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Effectiveness of Cognitive Strategies on Short-Term Information Retention: An Experimental Study

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ORIGINAL RESEARCH REPORTS

Effectiveness of Cognitive Strategies on Short-Term Information Retention: An Experimental Study

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Abstract

Background: **In medical education, particularly in the clinical environment, learning theories can enhance the education process. Cognitive theory, which focuses on how we receive, organize, and store incoming information and subsequently retrieve it, is an example. Based on this theory and the memory model, different strategies have been suggested to maintain learners' attention and improve their memory. For instance, changing the tone or position during lectures or beginning a lecture with a review or summary slide. Our study, using post-lecture quizzes, assessed the impact of cognitive strategies implemented in lectures delivered to the medical students of King Saud bin Abdulaziz University for Health Sciences.**

Method: **We used an experimental pre-test-post-test control group design, and 36 medical students were randomly assigned to 2 groups, namely Interventional (received lectures that used cognitive strategies) and Traditional (received lectures that did not use cognitive strategies). Each group took a pre-lecture quiz, to determine pre-existing knowledge, and a post-lecture quiz.**

Results: **The mean score of the pre-test showed no difference, but this difference was significant post-test (p-value <0.001). Both groups showed statistically significant differences when the mean score was compared within each group. The Interventional group students scored significantly higher in the post-lecture test compared to the Traditional group students.**

Conclusion: **Using cognitive strategies and other learning modalities while teaching medical professionals would not only improve medical education, but also promote health care outcomes. Summarization also improved learning and enhanced information retention by helping the learners actively organize the received information. Mind-wandering and lack of attention during lectures negatively affected education and information retention.**

Keywords: Cognitive strategies, Short-term retention, Experimental study, Saudi Arabia

1. Introduction

In the context of medical education, especially within the clinical environment, learning theories like social constructivism, experiential learning, and cognitive theory [1] can be used to enhance the educational process. Social constructivism helps students learn by actively building new knowledge on previously-acquired knowledge. In this learning method, the tutor is a facilitator rather than a teacher, and interaction among students is encouraged [2,3]. Kolb suggested that the best learning comes through experience [1,4]. However, a good teacher focuses on how students think and learn. This entails cognitive theory, which is a learning theory that focuses on how we receive, store, and

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Fig. 1. Cognitive theory and memory model. Sources: Spencer, 2003; Atkinson and Shiffrin, 1968.

organize information and then retrieve it [3]. According to the Atkinson-Shiffrin memory model (Fig. 1), information is processed in our short-term (working) memory and then transferred to the long-term memory [5]. Consequently, and to ensure that the incoming information is received and transferred to the working memory without any information loss, learners' attention is essential. Additionally, organizing and summarizing the incoming information help to store and retrieve information [6].

Based on the cognitive theory and memory model, different strategies have been suggested to maintain learners' attention and improve their memory. For example, changing the tone or position during lectures [7], using cues or challenging questions, beginning a lecture with a review or summary slide to help learners establish a link between their existing knowledge and the new incoming knowledge. These strategies would ensure information retention in the working memory and its availability for further processing. Finally, as educators, we can help learners actively organize the received knowledge in a systematic fashion by using a graphic organizer, summary slide, or the notion of chunking [3].

Evident from the existing literature, many attempts have been made to evaluate these cognitive strategies and to investigate means to maintain learners' attention during lectures. For example, a study by Schacter and Szpunar [7] at Harvard University's Department of Psychology revealed that frequent quizzes during lectures improved students' attention, decreased mind-wandering, and enhanced the learning process. Additionally, episodes of inattention and mind-wandering during classes impaired learning and the ability to retain the received knowledge [8]. Other studies have supported that summarization or organization, as a cognitive strategy, enhances leaning by helping students recognize and organize important aspects of the received information [9]. Particularly, summarization improved learners' abilities to recall and write academic essays [10].

We conducted a prospective experimental study to determine the effectiveness of implementing cognitive strategies in lectures delivered to medical students, especially organization and chunking information. We examined this using post-lecture quizzes in terms of the students' ability to recall, understand, and apply acquired knowledge according to Bloom's Taxonomy. To the best of our knowledge, there is no similar experimental study evaluating the effect of using cognitive strategies in lectures in the medical field. Our study will increase awareness among medical professionals about methods that can be used to bridge the gap between learning theories and clinical practice. This will eventually improve medical education and promote health care outcomes.

