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Research Article

A Comparative Study of the Effect of Concept Mapping Versus Debriefing on Learning, Achievement Motivation, and Retention in Anesthesia Management of Neurosurgery among Anesthesia Students

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ABSTRACT

Background: Concept mapping and debriefing are educational strategies used to create motivation and meaningful learning. This study compared the effect of teaching incorporating these two techniques on learning and achievement motivation in anesthesia management of neurosurgery among anesthesia students.

Methods: This was a quasi-experimental study involving two experimental groups (concept mapping and debriefing) and one control group. The statistical population included all 5th- and 7th-semester undergraduate students of anesthesia at Ahvaz Jundishapur University of Medical Sciences. Census sampling yielded 51 participants, who were then randomly assigned to three groups: 17 in the concept mapping group, 17 in the debriefing group, and 17 in the control group. The experimental groups were exposed to group concept mapping and debriefing, while the control group received traditional instruction. Data were collected using the Hermans Achievement Motivation Questionnaire and a standard learning questionnaire. Data were analyzed using analysis of covariance (ANCOVA) and t-tests.

Results: Covariance analysis demonstrated that teaching interventions, using both group concept mapping and debriefing, significantly increased achievement motivation and learning outcomes in anesthesia students ($p < 0.05$). Furthermore, concept mapping yielded a statistically significant increase in achievement motivation as well as meaningful and deep learning compared to debriefing. Regarding learning levels, after two months of intervention, students taught using concept mapping exhibited significantly higher scores (30.41 ± 0.732) than both the debriefing group (29.17 ± 0.772) and the control group (28.78 ± 0.771, $p < 0.05$).

Conclusion: This research suggests that educational stakeholders should integrate concept mapping into anesthesia curricula, focusing on its motivational components, to significantly boost student achievement and learning outcomes.

Introduction

Despite the substantial allocation of national income to education worldwide, numerous variables impede the efficient utilization of these resources. Analysis of educational investment outcomes suggests that student capabilities significantly influence their efficacy. Given the critical role of well-trained professionals in societal advancement, particularly in healthcare disciplines such as anesthesia, the

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development of student competencies is paramount [1-2]. Two of the most critical capabilities a student needs to improve their academic performance and subsequently become an influential and important member of society are high learning capacity [3] and strong achievement motivation [3-7].

Learning represents a relatively stable and persistent change in cognitive, affective, or behavioral domains, derived from experiential engagement. In essence, learning must be meaningful, and new desired feelings, knowledge, beliefs, ideas, and behaviors must be acquired and integrated with existing ones to create the best conditions for problem-solving. Therefore, learning approaches should be continuously revised and improved to prepare students for the current turbulent world. Enhancing teaching-learning methods to improve conceptual knowledge may help students apply their knowledge in medical settings like the operating room [7].

Motivation serves as an internal impetus for individual action, with achievement motivation representing a salient form. This psychological construct is pivotal in determining progress and occupies a central position among non-intellectual determinants [2, 4, 8,]. Achievement motivation is a self-driven force that exceptional individuals generate to sustain their best efforts. With this motivation, individuals are driven to participate in challenging and meaningful activities and excel compared to others. According to the theory of achievement motivation, when a student achieves academic goals, overcomes challenges, and attains academic progress, they experience positive feelings, leading to improved psychological-cognitive (mental) well-being. Students with high achievement motivation are generally more determined and motivated to pursue academic progress. They value their achievements more and are more likely to experience satisfaction and high psychological-cognitive well-being [2].

Educational researchers continually seek optimal teaching methodologies. Concept mapping and debriefing stand out as particularly promising recent techniques. They can play a decisive role in improving students' learning and achievement motivation, fostering more capable and talented students in medical science fields, including anesthesia [1-2]. Teaching methods based on concept mapping and debriefing can significantly influence the most important academic and psychological-cognitive variables of students, including learning and achievement motivation [1-2, 5-7, 12, 14-19]. Therefore, concept mapping-based instruction undoubtedly plays an undeniable role in enhancing academic learning variables [7, 15] and achievement motivation [16, 19] among anesthesia students in medical practices, such as neurosurgery anesthesia management. A thorough understanding of concept mapping and debriefing is essential for their effective pedagogical application and optimal educational outcomes.

