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Original Article

The impact of educational intervention: a comparison of traditional teaching methods and model-based approaches

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Abstract

***Background & Aims*:** Two common teaching methods, the lecture and concept map method, focus on understanding how people learn effectively. The concept of learning styles pertains to the different ways that individuals prefer to learn. This study compares the effectiveness of lecture and concept map methods on student learning outcomes, considering the influence of learning styles (visual, auditory, read/write, kinesthetic).

***Materials & Methods*:** This randomized controlled trial with 78 public health students compared the effectiveness of concept mapping and traditional lecture methods. The VARK questionnaire was used to assess participants' learning styles. The intervention group received concept mapping instruction, while the control group received traditional lecture instruction. Data analysis was performed using SPSS software.

***Results*:** The concept map method employed in the intervention group had a statistically significant effect on the learning of students with visual learning styles ($p = 0.036$). The mean learning style scores for the intervention group in the visual learning style increased from 45.2 to 51.3, while the mean scores for the control group increased from 44.8 to 46.1. No statistically significant differences were reported between the two groups in the other three learning styles (auditory, read/write, kinesthetic).

***Conclusion*:** Concept mapping is an effective teaching strategy with visual learning styles. Educators can use concept mapping to enhance deep learning experiences with different learning styles. The VARK model can be used to assess students' learning styles and guide instructional decisions. To create an inclusive and effective learning environment, educators should use a variety of teaching strategies and regularly assess students' learning styles.

***Keywords*:** Cognition, Educational measurement, Problem-based learning, Public health, Students, Teaching methods

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Introduction

Learning is a process of acquiring knowledge, skills, and abilities that can be used to make decisions and take actions (1, 2). However, students have different learning styles, and traditional teaching methods may not be effective for all students. Learning style, on the other hand, pertains to an individual's preferred method of acquiring information, which is often natural, habitual, customary, fixed, and unique. Such a style is instrumental in accepting, processing, and retaining new information and skills (3).

While traditional teaching methods, characterized by teacher-centered lectures, textbook reading, and standardized assessments, have served as the educational backbone for generations, their "one-size-fits-all" approach fails to cater to the inherent diversity of learning styles present in every classroom. This can significantly disadvantage students, hindering their engagement, comprehension, and overall learning effectiveness. Let's delve deeper into these limitations and how they disproportionately impact different learning styles. Visual learner's traditional method heavily relies on text-based instruction and passive information delivery, neglecting the needs of visual learners who thrive on visual aids, diagrams, and interactive presentations. A lecture-centric approach leaves them grasping for visual anchors to connect with the abstract concepts being presented, leading to disengagement and difficulty in consolidating information (4).

In auditory learners, while lectures might cater to some auditory learners, the static format often lacks variation in tone, pacing, and emphasis, failing to resonate with all auditory preferences. Students who process information best through sound may struggle to retain information delivered in a monotonous tone, potentially missing key points and finding it challenging to connect with the material (5).

In kinesthetic learners, traditional methods offer minimal opportunities for movement and physical engagement, leaving kinesthetic learners feeling restless and disengaged. These hands-on learners struggle to internalize abstract concepts without the opportunity to manipulate materials, role-play situations, or actively participate in the learning process (6). In reading/writing learners, while traditional methods emphasize text-based learning, their focus on standardized testing and rigid writing formats can disadvantage students with reading or writing difficulties. Struggling readers may miss crucial information delivered through dense textbooks, while those with writing challenges may feel discouraged by the pressure to conform to specific essay structures (7). Further highlighting the problem, research by Felder and Silverman indicates that only around 20% of students learn effectively through traditional lecture-based methods. This underperformance underscores the urgent need for educational practices that embrace the individuality of learning styles and provide diverse pathways to knowledge acquisition (8).