2. Methods

2.1. Study design and participants

This study used an experimental randomized pre-test-post-test control group design. It was conducted in the College of Medicine, King Saud bin Abdulaziz University for Health Sciences (KSAU-HS COM), Jeddah, Saudi Arabia. All male fourth-year medical students were included in the study. Third year students were excluded to minimize confounding factors like unfamiliarity with medical terms.

2.2. Sample size and procedure

The Open-Epi website was used to determine the sample size, with an expected standard deviation of 10, with power of 80% and a confidence level of 95%. Although the adequate sample size was calculated to be 32 students (16 in each group), we included 36 fourth-year medical students. Two students from one group missed a sessions, so the final number of students was 34. They were randomly assigned to either the Interventional or the Traditional groups based on their Grade Point Average (GPA) scores to ensure uniformity within the group regarding the level of achievement.

This study was conducted during the Special Senses course related to Ophthalmology. A lecture using cognitive strategies was conducted with the Interventional group students (Table 1); a traditional lecture devoid of such strategies was conducted with the Traditional group students. Each group took a 10-min pre-lecture quiz followed by a 20-min lecture. Subsequently, a 10-min post-lecture quiz was conducted. Both pre- and post-lecture quizzes

Table 1. Types of cognitive strategy used in the study.

Cognitive Strategies	Interventional group	Traditional group
Beginning the lecture with a learning objectives slide	Yes	No
Changing the tone and position during the lecture	Yes	No
Asking questions frequently during the lecture	Yes	No
Periodically inserting questions or summaries during the lecture	Yes	No
Using table, cues, summary slides, or pictures during the lecture	Yes	No

had the same questions and entailed several short-answer questions. The resultant scores (out of 100) were collected and compiled by the research coordinator.

2.3. Data analysis

Statistical software IBM Statistical Package for Social Sciences version 20.0 (SPSS, Inc. IBM, Armonk, NY, USA) was used for the analysis. The Shapiro–Wilks test was used to test the assumption of normality of scores. For descriptive statistics, the mean, standard deviation (SD), and median (range: minimum–maximum) was used. Mann–Whitney U and independent samples t-tests were used to compare test scores between the groups. A general linear model was used for statistically comparing the two groups. The independent variable of interest was the teaching approach (Interventional group), and the pre-score was entered in the model as the covariate. Effect sizes were reported as partial eta^2 ($\eta 2$) (partial η^2: small = 0.01 to 0.059, medium = 0.06–0.139, large $\geq$0.14). P-value<0.05 was considered statistically significant.

3. Results

Table 2 presents descriptive statistics for the test scores. The median pre-score for the Interventional group was higher than that of the Traditional group (32.9 vs. 23.75); however, no statistically significant difference in the score distribution was found between the two groups (Mann–Whitney U test = 113.5, p-value = 0.29). For the post-test, there was a statistically significant difference in the mean score between the Interventional and Traditional groups (t = 5.65, mean difference = 29.7, p-value<0.001). Table 3 shows the results of the final analysis of assessment scores for main effects and covariate. The assumption of homogeneity of variances was met (F(1,32) = 0.41, p-value = 0.52). The results showed a significant main effect of the groups (p-value< 0.001, large effect size: partial eta [2] = 0.536). This effect indicates differences in scores of the two groups. Estimated marginal

Table 3. General linear model results (outcome is the overall score).

Source	Df	F	p-value	Partial eta^2
Group	1	35.82	<0.001	0.536
Pre-score	1	15.88	<0.001	0.339
Error	31			
Total	34			

The dependent variable is the overall score.

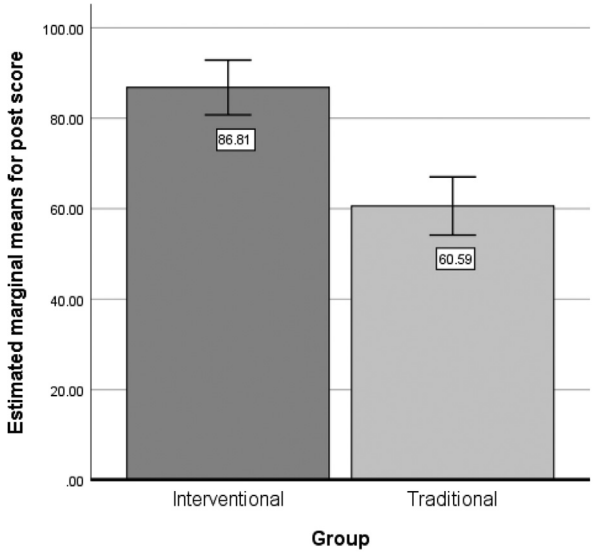

Fig. 2. Estimated marginal means, standard errors, and 95% confidence intervals for the total score.

