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Assessment of Perception Towards the Concept Map Approach in Health Professions Education: A Psychometric Study

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A B S T R A C T

Background: Concept maps serve as an effective visual and organizational tool that aligns well with the interactive and engaging nature of game-based learning. This study aims to evaluate the validity, reliability, and exploratory factor analysis of a tool for assessing student perception of the concept map approach as a teaching method.

Methods: It was a descriptive cross-sectional study. The study was carried out in three phases: validity assessment, reliability assessment, and factor analysis of the tool. The questionnaire, adapted from Chiou et al., consisted of 10 items on a 5-point Likert scale. The content and face validity of the Persian version were assessed using the Delphi technique with 15 medical education experts over three rounds. Moreover, quantitative content validity was determined using the Content Validity Ratio (CVR) and Content Validity Index (CVI). Reliability was evaluated through internal consistency (Cronbach's alpha) and reproducibility (intraclass correlation coefficient (ICC)). Exploratory factor analysis was performed using the Kaiser-Meyer-Olkin (KMO) index, Bartlett's test, principal component analysis, and Varimax rotation. Finally, data were analyzed using IBM $SPSS_{24}$.

Results: The results confirmed the face and content validity, with all items scoring above 0.94 for CVR and above 0.79 for CVI. Internal consistency (Cronbach's alpha = 0.86) and reproducibility (ICC = 0.83) indicated desirable reliability. Exploratory factor analysis also revealed two domains: "facilitating learning" and "encouraging learning," with significant factor loadings for all items.

Conclusion: The study confirmed the validity and reliability of the tool for measuring students' attitudes toward the concept map approach in Iran. Given the importance of assessing student reactions to innovative teaching methods, this instrument is recommended for evaluating attitudes toward concept map-based teaching.

Keywords: Concept Map, Concept-Based Learning, Evaluation, Attitude, Reaction, Teaching

Introduction

In medical education, the development of innovative and practical teaching methods to promote effective and lasting learning is a critical priority. Traditional learning approaches, which often rely on the accumulation of vast amounts of information, have a limited impact on fostering critical thinking, analytical skills, and long-term retention (1). In contrast, modern learning theories, such as meaningful learning theory, constructivism, and cognitive theory, emphasize active learner engagement and the integration of new knowledge with prior understanding, leading to deeper and more sustainable learning outcomes (2, 3). Constructivism posits that learners actively construct knowledge, guiding themselves toward meaningful learning (4). Similarly, Ausubel's

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theory of meaningful learning highlights the importance of organizing and connecting new information within learners' existing cognitive structures, resulting in a hierarchical organization of knowledge that enhances understanding (2, 5). One effective educational strategy for achieving meaningful and organized learning is the use of concept maps (1, 6). Concept maps facilitate learning by organizing information into structured, visual representations, enabling learners to grasp the relationships between concepts and manage large volumes of material more effectively.

A concept map is a diagrammatic tool that represents a set of concepts within a framework of propositions, using nodes connected by labeled arrows to illustrate relationships between ideas. These maps serve as visual representations of knowledge stored in long-term memory and can be structured hierarchically to enhance comprehension. Concept maps are versatile and can be designed in various formats, such as spider, flowchart, hierarchical, and process models, depending on the educational content (5, 7).

The implementation of concept maps in education involves four key steps: (1) individual or group reading of the material to identify key points, (2) distinguishing main concepts from sub-concepts and selecting an appropriate map model, (3) completing the map by organizing concepts hierarchically and using visual cues to differentiate levels, and (4) evaluating learners through map review, discussion, and concept-based questioning (4, 6). This approach shifts the focus from rote memorization to reflective, critical thinking, decision-making, and problem-solving. By integrating knowledge management, instruction, learning, and technology, concept maps support meaningful learning and help learners connect new ideas with existing cognitive frameworks (3, 5, 7).

Thus, concept maps represent a powerful tool for promoting meaningful learning in the new approach to medical education. By encouraging active engagement, critical thinking, and the integration of knowledge, this approach addresses the limitations of traditional methods and aligns with modern learning theories. Evaluating learners' attitudes toward concept maps is crucial for ensuring their successful adoption and optimizing educational outcomes.