By understanding these limitations and adopting more flexible, multi-sensory approaches, educators can foster a more inclusive learning environment where all students, regardless of their preferred learning style, have the opportunity to thrive and reach their full potential. Concept maps are a visual learning tool that can be used to help students learn new concepts. Concept maps are powerful visual learning tools that can assist students in grasping and internalizing new ideas (9-11).

Traditional one-size-fits-all teaching methods often leave students behind, struggling to connect with the material in a way that suits their natural learning preferences. To address this, present study takes a step towards personalized learning by incorporating the VARK model (12).

Developed by Neil Fleming in 1987, the VARK model identifies four dominant learning styles. Visual (V), learners thrive on visual aids like diagrams, graphs, and videos. Auditory (A) learners, hey learn best through lectures, discussions, and music. In read/write (R), words are their playground. They absorb information through textbooks, articles, and written instructions. Research by Fleming et al. (2011) suggests that read/write learners prefer detailed

information and structured formats, both of which are readily provided by well-constructed concept maps (13). Kinesthetic (K) learners prefer hands-on experiences, learning by doing, manipulating objects, and role-playing (13). Most learners possess a combination of preferences, with varying degrees of strength in each domain (14). Therefore, effective teaching involves creating a multifaceted learning environment that incorporates diverse modes of instruction and materials to cater to the spectrum of learning styles present in the classroom (14).

Undoubtedly, the development of skills and knowledge in the field of education remains a significant challenge that requires attention. University professors, in particular, need to be aware of their students' learning styles to accommodate their individual learning preferences and promote a better understanding of the subject matter[3]. Policymakers and researchers have emphasized the importance of certain skills and knowledge for economic growth, competitiveness, employability, and social inclusion in the context of globalization (15, 16). Additionally, there is a consensus among educators, businesses, and stakeholders that there is a gap between the knowledge and skills needed for success in life and the current state of education worldwide (17). To address this challenge, educators must be flexible and adaptive, encouraging open dialogue and effectively using online communications (18). The transition from classroom to professional practice also requires coherence between theoretical knowledge and practical skills, as well as alignment with learning outcomes in education and professional practice (19). Overall, there is a need to focus on developing realistic strategies for improving the development of skills and knowledge in education.

Research on the impact of specific teaching methods on different learning styles is ongoing, and further studies are needed to refine our understanding of the most effective approaches for each combination of styles. In addition, research into the effectiveness of technology-based tools and personalized learning strategies in accommodating different learning preferences holds promising potential for future advances in education (20).

Understanding the strengths and weaknesses of each approach through the VARK model is crucial for maximizing both effectiveness and student learning in the classroom. Here are some ways to bridge the gap: Traditional methods can be catered to diverse learning styles by supplementing them with visual aids, interactive activities, and cooperative learning opportunities. Concept maps can be combined with traditional methods to provide visual representations and promote active learning. Educators can be trained in the use of the VARK model and adapt their teaching strategies to meet different learning preferences. Technology-based tools and personalized learning strategies can be explored to enhance diversity and engagement in the learning process. By adopting a multifaceted approach that acknowledges both the unique strengths and challenges of each method and considers diverse learning styles in the classroom, educators can create a more effective and inclusive learning environment for all students.

With the use of evidence-based techniques, this study has the potential to significantly improve learning outcomes for students. By tailoring teaching methods to individual learning preferences, students may be more engaged and motivated in the classroom, leading to better retention of information and overall academic success. In the field of education, this study stands out as a valuable contribution through its evidence-based approach to addressing the shortcomings of traditional, one-size-fits-all teaching methods. Not only does it recognize the importance of diverse learning styles, but it also presents a multifaceted approach through the use of the VARK model and concept maps. Additionally, by potentially improving learning outcomes for students through tailored teaching methods, this study has the potential to make a profound impact in the education system. Overall, this study has the potential to greatly benefit students and educators alike. This study compares the effects of traditional teaching methods and concept

maps on student learning based on the VARK learning style model.

