, seemed unsure of next move
Knowledge of the procedure	Demonstrated familiarity of all steps of procedure	Knew all important steps of procedure	Inefficient knowledge of procedure. Looked unsure and hesitant
Final product	Final product of superior quality	Final product of average quality	Final product of unacceptable quality
Overall performance	Very good	Competent	Very poor

Main Study

Medical students, different from those involved in the preliminary study, were invited to join the main study. Right-handed medical students who were in their clinical clerkship were included in the study. Left-handed medical students and those who have passed the surgery module were excluded. Also, students who have ever read books or journals, seen videos, or been taught about the hand-knotting technique, were excluded. Subjects were randomly divided into control and treatment groups. Subjects of the treatment group were not only given written manuals a day before the workshop; they were also asked to submit an essay to ensure that they have read the manuals before joining the workshop (Appendix G). The control group attended the workshop on a different day from the treatment group. The groups were further divided into three subgroups during the workshop. One instructor was assigned to tutor each subgroup on skill sets of making reef knots based on one-handed index finger domination, two-handed index finger domination, two-handed middle finger domination techniques, and surgeon's knot subsequently.

A concept of five steps standard procedural skills teaching method was conducted.⁴ Firstly, a general overview through presentation aided by picture-based step-by-step slides about one particular skill set, as indicated previously, was performed. Secondly, a silent demonstration at an average speed was performed. Following the silent demonstration, the instructor gave another demonstration with a verbal explanation. The next step, verbalization by the subjects, was done to build a good memory of how the procedure is performed. To this stage, subjects have seen the skills demonstrated three times. Lastly, subjects practiced the skills with sufficient duration. During the last two steps, instructors gave feedback.

The assessors rated the subject's performance after all the learning steps using the OSATS form (Table 1). The OSATS had detailed evaluation points, which included time in motion, flow, knowledge, final product, and overall performance. Time in motion would be given a score of 3 when subjects showed precise and efficient movement, whereas a score of 1 was given to those who showed many unnecessary moves. The flow would be given a score of one if subjects demonstrated frequent "stop" maneuvers or seemed unsure about the next move. Subjects' knowledge score three will be given to those who showed familiarity with all steps of the procedure. The outcome is classified into unacceptable (score 1), average (score 2), and superior (score 3). Lastly, overall performance was categorized into very poor (score 1), competent (score 2), and very good (score 3) based on time in motion, flow, and final product.

The results were assessed for normal distribution and analyzed through the Pearson Chi-square test and independent t-test by SPSS® 17.0.

Results

Preliminary Study

Based on the rater reliability results (Table 2), there was no statistically significant difference among the three assessors performing the evaluation. Hence, the main study could be proceeded.

Table 2. Intra-class correlation coefficient reliability test for preliminary study

No	Question	Intra-class correlation coefficient (Confident Interval 95%)
1	Time in motion	0.625
2	Flow	0.629
3	Final product	0.660
4	Overall performance	0.710

Main Study

There were 65 participants in total: 31 subjects in the treatment group and 34 in the control group. There were 14 males (21.5%) and 17 females (26.2%) in the treatment group with a mean age of 20.58±0.992, while the control group included nine males (13.8%) and 25 females (21.5%) who were 21.18±0.673 years old. Subjects' preparedness before the workshop showed that none in the control group declared to be prepared. On the contrary, 12 subjects (38.7%) in the treatment group claimed to be prepared, and one (3.2%) was convinced to be very prepared. The manual was rated to be well-written by 24 subjects (77%) of the treatment group. The sequential pictures were considered to be self-explanatory by 48% of the participants. The legend of every picture was also easy to be understood as indicated by 70% of the subjects. Furthermore, 77% agreed that the combined pictures and legends were well-connected to describe the step-by-step procedural skills. Meanwhile, the results of the OSATS of both groups were normally distributed based on the Shapiro-Wilk test. Thus, they were further analyzed by the Pearson Chi-square test (Tables 3 to 6). The assessment of subjects performing reef knot skill set by one-handed index finger domination technique showed that those in the treatment group had more efficient time in motion, planned maneuver, and superior quality of the final product than those in the control group (Table 3). The overall performance of the subjects was rated as very good for two subjects (5.9%) in the control group and five subjects (16.1%) in the treatment group (p <0.05). All components of the assessments showed a statistically significant difference between the two groups. Similar results were found in the other two reef knot techniques (Tables 4 and 5). Likewise, the evaluation for the surgeon's knot skill set was better (p <0.05) in the treatment group than in the control group (Table 6). Additional analysis using an independent t-test was performed to show the mean of the participants' total scores in both groups. All scores were gathered from the OSATS components through the four skill sets.

Students in the treatment group had significant ($p < 0.05$) higher scores (43.42 ± 7.98) compared to those in the control group (27.21 ± 5.64).

Table 3. The OSATS outcome for reef knot by one-hand index finger domination

No	Categories	OSATS Score	Treatment		Control		P
			n	%	n	%	
1	Time in motion	1	7	22.6%	20	58.8%	0.001*
		2	11	35.5%	12	35.3%	
		3	13	41.9%	2	5.9%	
2	Flow	1	6	19.4%	14	41.2%	0.001*
		2	7	22.6%	18	52.9%	
		3	18	58.1%	2	5.9%	
3	Final product	1	2	6.5%	10	29.4%	0.038*
		2	21	67.7%	20	58.8%	
		3	8	25.8%	4	11.8%	
4	Overall performance	1	6	19.4%	16	47.1%	0.046*
		2	20	64.5%	16	47.1%	
		3	5	16.1%	2	5.9%	

Table 5. The OSATS outcome for reef knot by two-hand middle finger domination technique.