With the growing adoption of game-based learning approaches and the advancement of e-learning, concept maps as a means within these frameworks have gained significant attention (8-11). Concept maps serve as an effective visual and organizational tool that aligns well with the interactive and engaging nature of game-based learning. By integrating concept maps into e-learning platforms, educators can enhance the structure and clarity of complex information, making it more accessible and meaningful for learners. This approach not only supports the development of critical thinking and problem-solving skills but also fosters active engagement and motivation, which are essential components of successful game-based and e-learning environments. As a result, concept maps are increasingly recognized as a valuable resource for facilitating deeper understanding and retention of knowledge in digital and gamified educational settings.

The findings of Torre's study on students' attitudes toward the concept mapping approach revealed that students perceived concept maps as valuable tools for bridging theoretical knowledge and clinical practice. Furthermore, they viewed concept maps as effective learning aids that enhanced their ability to think critically and explore innovative methods (4). Akbari et al, (12) showed a Mindtools strategy in Mobil-based learning in clinical education has a positive effect on learners' knowledge.

Kirkpatrick's model emphasizes assessing participants' reactions as a foundational step in evaluating educational programs. According to Kirkpatrick, this level of evaluation provides essential insights for program improvement. While reaction evaluation focuses on participants' feelings and does not directly measure individual performance or learning outcomes, unfavorable

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reactions can signal potential program failure. Positive reactions, although not guaranteeing learning, create a conducive environment for educational success, whereas negative reactions can hinder learners' abilities (13). Thus, evaluating reactions to teaching methods is a vital component of the educational program assessment process. Using a validated and reliable instrument is essential for accurately assessing students' reactions to the concept mapping approach. This study aimed to conduct a psychometric evaluation and factor analysis of an instrument designed to measure students' attitudes toward the use of the concept mapping approach as a teaching method.

Materials and Methods

This descriptive cross-sectional study was conducted at Shahid Sadoughi University of Medical Sciences. The study was carried out in three phases to assess the validity, reliability, and exploratory factor analysis of a tool designed to evaluate master's students' attitudes toward the use of concept maps in education.

Study Tool

The perception assessment of the concept map tool, originally developed and psychometrically tested by Chiou et al (14) in Taiwan, was used in this study. The English version of the tool, published in 2008, consists of 10 items scored on a 5-point Likert scale, ranging from "completely disagree" (1) to "completely agree" (5)

Participants

1. *Validity Assessment Phase*: The eligibility requirements for specialists stipulated a minimum of two years of teaching experience employing the concept mapping method or engagement in research about conceptual learning and concept mapping. Participants included medical education specialists and faculty members with experience using the concept map method. The sample comprised 15 individuals (5 males, 44.44%; 10 females, 66.66%), with an average age of 38 ± 4 years.

2. *Reliability Assessment Phase*: Participants were students who had attended at least five training sessions using the concept map method. A total of 45 students (29 females, 64.44%; 16 males, 55.17%) participated, with an average age of 20 ± 2 years. Internal consistency was assessed using responses from 30 students, while test-retest reliability was evaluated with 15 students who completed the questionnaire twice over two consecutive weeks.

3. *Factor Analysis Phase*: Master of Science (MSc) students enrolled in public health or medical programs were eligible for participation in this study phase if they had completed a minimum of five concept map-based training sessions. 115 learners (71 females, 61.73%; 44 males, 38.26%) participated, with an average age of 20.53 ± 3 years.

Implementation stages of the study

The study adhered to the "Toolkit on Translation and Cultural Adaptation of an Instrument" to ensure the accuracy and cultural relevance of the translated questionnaire. This process involved several key steps: initial translation by bilingual experts, review by a specialized panel for accuracy and fluency, back-translation to verify alignment with the original version, and final adjustments to compile the Persian version of the questionnaire (15). By following this rigorous methodology, the study ensured that the translated tool was linguistically and culturally appropriate for the target population, maintaining the integrity and validity of the instrument while adapting it to the local context.