Materials & Methods

Design:

This study employed a randomized controlled trial (RCT) design with four intervention groups and four control groups, conducted at the Health Department of Torbat Heydarieh University of Medical Sciences (THUMS). The study spanned two semesters, from February to May 2022.

Participants and Setting:

The participants were 78 public health students enrolled in the Bachelor of Science program at THUMS. They possessed four different learning styles: visual, auditory, reading/writing, and kinesthetic.

Inclusion/Exclusion Criteria:

Inclusion criteria included, being enrolled in the emergency medicine and first aid course, completing the course as a requirement for their degree, volunteering to participate, and having no prior knowledge of concept mapping. Exclusion criteria included, having already passed the course and missing three or more intervention sessions.

Sampling Procedures and Participants

Sampling:

A random sampling method was used to select participants. First, they were stratified by gender and year of entry. Then, a random sample was chosen from each stratum, resulting in approximately 20 participants per group.

Sample Size Estimation:

Based on the paper by Boström et al. (2013) (21), mean learning change was equal to intervention group (0.8 units) and Control group (0.2 units). Standard deviation of learning change was equal to 0.5 units in both groups, Confidence level was equal to 95%, Power: 90%, Pocock's formula was equal to $n = (Z\alpha/2)^2 \sigma^2 / \Delta^2$. Substituting values was equal to $Z\alpha/2 = 1.96$ (critical value for a two-sided test with 95% confidence level), $\sigma = 0.5$ units, $\Delta = 0.6$ units (0.8 - 0.2).

Based on the information provided in the paper by Boström et al. (2013), and considering a 95% confidence level and 90% power, the required sample size per group is 28 participants ($n = (1.96)^2 0.5^2 / 0.6^2$, $n \approx 28.04$). The required sample size per group, without attrition, was determined to be 28 participants, with a 10% attrition was 31 participants (28 100/90).

The sample size for the current study sample size is based on similar research findings (22). With a calculated sample size of 78 students (comprising roughly 20 students with four distinct learning styles) and a power of 0.80 at a significance level of 0.05 to detect statistically significant differences between study groups, 78 students who had completed an emergency medical care and first aid course were recruited.

Participants were requested to express their learning experiences through an online questionnaire, accessible at https://forms.gle/e9TQP8JGk6wuwXxn7. In the subsequent stage, participants were randomly assigned to one of four intervention groups (comprising approximately 20 individuals each) based on their learning style and were taught using a native method. Alternatively, they were allocated to one of four control groups (comprising approximately 20 individuals each) who learned through traditional shared lectures, supplemented with a concept map. The questionnaire has been shown to have good validity and reliability (e.g., McNeil & Kreuger, 2003)(23).

A randomized controlled trial was conducted under the direction of the THUMS Health Department to compare the effectiveness of the concept mapping method to a traditional presentation method for teaching health measures and first aid during emergencies. The study spanned two semesters, from February to May 2022. Participants were randomly assigned to either the intervention group (utilizing the

concept mapping method) or the control group (receiving traditional teaching).

Both groups underwent a 6-week training course, and their learning outcomes were assessed using VARK questionnaires administered before and after the training. The study revealed that the effectiveness of the concept mapping method varied depending on the individual's learning style. Participants were randomly assigned to either the intervention group (utilizing the concept mapping method) or the control group (receiving traditional teaching).

The Randomization Method:

The randomization process consisted of three key steps. Stratified Random Sequence Generation, including arandom sequence that was generated to assigning each participant a random probability of being placed in either group. Stratification was utilized to reduce group heterogeneity by classifying participants based on relevant variables like gender and year of entry into education. Samples were first stratified by center, then software was used to generate a random sequence within each stratum (24).

Sequence Concealment:

The generated sequence was concealed to prevent researchers from predicting intervention assignments or favoring specific groups. The central randomization method assigned random sequences to individuals by sampling at specific centers. Researchers contacted a central contact center by phone to learn a participant's assigned group based on their order of study participation.