Concept mapping

Concept mapping is one of the most important academic teaching and learning techniques, proven useful in developing active learning [1, 11, 14]. It is a technique developed by Joseph Novak in the 1970s to visually represent relationships between different concepts [1, 10-12]. A tool for visually organizing and planning medical procedures in the operating room, concept mapping highlights the connections between issues [14].

Concept mapping-based instruction is a technique where learners are asked to depict their experiences in a hierarchical diagram. More general and comprehensive content is placed at the top of the diagram, while less significant concepts and content are positioned at the bottom [2, 11, 13]. Concept mapping-based instruction encourages students to generate ideas, make connections, and enhance learning. It also helps them develop relationships between different pieces of information and improve prior knowledge and skills. The ideal way to create a concept map is to ask students questions about their experiences and have them present the answers in a concept map format [14].

Debriefing

Debriefing is widely acknowledged by researchers and scientists as a significant educational technique, essential for enhancing effectiveness [14] and promoting experiential learning [15]. This post-experience learning process [16] involves a facilitated session [17] where participants [20] engage in two-way dialogue [18] and collaborative conversation [19] to reflect on and process their shared experiences. This systematic processing of experiences facilitates future correct behaviors and performance enhancement [4-5, 16-17, 19-23].

According to Warick et al. [21] (1979), debriefing is a deliberate [22], purposeful, and significant process, facilitated by structured sessions, which cultivates synergistic learning and enables the transfer of knowledge [18, 24]. This technique skillfully guides learners to extract vital information from their experiences, promoting the acquisition of new knowledge [24] and insight [18, 25]. As Fanning and Gaba [26] (2007) highlighted, debriefing originated in military contexts for mission analysis [27], later expanding into therapeutic psychology for trauma processing, and subsequently becoming a key educational method following experiential learning activities. In educational settings, debriefing is usually conducted after an experiential activity such as simulation [28], games, direct observation, etc., and primarily attempts to use the information generated during the experiential activity to facilitate learning.

During debriefing, facilitators guide participants to reflect on and reconstruct their experiences [19].

The foregoing points demonstrate a clear relationship between learning and achievement motivation, key educational and psychological variables, and the instructional strategies of concept mapping and debriefing. Given the significant benefits of learning and achievement motivation for anesthesia students and their strong link to concept mapping and debriefing, analyzing these variables is crucial for their enhancement. Also, given the critical, reasoning-intensive nature of anesthesia, rigorous training is paramount. Anesthesia professionals are entrusted with patients' lives, where even minor errors can have fatal consequences. Therefore, a bachelor's program of anesthesia must cultivate not only deep knowledge but also a relentless drive for continuous improvement. To ensure patient safety and meet future healthcare demands, we must prioritize principled and highly efficient training programs that produce skilled, proficient, and ethically sound practitioners. Iranian medical universities primarily employ traditional lecture-based education, with clinical anesthesia training in neurosurgery relying heavily on observation and question-and-answer sessions. To address potential limitations in this approach, this study aimed to compare the effectiveness of concept mapping and debriefing-based training in enhancing learning and achievement motivation among anesthesia students in neurosurgical anesthesia management.

Methods

This research employed a quasi-experimental method with a pretest-posttest control group design. The study consisted of two experimental groups (the concept mapping training group and the debriefing group) and one control group. The study population consisted of all 5th and 7th semester anesthesia bachelor's students at Jundishapur University of Medical Sciences in Ahvaz, with a sample size of 51, obtained through census sampling. Participants were included if they were: (1) anesthesia students enrolled in the fifth semester or higher, (2) willing to provide informed consent, and (3) had no prior experience with concept mapping or debriefing training. Exclusion criteria were: (1) withdrawal from the study at any point, (2) absence from either the pretest or posttest, and (3) absence from any session of the concept mapping or debriefing training. Participants were randomly allocated to one of three groups: the concept mapping experimental group (n=17), the debriefing experimental group (n=17), or the control group (n=17). The experimental groups received training via concept mapping and debriefing, respectively, while the control group received standard curriculum instruction.