Phase 1 - Validity Assessment: The translation was conducted by two bilingual experts fluent in Persian and English, resulting in an initial Persian version of the questionnaire. This version was reviewed by an expert panel of five experts from various medical education fields, who suggested corrections to improve the accuracy and fluency of the translation. The revised Persian version of the questionnaire was back-translated into English by bilingual experts to ensure its alignment with the original questionnaire. After final adjustments, the Persian version of the questionnaire was compiled.

To qualitatively assess the content and face validity of the Persian version, the Delphi

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technique was employed over three rounds, and 15 medical education faculty members participated. The Delphi technique was employed to evaluate content validity through a qualitative process. In the first round, semi-structured questionnaires containing the draft items were distributed to expert participants, who were instructed to provide detailed feedback on each statement. Participant responses were systematically analyzed for every item. The refined questionnaire, incorporating these revisions, was then recirculated in subsequent rounds (second and third) to allow for further expert consensus. By the third round, no additional modifications were proposed by participants, indicating that theoretical saturation had been reached.

Two indices including the Content Validity Ratio (CVR) and the Content Validity Index (CVI). was assessed for the quantitative content validity assessment. A panel of experts assessed each item using a three-point content validity rating scale including necessary, useful but not necessary, and not necessary. CVR was calculated for each item, with a predetermined minimum acceptable value of 0.49 based on Lawshe's table (with 15 evaluators participating in the validation process) (16). Items failing to meet this threshold were excluded from subsequent analyses. For CVI, the relevance of each item was assessed using a four-point scale (17). These steps ensured the questionnaire's validity and readiness for subsequent phases of the study.

Phase 2- Reliability Assessment: In this phase, internal consistency and reproducibility of the tool were assessed. Internal consistency was evaluated using Cronbach's alpha, which measures the extent to which the questionnaire items are correlated and consistent in assessing the intended construct. To evaluate the questionnaire's reproducibility, the authors employed a test-retest reliability design. Participants completed the identical questionnaire on two occasions separated by a 14-day interval. Then, the authors analyzed response consistency using intraclass correlation coefficients (ICC) to determine the instrument's stability.

Phase 3- Exploratory Factor Analysis (EFA): The original questionnaire was not structured with predefined classifications. In this study, the categories were derived empirically for the first time using exploratory factor analysis.

EFA was conducted to examine the underlying structure of the questionnaire and identify the dimensions of learning constructs related to the concept map approach.

Data Analysis

The data were analyzed in SPSS (version 24, IBM Corporation, Armonk, NY). Internal consistency was calculated using Cronbach's alpha and reproducibility using the Interclass coefficient (ICC) test.

In EFA, sampling adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) index, and Bartlett's test was employed to evaluate the suitability of the data for factor analysis. Principal component analysis (PCA) with Varimax rotation was used to extract and interpret the factors, revealing the scales' dimensions. This phase aimed to provide a deeper understanding of the questionnaire's structure and its alignment with the theoretical framework of the concept map approach. *P-values* < 0.05 were considered as the significant level.

Results

Content validity: During the assessment of qualitative validity in Delphi rounds, a proposal for correcting two items was made, and these correction proposals received approval from the expert panel. Regarding quantitative indicators, the results showed that the CVR index of all items was above 0.49 and remained in the questionnaire. In the CVI index, all the items were above 0.79 and remained in the questionnaire. In total, the questionnaire consisted of 10 final questions.

Reliability: The internal consistency of the questionnaire was confirmed with Cronbach's alpha of 0.86, and the reproducibility of the instrument was confirmed with ICC=0.83, which confirms the desired level of reliability of the questionnaire. (Table 1).