Individual Random Assignment:

A dedicated individual, separate from other researchers, controlled entry and exit criteria, registration, and group allocation. Randomization used the even/odd format of participants' National Codes. Randomization units included stratified, central, and individual. Randomization layers included sex and year of entry into education. Randomization tool included allocation software. All available participants were recruited. Figure 1 illustrates the research process.

Data Collection:

Kuder-Richardson method (K-R21) confirmed questionnaire reliability (coefficient of 0.80).

VARK Questionnaires:

To assess learning styles and measure learning outcomes, all participants completed standardized VARK questionnaires (Fleming, 1998) before and after the training course. The questionnaires were chosen for their established reliability and validity (25).

VARK Questionnaire Details:

The VARK questionnaire (Version 7.8) identifies dominant learning styles (visual, auditory, reading/writing, kinesthetic) through 16 multiple-choice questions. For this study, the questionnaire was translated into Persian and its relevance assessed by health education, promotion, and medical education specialists. Expert evaluation confirmed its validity, and Cronbach's alpha (0.84) established its reliability (26).

Demographic Data:

Demographic information including age, study type, and major was collected.

Post-Training Evaluation:

The researcher developed 16 post-training questions aligned with the approved curriculum and VARK model. These multiple-choice questions assessed Bloom's Taxonomy domains (understanding, application, analysis, evaluation, creation) through meaningful learning concepts. Each session had 3-4 questions (total of 16 across 6 sessions). Scores ranged from 0 (pre-evaluation) to 16 (maximum post-evaluation), with each question worth 0.5 points.