Table 2. Descriptive statistics for scores.

Group	Score	Mean ± SD	Median (Minimum-maximum)
Interventional (n = 18)	Pre-score	36.6 ± 22.4	32.9(5–70)
	Post-score	88.4 ± 13.3	91.7(44–100)
Traditional (n = 16)	Pre-score	28.2 ± 19.0	23.75(0–63.3)
	Post-score	58.7 ± 16.8	61.6(34.1–85)

SD: Standard deviation.

means, standard errors, and 95% confidence intervals for the total score with a significant main effect of the groups are presented in Fig. 2. Students in the Traditional group had lower scores than those in the Interventional group.

4. Discussion

Our study was designed to experimentally determine whether the medical students at the KSAU-HS COM would benefit from cognitive strategies applied in their clinical lectures.

4.1. Comparison between cognitive strategies for improving memory and attention

The Interventional group students had a significantly higher mean score (i.e., by 30%)on their post-lecture quiz compared to the Traditional group students (P= <001). There was no significant difference between the pre-lecture quiz mean scores of both groups (P = 0.25), which indicates that the groups had similar academic abilities, and any difference in the result was mainly due to the intervention. However, to control for the effect of the pre-test on our result, we also calculated the mean difference between the pre- and post-tests in each group to determine the gained score. This was significantly higher (i.e., by 22%) in the Interventional group than the Traditional group (P = 0.001). Thus, our findings support the rationale behind using cognitive strategies in enhancing the learning process to help students improve their memory and attention during lectures. Additionally, organize and later retrieve new information [3,6,7].

4.2. Comparison between cognitive strategies for mind-wandering and information retention

In the existing literature, similar results in different fields were observed using cognitive strategies, such as frequent quizzes and summarization during lecture [7,10]. For example, Szpunar and Schacter found that interpolating an online lecture with frequent quizzes improved students' attention, decreased mind-wandering, and enhanced the learning process [10]. Summarization also was found to improve learning and enhance information retention by helping the learner to actively organize received information [9,11]. However, mind-wandering and lack of attention during lectures had a negative impact on education and information retention of information [8]. To the best of our knowledge, there is no similar experimental study evaluating the effect of using cognitive strategies in lectures in the medical field.

4.3. Limitations

The limitations of our study include the use of a pre-test, which may have affected students' performance in the post-lecture quiz, resulting in a testing effect or improved attention [12]. However, that should not affect the findings, because both groups took the pre-test. Another limitation is the use of non–probability sampling, which may have affected the generalizability of our findings.

4.4. Strengths

The strength of our study lies in our approach of using random assignment and matching students based on their GPA to create comparable groups. Additionally, the pre-lecture quiz verified that both groups had the same academic capability. This ensured that any observed difference was due to the intervention.

5. Conclusion and recommendations

Our study clearly indicated the benefit of introducing cognitive strategies in lectures conducted with medical students at the KSAU-HS COM in Jeddah. Our recommendations include using different learning approaches, such as the cognitive theory, to improve medical education and promote health care outcomes. Further studies in the medical field in this regard will help bridge the gap between learning theories and clinical practice.

Authors' contributions

HM conceived the idea of the research and wrote the full manuscript; MAK undertook the statistical analysis. All authors read the manuscript and approved it.

Consent for publication

All authors consent to the publication of this manuscript.

Data availability

The datasets analyzed in the current study can be obtained from the corresponding author upon request.

Conflict of interest

This manuscript has not been published and is not under consideration for publication by another journal. Its publication has been approved by all the co-authors, and the study design was approved by the appropriate ethics review board. We have read and understood your journal's policies, and we believe that neither the manuscript nor the study violates any of these. There are no conflicts of interest to declare. Ethics approval and consent to participate: The King Abdullah International Medical Research Center approved this study. The medical students were invited to participate, and the entire study was explained to them. It was made clear that they could withdraw from the study anytime, without facing any consequences in their academic career. The IRB no. is SP15/166.

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