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Table 1. The content validity indices of the instrument

Items	CVI*	CVR**		
		Relevance	Clarity	Comprehensiveness
1. Concept mapping helped me learn	0.9	1	1	1
2. Concept mapping helped me integrate and clarify the interrelationships among curriculum contents	0.9	1	1	1
3. Concept mapping learning strategy stimulated me to learn and think independently	0.9	0.9	1	1
4. Concept mapping helped me reduce the barriers and enhance my interest in learning	1	1	1	0.9
5. Concept mapping can be a new teaching and learning approach in my discipline	0.9	1	1	1
6. I think the concept mapping strategy can be easily used in other curricula	0.9	1	1	1
7. I will consider using the concept mapping learning strategy in other curricula	1	1	1	1
8. I was satisfied with using concept mapping to learn my lessons	1	0.9	1	1
9. I liked using concept mapping to assist me to learn my lessons	1	1	1	1
10. I can soon adapt to concept mapping	0.9	1	1	0.9

*Content Validity Index
** Content Validity Ratio

Exploratory factor analysis: The results of this stage showed that the adequacy of sampling based on the KMO index (0.90) confirmed the permissibility of factor analysis, and the Bartlett test confirmed the appropriateness of the data at the P = 0.001 level. Based on exploratory factor analysis, the measured model includes questions with significant factor loadings, and the constructs of the perception toward a concept map questionnaire were reported using two domains, including "facilitating learning" and "encouraging learning." Table 2 presents the factor loadings of each item.

Table 2. Factor loadings of items in the perception toward learning questionnaire using a concept map

Items	Encouraging learning*	Facilitating learning**
1. Concept mapping helped me learn		**0.772**
2. Concept mapping helped me integrate and clarify the interrelationships among curriculum contents		**0.801**
3. Concept mapping learning strategy stimulated me to learn and think independently	0.871	
4. Concept mapping helped me reduce the barriers and enhance my interest in learning	0.790	
5. Concept mapping can be a new teaching and learning approach in my discipline		0.696
6. I think the concept mapping strategy can be easily used in other curricula		0.834
7. I will consider using the concept mapping learning strategy in other curricula	0.650	
8. I was satisfied with using concept mapping to learn my lessons		0.743
9. I liked using concept mapping to assist me to learn my lesson	0.642	
10. I can soon adapt to concept mapping		0.753

*Encouraging learning domain: Total 3.497, % of variance 34.973, cumulative % 80.237
Facilitating learningdomain: Total 4.526, % of variance 45.264, cumulative % 45.264

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Discussion

As the development of innovative teaching and meaningful learning methods, including concept maps, continues to gain traction in educational systems, assessing students' reactions and attitudes is critical for advancing concept-based learning approaches in medical education. The findings of this study demonstrated that the questionnaire is valid for measuring two key dimensions: encouraging learning and facilitating learning within the Iranian educational context.

Evaluation plays a pivotal role in understanding participants' reactions to an educational program and their attitudes toward its application in the learning process. The growing adoption of concept-based learning methods and concept maps in e-learning and micro-learning within medical education systems underscores the need for reliable tools to assess student reactions. This study confirmed the validity of the student reaction evaluation tool for the concept map method.

A primary domain identified in the tool was "facilitating learning," which evaluates how the concept map approach supports learners in organizing, integrating, and understanding complex information. The primary objective of the concept-based learning approach and concept maps is to facilitate learners' learning and foster independent thinking (14). The current tool evaluates learners' reactions to using concept maps in supporting learning by identifying main and secondary concepts, establishing connections, and integrating concepts to promote meaningful learning. Chiou's study (14) demonstrated that the application of the concept maps not only facilitates learning and independent thinking but also reduces learning barriers and enhances learners' motivation. These results are further supported by the study conducted by Ab Latif. in 2018 (18). Furthermore, the research by Yue et al. (19) confirmed that concept map accelerates learning, enhance critical thinking, and improve independent thinking skills in nursing education. Their findings highlighted that the use of concept maps facilitates learning and creative thinking among learners due to several factors: 1) The presence of a structured hierarchical pattern (moving from general concepts at higher levels to specific concepts at lower levels), 2) The existence of distinct levels between concepts, ensuring that concepts with similar degrees of specificity or generality are placed at the same level, and 3) The inclusion of cross-connections between concepts at different levels. Abbasi et al. (20) argue that concept maps facilitate the learning process by enabling learners to identify concepts or topics and connect them using geometric shapes. Furthermore, concept maps help learners organize visual knowledge into a hierarchical and communicative network, enhance conceptual understanding by recognizing cause-and-effect relationships, and store information in long-term memory. Given the importance of concept maps in facilitating learning and promoting independent thinking, assessing students' reactions to the use of the concept map teaching method is crucial. This aspect has been carefully incorporated into the design of the present tool.