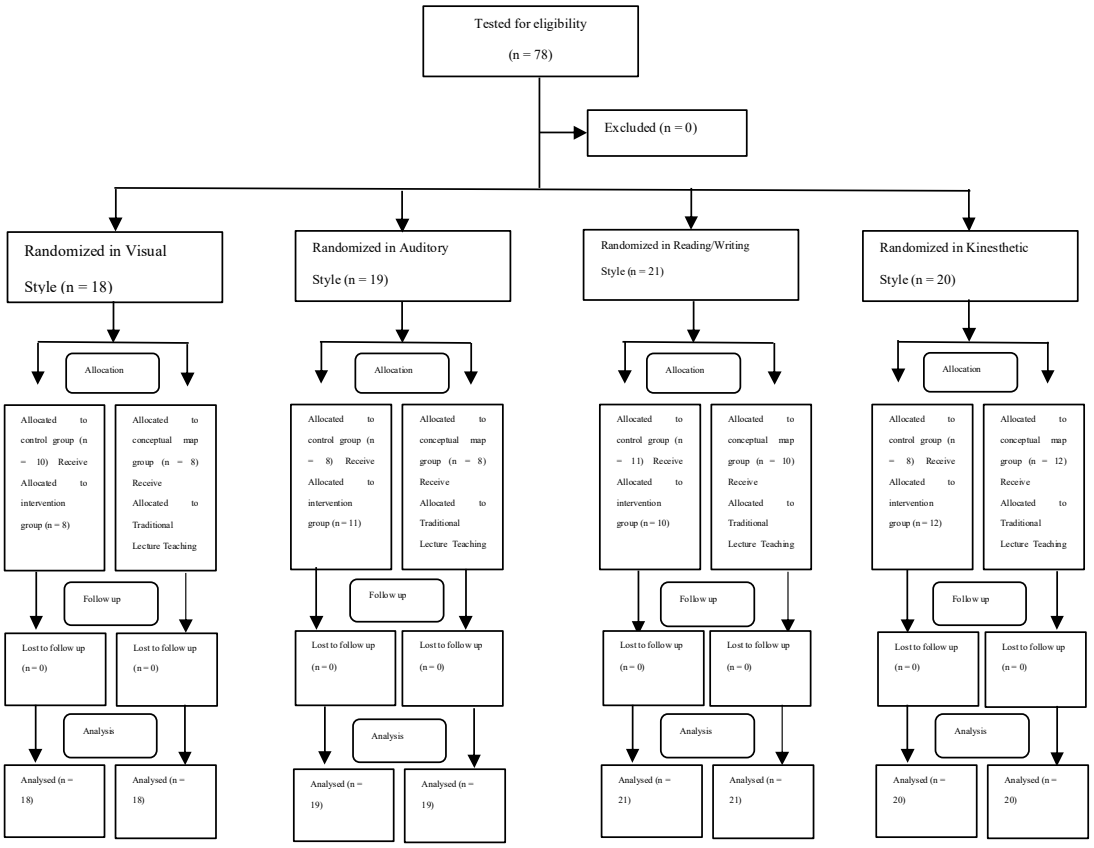

Fig. 1. A schematic model of characteristics of the public health students of THUMS

Interventions:

Participants were randomly assigned to one of four intervention groups using a concealed allocation. Group 1 included concept mapping (intervention), Group 2 included concept mapping (intervention), Group 3 included concept mapping (intervention), Group 4 included concept mapping (intervention). The remaining participants were assigned to four control groups: Group 5 included traditional teaching (control), Group 6 included traditional teaching (control), Group 7 included traditional teaching (control), Group 8 included traditional teaching (control). Each group received a 6-week training course on health measures and first aid in emergencies. The intervention groups used the concept mapping method, while the control groups employed traditional lecture-based instruction.

Interventions Objective:

To compare traditional and concept mapping teaching methods for improving knowledge of emergency medicine and first aid across different learning styles.

Interventions Method:

Two groups (control & intervention) participated in six training sessions on first aid principles delivered by trained instructors. The control group received traditional lectures. The intervention group used concept mapping method in three phases: pre-educational, teaching, and post-class. Pre- and post-tests assessed knowledge gain before and after training.

Interventions Results:

Concept mapping method was more effective than traditional teaching for all learning styles (visual, auditory, reading/writing, kinesthetic). The study excluded students who previously took the course or missed more than two sessions.

Interventions Additional Information:

Training sessions lasted 90 minutes and were conducted over four consecutive days per week. Materials included visuals, audio, readings, and hands-on activities. The program was held at Torbat Heydarieh University of Health Sciences in Iran.

Ethical Considerations:

This study adhered to ethical principles and received prior approval from the Ethics Committee of Shahid Beheshti Medical University (reference number IR.SBMU.SME.REC.1401.060). Informed Consent was obtained, where students were informed about the study's objectives, the confidentiality of their data, and their right to voluntary participation without repercussions for withdrawal The researcher ensured anonymity and data security according to the approved protocol. Permission to use copyrighted materials (e.g., VARK Surveys) was obtained from the owners (12).

Data Analysis:

Descriptive statistics were used to summarize the data. Inferential statistics, including independent t-tests and ANOVAs, were employed to compare the effects of the intervention and control groups on learning outcomes, considering learning styles as a potential moderator. Statistical analyses were conducted using SPSS 19 software and summarized participant characteristics and learning outcomes.

Using the independent t-test, learning results were compared between the intervention and control groups. With the ANOVA test, the potential interactions between the intervention and learning styles were investigated.

Results

Table 1 summarizes participant demographics. The majority of students were female (80.8%), and a significant portion were married (20.5%). Semester distribution was as follows: 7th (42.3%), 1st (23.1%), 5th (17.9%), and 3rd (16.7%).

The age range was 19-26 years, with a mean of 19.5 ± 0.7 years. No significant differences were found between intervention and control groups in terms of age, gender, or specialty. Furthermore, there were no pre-assessment score differences, indicating group homogeneity (Tables 1).