Research procedure:

Following recruitment and informed consent acquisition from eligible anesthesia students, participants were randomly assigned to the concept mapping, debriefing, or control groups. Subsequently, a pretest was conducted for each group using the research instruments. Prior to the intervention, a 1.5-hour orientation session was conducted by the researcher to detail study procedures. During this session, the concept mapping group received a demonstration of concept mapping, and the debriefing group engaged in a debriefing practice exercise. At the study's onset, participants completed a demographic questionnaire and were assured of data confidentiality. Subsequently, pretests for learning and achievement motivation, utilizing validated instruments, were administered.

For one month, each week, the concept mapping and debriefing groups separately convened in the hospital's conference hall. The concept mapping group presented their designed concept maps, while the debriefing group engaged in circular debriefing sessions, recounting their learning. This process was conducted over four weeks. Throughout the study, the researcher served as a facilitator, ensuring adherence to the intended discussion and resolving any emerging contradictions. Following the intervention, posttests were administered to all groups, including the control group, which received routine neurosurgery anesthesia training. Learning retention was assessed via posttests at two and four weeks post-intervention, but achievement motivation was not included in the follow-up evaluation.

Data collection instruments:

Data were collected using the Hermans Achievement Motivation Questionnaire and a standardized learning questionnaire. The Hermans Achievement Motivation Questionnaire was developed by Hermans (1970). This questionnaire consists of 29 four-choice questions. The score range is between 29 and 116, with higher scores indicating higher achievement motivation, and lower scores representing lower achievement motivation. Hermans (1970) used ten characteristics that distinguish individuals with high achievement motivation from those with low achievement motivation as a basis and guide for selecting the questionnaire's questions. He initially prepared 92 questions for the questionnaire and ultimately selected 29 multiple-choice questions as the final achievement motivation questionnaire based on the correlation coefficient between each question and achievement-oriented behavior. Since Hermans wrote the questionnaire's items based on previous research on achievement motivation and calculated the correlation coefficient of each question with achievement-oriented behaviors, the test is considered valid. He administered this test to a sample of 800 individuals, and the correlation coefficients reported for the questionnaire's questions ranged from 0.30 to 0.57 (Shahmirzaei, 1391). Hermans established the test's validity through content validation, grounded in prior achievement motivation research. Furthermore, a correlation coefficient of 0.88 was found between two items and achievement-oriented behaviors. Reliability was assessed using Cronbach's alpha and test-retest methods, yielding coefficients of 0.82 and 0.85, respectively.

The standardized organizational learning questionnaire was developed by Khalafi and colleagues in 2023 at Ahvaz Jundishapur University of Medical Sciences (AJUMS). It consists of 21 questions regarding anesthesia management in neurosurgical procedures. The questionnaire utilizes a five-point Likert scale and includes a valid source, scoring method, conceptual and operational definitions, and satisfactory validity and reliability (Cronbach's alpha above 0.70). Furthermore, the learning questionnaire was validated by faculty members of the anesthesia department.

In this study, analysis of covariance (ANCOVA) was used to test the research hypotheses. Given that follow-up periods of two and four weeks post-intervention were included for the learning variable, repeated measures ANOVA was used for data analysis. These statistical methods were analyzed using SPSS 18 to ensure greater accuracy and precision of the results.

Results

Before performing the analysis of covariance, its assumptions were examined. For this purpose, the normality of the distribution of the research variable scores was first investigated. A normal distribution is a symmetrical distribution where the maximum height is at the mean. In this distribution, half of the scores are above the mean, and the other half are below the mean. The tails of the normal distribution curve are parallel to the X-axis. One of the tests used to assess normal distribution is the Kolmogorov-Smirnov test (Table 1).

The findings show that the significance level (P value) of the Z values obtained for the score distribution of achievement motivation and learning in the pre-test and post-test of the three studied groups is higher than 0.05 ($p > 0.05$). This indicates that the scores of the research variables have a normal distribution. Therefore, it is possible to use parametric tests to examine the hypotheses.