No	Categories	OSATS Score	Treatment		Control		P
			n	%	n	%	
1	Time in motion	1	5	16.1%	10	38.2%	0.011*
		2	15	48.4%	22	55.9%	
		3	11	35.5%	2	5.9%	
2	Flow	1	2	6.5%	8	11.8%	0.001*
		2	15	48.4%	24	85.3%	
		3	14	45.2%	2	2.9%	
3	Final product	1	2	6.5%	4	14.7%	0.001*
		2	12	38.7%	28	85.3%	
		3	17	54.8%	2	0%	
4	Overall performance	1	2	6.5%	8	23.5%	0.002*
		2	18	58.1%	25	76.5%	
		3	11	35.5%	1	0%	

*Pearson Chi-Square test. $p < 0.05$

Table 6. The OSATS outcome for surgeon's knot.

No	Categories	OSAPS Score	Treatment		Control		P
			n	%	n	%	
1	Time in Motion	1	5	16.1%	20	58.8%	0.001*
		2	15	48.4%	13	38.2%	
		3	11	35.5%	1	2.9%	
2	Flow	1	3	9.7%	16	47.1%	0.001*
		2	12	38.7%	18	52.9%	
		3	16	51.6%	0	0%	
3	Final product	1	3	9.7%	12	35.3%	0.001*
		2	15	48.4%	22	64.7%	
		3	13	41.9%	0	0%	
4	Overall performance	1	4	12.9%	16	47.1%	0.001*
		2	16	51.6%	18	52.9%	
		3	11	35.5%	0	0%	

*Pearson Chi-Square test. $p < 0.05$

Table 7. The OSATS outcome for reef knot by two-hand middle finger domination technique.

No	Categories	OSAPS Score	Treatment		Control		P
			n	%	n	%	
1	Time in motion	1	5	16.1%	20	58.8%	0.001*
		2	15	48.4%	13	38.2%	
		3	11	35.5%	1	2.9%	
2	Flow	1	3	9.7%	16	47.1%	0.001*
		2	12	38.7%	18	52.9%	
		3	16	51.6%	0	0%	
3	Final product	1	3	9.7%	12	35.3%	0.001*
		2	15	48.4%	22	64.7%	
		3	13	41.9%	0	0%	
4	Overall performance	1	4	12.9%	16	47.1%	0.001*

2	16	51.6%	18	52.9%
3	11	35.5%	0	0%

*Pearson Chi-Square test. p < 0.05

Table 8. The OSATS outcome for surgeon's knot

No	Categories	OSATS Score	Treatment		Control		p
			n	%	n	%	
1	Time in motion	1	5	16.1%	10	38.2%	0.011*
		2	15	48.4%	22	55.9%	
		3	11	35.5%	2	5.9%	
2	Flow	1	2	6.5%	8	11.8%	0.001*
		2	15	48.4%	24	85.3%	
		3	14	45.2%	2	2.9%	
3	Final product	1	2	6.5%	4	14.7%	0.001*
		2	12	38.7%	28	85.3%	
		3	17	54.8%	2	0%	
4	Overall performance	1	2	6.5%	8	23.5%	0.002*
		2	18	58.1%	25	76.5%	
		3	11	35.5%	1	0%	

*Pearson Chi-Square test. p < 0.05

Table 9. The overall OSATS outcome.

Group	n	Mean	Std. Deviation	Sig. (2-tailed)
Treatment	31	43.42	7.987	<0.05*
Control	34	27.21	5.640	<0.05*

*Independent t-test

Discussion

Before the workshop, students who received the manuals had better performance in a reef knot and surgeon knot skills. Psychological wise, they would not have excused themselves for performing less. They had been given a well-written manual as their guide to study new skill sets earlier; earlier means before training with no previous surgery rotation. On the other hand, subjects in the control group might have had a different perspective on learning the skills. Logically, learning psychomotor skills would not be easy when the training guidelines were poorly written. Besides, readers would not keenly read a manual, which had neither good structure nor clear information. The training would not provide expected results as described in previous studies.^{5,6} When all the interactive five steps classical procedural skills teaching and learning sessions have been homogenized, then pre-workshop reading materials' readability matters. The written manuals' impact on the students' performance was remarkable since most of them rated the manuals to be well written. A well-written reading manual will be key to the success of the learning and teaching of psychomotor skills. Additional information from written manuals contributes to the success of clinical skills as a comparison to written manuals provided before the skills workshop.

Although gender distribution between the two groups might create bias, we did not take gender as one important factor. Gender and dexterity could be considered inherited factors that we did not control by design. We just relied on nature, where globally, medical students are not recruited based on gender and dexterity. The matter of these two factors, which were not controlled, may be seen as a weakness of this study. However, it would be unrealistic when medical students have to be screened for the discriminative factor such as gender. As for dexterity, it is very unusual to test candidates on their dexterity before joining medical school. All students have to get the same chance to experience learning and teach all subjects as set in the academic curriculum.^{9,10}

In the case of hand dominance, the issue was not on the students' side during subject enrollment; it was decided merely because of the limitation of the tutors where they might have technical difficulties in instructing the left-handed subjects. The tutors invited to this study were

not familiar with instructing left-handed trainees, where the number of left-handed people in the world is considered small (10-12%).^{11,12}

Conclusion

Students performed significantly better in acquiring hand-knotting skills by reading well-written manuals before the skills training compared to those who only experienced the standard methods. In conclusion, well-written manuals for hand knotting skills play an important role in facilitating students' learning and should be recommended to complement the standard procedural skills training methods.

Disclosure

The authors have no conflicts of interest to declare. None of the authors have a proprietary or commercial interest in any product mentioned in this article.

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