Table 1. Distribution of demographic variables of the public health students of THUMS

Variable	No. (%)
Age, y	
≤ 20	3 (3.9)
21-22	42 (53.8)
23-24	31 (39.7)
25	2 (2.6)
Marital status	
Single	62 (79.5)
Married	16 (20.5)
Place of residence	
City	69 (88.5)
Village	9 (11.5)

In visual learners, concept mapping was more effective ($p = 0.310$) than traditional teaching for visual learners. In other learning styles, no significant differences between groups for auditory, reading/writing, or kinesthetic learners were observed.

Combining mean and median scores, concept mapping showed greater effectiveness across all styles. While no significant differences in median scores emerged, the trend suggests a positive impact. Concept mapping is beneficial for all learning styles, possibly optimizing performance for visual learners. Educators should consider this method, particularly for visual learners (Table 2).

Table 2. Demographics of THUMS health students within the group

Variable/Group	Visual		Audio		Reading/writing		kinesthetic		Total
	Intervention N (%)	Control N (%)	Intervention N (%)	Control N (%)	Intervention N (%)	Control N (%)	Intervention N (%)	Control N (%)	N (%)
Gender									
Male	3	2	1	2	2	2	2	1	15 (19.2)
Female	5	8	10	6	9	8	10	7	63 (80.8)
Statistics	$P = 0.310$ $X^2 = 1.012$		$P = 0.054$ $X^2 = 3.342$		$P = 0.987$ $X^2 = 0.0001$		$P = 0.332$ $X^2 = 0.887$		
Entry of public health students									
Semester 1	2	2	3	1	3	2	3	2	18 (23.1)
Semester 3	1	2	1	2	2	2	2	1	13 (16.7)
Semester 5	2	2	2	1	2	2	2	1	14 (17.9)
Semester 7	3	4	5	4	4	4	5	4	33 (42.3)
Statistics	$P = 0.310$ $X^2 = 1.012$		$P = 0.681$ $X^2 = 1.118$		$P = 0.062$ $X^2 = 2.876$		$P = 0.232$ $X^2 = 1.118$		
Age									
M ± SD	19.6 ± 0.7	19.4 ± 0.7	19.4 ± 0.7	19.3 ± 0.7	19.5 ± 0.7	19.5 ± 0.7	19.4 ± 0.7	19 .7 ± 0.7	19.5 ± 0.7
Statistics	Z = -0.101 $P = 0.363$		Z =-0.765 $P = 0.412$		Z = -0.286 $P = 0.721$		Z = -0.073 $P = 0.814$		

No demographic or pre-assessment score differences confirmed group homogeneity. Concept mapping had a statistically significant impact on visual learners compared to the control group (traditional visual learning). Figure 2 visually represents mean and median score differences for various learning styles and teaching methods.

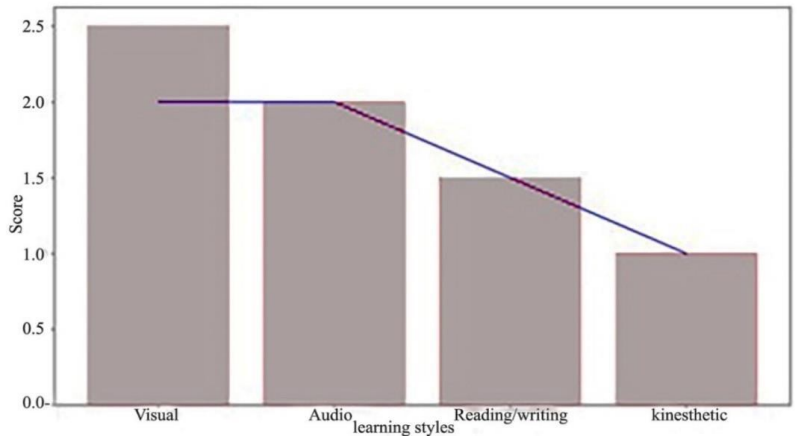

Fig. 2. Differences between means and medians of learning styles

Interestingly, the traditional lecture method showed varying significant outcomes for three learning styles: reading/writing (p = 0.987), listening (p = 0.054), and kinesthetic (p = 0.332). However, the concept mapping group showed no significant differences across learning styles (p = 0.332) (Tables 1, 2). In the visual group, the increase in scores in the concept mapping group was significantly higher than in the traditional instruction group (p = 0.036).