The findings also indicate that the significance level of the F values obtained for the difference in the slopes of the regression lines of the pre-test and post-test scores of achievement motivation and learning is higher than 0.05. Therefore, the slopes of the regression lines of these scores do not have a significant difference between the three groups, and the assumption of homogeneity of regression slopes is confirmed.

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The results of Levene's test for determining the homogeneity of variances showed that there was no significant difference in the variance of achievement motivation and learning data between the three groups. This is because, in this case, the significance level of the F value is greater than 0.05 ($p > 0.05$). Therefore, the assumption of homogeneity of variance of achievement motivation and learning scores between the three groups is accepted (Table 2).

First hypothesis: The effect of concept map-based and debriefing-based training on achievement motivation in neurosurgical anesthesia management differs among anesthesia students.

Based on the results presented in (Table 3), it can be concluded that there is a significant difference between the means of the three groups, favoring the experimental group. Therefore, the experimental intervention was effective. In other words, the concept mapping and debriefing methods lead to greater achievement motivation in anesthesia students compared to the conventional teaching method.

The results from the t-test showed a significant difference in achievement motivation between the pre-test and post-test phases ($p < 0.05$). Specifically, achievement motivation increased in anesthesia students undergoing neurosurgical anesthesia management following the educational interventions. In other words, all three groups demonstrated a significant difference in achievement motivation concerning neurosurgical anesthesia management, with the concept map group exhibiting the highest mean achievement motivation ($p < 0.05$). Therefore, the first research hypothesis was accepted. Additionally, the findings indicate that there was no significant difference in achievement motivation scores among the three groups at the pre-test stage. The mean pre-test scores were 84.28 for the concept mapping group, 82.78 for the debriefing group, and 83.167 for the control group. However, the mean post-test achievement motivation scores differed significantly among the three groups, with the concept mapping group having a mean score of 87.41, the debriefing group 85.75, and the control group 82.72. Thus, the second research hypothesis, as stated in (Table 4), was also accepted. Second hypothesis: The effect of concept mapping-based and debriefing-based training on learning in neurosurgical anesthesia management differs among anesthesia students.

Following the completion of the educational interventions and instruction in neurosurgical anesthesia management, the pre-test, post-test, and 2-week and 4-week post-intervention scores were evaluated for the three groups (Table 5). The repeated measures ANOVA results revealed no significant difference in the mean pre-test scores among the concept mapping group (30.41 ± 0.732), the debriefing group (29.17 ± 0.772), and the control group (28.78 ± 0.771) ($p = 0.057$). Conversely, a significant difference was observed in the mean post-test scores among the concept mapping group (35.94 ± 0.712), the debriefing group (34.88 ± 0.733), and the control group (32.47 ± 0.733) ($p < 0.05$).

Table 1- Kolmogorov-Smirnov Test for Assessing the Normality of Research Variable Score Distributions

Groups	Post-test Achievement Motivation	Z	sig
Control		0.231	0.013
Debriefing		0.181	0.179
Concept mapping		0.148	0.132
Control	Pre-test	0.177	0.162
Debriefing		0.166	0.534
Concept mapping		0.158	0.716
Control	Post-test Learning	0.204	0.041
Debriefing		0.186	0.038
Concept mapping		0.113	0.032
Control	Post-test	0.315	0.063
Debriefing		0.27	0.113
Concept mapping		0.52	0.098

Table 2- Levene's Test Results (Homogeneity of Variances Test)

Source of Change	F value	Degrees of Freedom	Significance Level
Achievement Motivation	2.48	3	0.067
Learning	3.82	3	0.05

Table 3- Summary of ANCOVA Results for Achievement Motivation Variable with Pre-test Effect Adjustment

Source of Change	Degrees of Freedom	Mean Squares	F	Significance Level
Pre-test	1	467.71	0.56	0.054
Group	2	30.469		
Error Variance	47	53.841		
Total	51	-		