Given that motivation and enthusiasm are essential for active learning, the "encouraging learning" domain emphasizes generating interest in this method. Creating interaction, fostering enthusiasm for learning, and motivating students are critical components of the teaching-learning process (21). The present tool evaluates learners' reactions to the persuasive role of the concept map method in enhancing their learning. This assessment focuses on students' acceptance, feelings, and understanding of using concept maps. In this approach, students initiate their learning through self-directed strategies and complete it by developing concept maps individually or in groups. Furthermore, the process of reflection and evaluating concept maps provides opportunities for students to develop critical thinking skills. Due to the multi-stage nature of this method, fostering enthusiasm and interest plays a pivotal role in its successful implementation among students. The tool includes components related to enthusiasm and

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encouragement for learning, aligning with the motivational items in the questionnaire used by Tseng et al. (22) which highlighted learners' acceptance and satisfaction with the concept mapping approach as key factors in the method's success. Concerns about students' lack of commitment and interest in using concept maps underscore the importance of evaluating these components in concept-based learning (18, 23). Hosseini et al. (21) demonstrated that analytical and reflective teaching-learning processes enhance the persuasiveness of teaching methods. When interactive methods encourage students to think critically, reflect, and present their interpretations, analyses, and arguments, learning outcomes improve. Moreover, purposeful activities, such as topic-oriented group work and instructor-guided discussions effectively promote interaction and encourage learner participation in the learning process. Therefore, measuring learners' reactions to the concept map approach, particularly in terms of interest and motivation, can provide valuable insights for educational planning and the effective implementation of this method.

The findings indicate that the internal consistency and reproducibility of the instrument were at an appropriate level in the studied environment. The reliability of this tool was also confirmed in the study by Chiou et al., (14) with an internal consistency of 0.85 and content validity of 0.91, which was consistent with the present findings. Tseng et al. (22) further validated this questionnaire for measuring students' perspectives on the use of concept maps in knowledge transfer, confirming its validity and reliability. These results support the robustness of the tool for assessing students' attitudes toward concept maps.

Limitation: The validity and reliability of this questionnaire were examined in a medical university, and the generalizability of the results was restricted to similar environments. The use of this questionnaire in the educational environment of other contexts requires a validity study.

Implementation in health professions education: These findings carry important implications for medical education reform. First, they support the systematic evaluation of concept-based pedagogies to enhance learning effectiveness. Second, they provide educators with a validated instrument to compare student experiences across different technology-enhanced learning environments. Finally, the culturally-adapted nature of this tool ensures its relevance for Persian-speaking academic settings while maintaining methodological rigor.

Conclusion

The growing emphasis on meaningful learning in complex fields like medical education has expanded the use of concept mapping and concept-based teaching methods. Evaluating student feedback on such approaches provides valuable insights for program improvement. This study confirmed the validity and reliability of a questionnaire for assessing student perceptions of these methods in Iran. The validated tool is recommended for evaluating concept-based learning across interactive formats—including game-based, mobile, and e-learning—making it useful for comparing effectiveness in different technology-enhanced educational settings while maintaining cultural relevance.

Ethical considerations

Ethical considerations: Data were collected anonymously using a code to maintain confidentiality. This project has been approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran. (ID: IR.SSU.REC.1400.251). The informed written consent forms were obtained from all participants. The work was conducted following the Declaration of Helsinki. The text has been reviewed and refined using AI for proofreading to ensure clarity, coherence, and grammatical accuracy.

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Authors' contributions

F.K. conceptualized and designed the study; AS.H. collected the data; F.K. analyzed and interpreted the data; F.K. and AS.H. wrote the main manuscript text; All the authors met the criteria for authorship and had a role in preparing the manuscript. Moreover, all authors approved the final manuscript.

Conflict of interests

The authors declared no conflict of interest.

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