In the auditory group, no significant difference was observed between the two groups. In the reading/writing groups, no significant difference was observed between the two groups. In the kinesthetic group, No significant difference was observed between the two groups (Table 3).

Table 3. Mean and standard deviation of learning style scores before and after assessment.

Learning styles	Control and intervention groups	M ± SD			t Test	df	p value
		Pre-assessment	Post-assessment	Difference			
Visual	Traditional Lecture teaching Concept map	8.80 ± 2.12 9.02 ± 2.18	15.78 ± 1.44 18.42 ± 1.12	6.98 ± 0.68 9.4 ±1.06	-2.12	37	0.034
Auditory	Traditional lecture teaching Conceptual map	9.04 ± 2.23 8.92 ± 2.12	18.30 ± 1.32 18.04 ±1.29	9.26 ± 0.91 9.12 ± 0.83	0.740	37	0.247
Reading/Writing	Traditional lecture teaching Conceptual map	8.52 ± 2.12 8.65 ± 2.30	17.87 ± 1.32 17.34 ± 1.45	9.35 ± 0.8 8.69 ± 0.85	0.670	37	0.411
Kinesthetic	Traditional lecture teaching Conceptual map	9.07 ± 2.03 8.87 ± 2.36	16.11 ± 1.09 17.48 ± 1.07	7.04 ± 0.94 8.61 ± 1.29	-1.802	37	0.69

In both traditional training and concept map groups, the visual learning style had the highest mean score among all learning styles before and after the education. The kinetic learning style had the lowest mean score among all learning styles before and after education. In all four learning styles, the mean scores after training in the concept map group were higher than the traditional intervention group (Figure 1). The use of the concept mapping method, compared to the traditional lecture method, generally led to an increase in the learning style scores of students in all four learning styles. This increase in the visual learning style in the concept mapping group is statistically significant. The concept mapping method appears to be more beneficial for students with a visual learning style, compared to the traditional method.

Discussion

This investigation was carried out to juxtapose the effects of concept maps and conventional teaching approaches on student learning, underpinned by the VARK learning style model. The findings demonstrate that the employment of the concept map approach has a statistically noteworthy influence on the learning outcomes of students in comparison to the traditional teaching method of visual learning. The concept map technique is a graphical pedagogical and learning approach that facilitates the comprehension of intricate information, while fostering ingenuity, introspection, and evaluative thinking. In the clinical milieu, it represents an invaluable teaching method. Certain students exhibit superior acquisition and comprehension of knowledge through its application (27). Perceived primarily through visual, auditory, or other sensory modalities (28).

Distinctive learning styles necessitate distinct learning methodologies for efficacious learning (29). A comprehension of student learning techniques advances student learning modalities (30). Nevertheless, our findings regarding the notable and incremental impacts

of concept maps on learning are in concurrence with antecedent investigations (31-33).

The findings may be approached from a dual perspective. Firstly, it is evident that the acquisition of knowledge through concept maps yields more significant results in comparison to conventional video lectures. This is due to the intricate nature of the elements and concepts that are encompassed within the visual format of concept maps, which can prove to be challenging to assimilate into a cognitive mode (10). This discovery corroborates the assertions of Hink et al., who espouse the benefits of mind mapping as a graphical technique. Additionally, students who possess a predilection for visual learning styles exhibit a marked preference for this modality over those who are predisposed to auditory or kinesthetic learning styles (34).

Based on the mean student outcomes, concept mapping surpassed other modes of learning across all groups of students who favored visual learning. However, students who exhibited a visual learning style performed better on average than those who manifested other learning styles, specifically listening and reading, when they were instructed through conventional lecture methods.