Table 4- Results of Pre-test and Post-test Scores for Achievement Motivation

Groups	Achievement Motivation	Mean ± Standard Deviation (Pre-test)	Mean ± Standard Deviation (Post-test)	P value
Control		83.167 ± 1.46	82.72 ± 1.78	0.054
Debriefing		82.78 ± 1.459	85.75 ± 1.785	0.061
Concept mapping		84.28 ± 1.47	87.41 ± 1.79	0.047

Table 5- Comparison of Test Scores between Three Groups: Control, Concept mapping, and Debriefing Groups at Pre-test, Post-test, 2-Week Post-Intervention, and 4-Week Post-Intervention

Time	Concept mapping	Debriefing	Control	P value
Pre-test	30.41 ± 0.732	29.17 ± 0.772	28.78 ± 0.771	0.057
Post-test	35.94 ± 0.712	34.88 ± 0.733	32.47 ± 0.733	0.0024
2-Week Post-Intervention	36.059 ± 0.752	34.76 ± 0.710	31.176 ± 0.725	0.001
4-Week Post-Intervention	35.941 ± 0.712	34.86 ± 0.752	31.17 ± 0.712	0.054
P value (Group Comparison)	< 0.001**	> 0.001**	> 0.001*	
Overall P value	< 0.001**			

Furthermore, the 2-week post-intervention scores showed a significant difference among the concept mapping group (36.059 ± 0.752), the debriefing group (34.76 ± 0.710), and the control group (31.176 ± 0.725) ($p < 0.05$). Similarly, the 4-week post-intervention scores demonstrated a significant difference among the concept mapping group (35.941 ± 0.712), the debriefing group (34.86 ± 0.752), and the control group (31.17 ± 0.712) ($p < 0.001$).

Based on the repeated measures results, there was a significant difference between the students' mean post-test scores compared to their pre-test scores ($p < 0.05$). This result was consistent across all three groups. Also, in the concept mapping group, no significant difference was observed between the students' mean post-test scores (35.94 ± 0.712) and their scores at the 2-week follow-up (36.059 ± 0.752) or the 4-week follow-up (35.941 ± 0.712) ($p > 0.05$). Similarly, in the debriefing group, there was no significant difference between the students' mean post-test scores (34.88 ± 0.733) and their scores at the 2-week follow-up (34.76 ± 0.710) or the 4-week follow-up (34.86 ± 0.752) ($p > 0.05$) (Table 6).

Discussion

This study examined the impact of instruction based on concept mapping and debriefing on the achievement motivation and learning of anesthesia students. The experimental groups, utilizing these methods, demonstrated a statistically significant increase in achievement motivation at post-test compared to the control group ($p < 0.05$). This finding is consistent with the research of Karami and Babamoradi [27], Ghanbari et al. [28], Piri et al. [29], Khamsan and Baradaran Khaksar [30], Eslami et al. [31], and Chiu et al. [32] regarding the effectiveness of the instruction based on concept mapping. Kim and Son (2022) conducted a study to research the effects of debriefing-based instruction on the achievement motivation of nursing students during in-class practice using the flipped learning model [16].

The utilization of concept maps in pedagogical practice necessitates instructors to prioritizing key concepts and their relational structures. This approach optimizes classroom delivery and positively influences student engagement. Concept maps also serve to clarify the organization of instructional content, illustrating interconnections and establishing hierarchies. The process of constructing or interpreting concept maps provides learners with a structured overview of the material, thereby integrating new knowledge into existing cognitive frameworks and promoting meaningful learning. Supporting this, Kim and Son (2022) reported a statistically significant improvement in achievement motivation among nursing students exposed to instruction based on concept mapping and debriefing, implying that similar benefits may be observed in anesthesia students [16].

Another finding of the present study is the increased learning of anesthesia students after the educational interventions two months later using the concept mapping (30.41 ± 0.732) and debriefing (29.17 ± 0.772) methods, compared to the control group (28.78 ± 0.771) ($p < 0.05$). Furthermore, the students' learning scores at the 2-month and 4-month follow-ups were also significantly higher in the concept mapping and debriefing groups compared to the control group ($p < 0.05$).