Curiously, the same trend was observed in students with auditory learning styles. Notwithstanding significant variations in listening, reading, and writing styles, the highest mean grades were obtained by students who were exposed to the lecture method. Plausible explanations for these findings may encompass disparities or inconsistencies in pedagogical approaches and student learning preferences.

Fleming posits that visual learners optimally acquire sensory input by representing it graphically, whereas auditory learners fare better through structured learning experiences, such as lectures and conventional classroom education (12). Moreover, those students who exhibited exemplary academic excellence along with those who were deemed capable of being trained manifested an aptitude to comprehend better by utilizing conventional techniques such as reading textbooks and transcribing lectures. Notably, the scholars of Kinetics domain belonging to the lecture group registered the least GPAs, which could be indicative of their inclination towards experiential learning. This observation is in consonance with the study conducted by Dobson, wherein it was found that students possessing certain exercise modalities performed relatively poorer in the lecture group as compared to the other three groups (35).

Strengths and Limitations:

The robustness of the present investigation lies in its ability to underscore a hitherto unexplored evaluation of the influence of concept maps on knowledge acquisition in varying learning modalities. Additionally, a notable asset of this inquiry was the employment of randomization to counterbalance any potential extraneous variables in the intervention and control groups (16, 36). However, our study did not incorporate the aforementioned study due to the lack of parity in the representation of both genders. Consequently, conducting such research was unfeasible in our study. Furthermore, the paucity of participants in each learning style constituted the second rationale.

Therefore, further investigations ought to be carried out in different fields with larger sample sizes, which should encompass students from various medical and healthcare specializations. In addition to the plethora of scientific resources, the outcomes of the mind map technique serve as an efficacious pedagogical approach to incite interest in every class and unveil new horizons.

Conclusion

The findings of the present study provide evidence that the utilization of conceptual mapping in the context of the VARK model's visual learning style has a significant impact on the learning outcomes of students, albeit in varying ways. The implementation of a concept map as an educational tool in the field of healthcare has proven to be an effective means of creating a comprehensive and meaningful representation of the first aid education process for individuals with a visual learning style. The use of the

concept mapping method was significantly more effective in increasing the visual learning style scores of students compared to the traditional lecture method.

It is paramount for medical educators to evaluate the learning style of their students prior to selecting a specific teaching method in order to enhance learning outcomes and foster a deeper understanding of the subject matter. The assessment of student learning according to the VARK model is a crucial step towards improving the quality of public health education and promoting more profound learning experiences.

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Author Contributions

MHD and SA: The authors of this article have collectively contributed to the development and design of the research concept, MHD data collection, MHD analysis and interpretation, article editing, and critical review, and SA have reached a consensus on the final version of this article.

Data availability

The raw data supporting the conclusions of this article are available from the authors upon reasonable request.

Conflict of Interest

The author declares no potential conflicts of interest pertaining to the research, preparation, and/or publication of this article.

Ethical statement

This research study titled "The Impact of Educational Intervention: A Comparison of Traditional Teaching Methods and Model-Based Approaches" with the identification code IR SBMU.SME REC 1401.060 adheres to the following ethical principles:

Informed Consent

All participants were provided with a detailed informed consent form that explained the study objectives, procedures, potential risks and benefits, and their right to withdraw from the study at any point. Participants provided written informed consent before participating.

Confidentiality:

All participant data was anonymized and kept confidential throughout the study. No personally identifiable information will be disclosed in any reports or publications.

Protection from Harm:

The study design minimized any potential risks to participants. Participation was voluntary, and participants were free to withdraw at any point without penalty.

Data Security:

All data collected during the study will be stored securely and protected against unauthorized access. The study protocol was reviewed and approved by an Institutional Review Board (IRB) to ensure compliance with ethical research guidelines.

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