Table 6- Results of Repeated Measures Test to Compare Pre-test, Post-test, 2-Week Post-Intervention, and 4-Week Post-Intervention Scores in Control, Concept mapping, and Debriefing Groups

Group	Comparison Between Tests	P value
Concept mapping Group	Pre-test vs. Post-test	p < 0.001
	Pre-test vs. Post-test (2 weeks later)	p < 0.001
	Pre-test vs. Post-test (4 weeks later)	p < 0.001
	Post-test vs. Post-test	p < 0.001
	Post-test vs. Post-test (2 weeks later)	p < 0.001
	Post-test vs. Post-test (4 weeks later)	p < 0.001
Control Group	Pre-test vs. Post-test	0.057
	Pre-test vs. Post-test (2 weeks later)	0.124
	Pre-test vs. Post-test (4 weeks later)	0.06
	Post-test vs. Post-test	0.131
	Post-test vs. Post-test (2 weeks later)	p < 0.001
	Post-test vs. Post-test (4 weeks later)	
Debriefing Group	Pre-test vs. Post-test	p < 0.001
	Pre-test vs. Post-test (2 weeks later)	p < 0.001
	Pre-test vs. Post-test (4 weeks later)	p < 0.001
	Post-test vs. Post-test	p < 0.001
	Post-test vs. Post-test (2 weeks later)	p < 0.001
	Post-test vs. Post-test (4 weeks later)	p < 0.001

The study further revealed a significant improvement in scores within the experimental groups after the introduction of concept mapping and debriefing techniques, relative to baseline measurements. This indicates that the application of these techniques promotes enhanced learning comprehension in anesthesia students.

Based on the results obtained from this study, the learning scores were higher in the concept mapping group compared to the control and debriefing groups, which indicates the greater impact of concept mapping compared to debriefing. In agreement with the current study, Lin et al. (2024) reported that instruction based on written debriefing improved cardiopulmonary resuscitation learning, although its efficacy was surpassed by debriefing based on dialogue [6].

Consistent with the present study, Gardner (2013) also points out that debriefing encourages self-reflection in the learning process, which significantly increases student engagement. The researcher believes that review should be implemented in clinical education. However, it is necessary to ensure that all facilitators are qualified to lead review sessions. This view is supported by Gardner [33], who states that facilitators should gain insights into specific descriptive sessions to be able to present discussions effectively. Based on ELT, new knowledge is built upon previous knowledge [34]. Therefore, involving students in the learning process is crucial [35]. Jenkins and Clark (2017) believe that active student participation in debriefing sessions seriously enhances learning outcomes [34]. Jenkins and Clark [34] and Kolb [36] emphasize the vital role of prior (concrete) experiences and reflective observation in promoting student learning. The author argues that this further supports the value of debriefing in clinical education, where students can observe and react to their shortcomings.

The use of concept maps in clinical education and its impact on learning approaches has only been investigated by August-Brady, where students in the experimental group created 6 concept maps about patients during a 15-week internship in maternal and neonatal care. The results showed that concept maps increase deep learning but do not affect surface learning. In addition to the impact of concept mapping as a metacognitive strategy, other factors in the research environment may have influenced this increase, which were beyond the control of the researchers [37].

Concept mapping is an educational strategy that requires learners to be able to identify, organize, and analyze key concepts. This approach enhances comprehension by revealing interrelationships between concepts and facilitates the learning of complex material that may be challenging with traditional methods. Concept mapping is also an efficient and effective tool in assessing students' learning. Corroborating the positive effects of concept mapping, Abbasi [38] found that its application significantly improved chemistry learning outcomes in secondary education regarding atomic structure. Likewise, Keykha [39] demonstrated that a concept mapping approach yielded greater academic achievement, enhanced material retention, and reduced student misconceptions compared to traditional teaching methods.

Conclusion

The findings of the present study showed that the learning and motivation scores of anesthesia students in the training method of concept mapping and retelling in the test group increased significantly after using concept mapping and retelling compared to before the test. The results also showed that the use of educational interventions in the form of concept mapping can increase knowledge, motivation for progress, and meaningful and deep learning in anesthesia students more than retelling. It is suggested that university professors, by using the concept mapping training method, make students dynamic in education and strengthen their learning and self-motivation to improve patient care.

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