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Exploring the Students' Perception Towards Using Concept Mapping in Problem-Based Learning Tutorials at the Faculty of Medicine, Suez Canal University

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Abstract

Introduction:

Problem-based learning is a student-centered strategy that promotes active, constructive, and collaborative learning. In line, concept mapping is an instructional activity used to organize and visualize the ideas of learners. Problem-based learning and concept mapping are based on the same learning principles. This study was designed to explore the students' perception towards using concept mapping in Problem-Based Learning tutorials.

Subjects and Methods:

This is a cross-sectional descriptive study that was conducted on a conventional sample of 421 first-year medical students at the Faculty of Medicine, Suez Canal University. Data were collected using an anonymous self-reported questionnaire and focus group discussions.

Results:

The perception questionnaire found that over 54% of students expressed satisfaction with the overall experience of using concept mapping in Problem-Based Learning. The highest level of agreement (69.1%) was regarding promoting teamwork. Additionally, more than 65% of students agreed that this method promoted critical thinking skills and helped them understand the original written problem. Similarly, students who participated in the focus groups argued some benefits of using concept mapping in Problem-Based Learning, such as collaboration, clinical reasoning, integration, and retention of knowledge. In contrast, they acknowledged some challenges, such as time constraints, the complexity of the activity, which needs practice, non-flexibility of paper concept maps, and tutor guidance.

Conclusions:

The students perceived using concept mapping in Problem-Based Learning positively, with agreement on promoting teamwork, critical thinking, and problem-solving. In contrast, students reported some challenges related to the concept mapping activity or the group.

Keywords

Concept Map; Problem Based Learning; Student Perception.

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1. Introduction:

The Problem-Based Learning (PBL) strategy is designed to integrate basic and clinical sciences [1]. PBL is an innovative student-centered educational strategy in which students learn through the real world, complex and open-ended problems, which aims to develop problem-solving abilities and communication skills [2].

As PBL tutorials happen in a collaborative setting in a social context, students are responsible for their own learning and learn how to retrieve prior knowledge as an essential step for knowledge construction and acquisition [2]. Collaboration in PBL is an important skill because students have to develop a shared understanding of the problem at the individual and group levels. Moreover, different viewpoints and interpretations must be discussed, interrelated, and negotiated to attain shared conceptions for problem-solving [3].

Synergistically, Concept Mapping (CM) is considered to be an effective tool that improves the development of problem-solving skills. CM is purposefully designed to work with groups and has a more structured process for organizing and visually representing the ideas of a group [4]. A concept map is a relationship-based graphical representation of the learners' knowledge structure. It represents how information is organized and represented in memory [5].

Concept mapping and chunking are closely linked cognitive processes that involve organizing information to enhance understanding and retention of knowledge [6]. Accordingly, concept maps have been used in classrooms across the globe as tools for idea creation, information recall, and knowledge integration [7].

Zwaal and Otting (2016) used CM in PBL by modifying the third and fourth steps of the seven jumps and assigning students to draw a systemic inventory of the analysis and generating hypothesis phases [3, 8]. CM prevents students from jumping to learning goals by spending too little time and attention on steps three and four. However, Addae et al. (2012) designed a five-phase method of PBL that produced three mapping phases that reflected the learning activities during the tutorial and two questioning phases [9].

Accordingly, PBL and CM can be seen as complementary tools [10]. CM can be used in PBL tutorials for enhancing discussion, identifying learning gaps, generating learning objectives, promoting learning integration, and assessing learning [11]. This alignment between PBL and CM may be due to the fact that both stem from the same learning principles as self-regulated, constructive, collaborative, and contextual learning. Both also encourage students to take an active role in their learning, be responsible for their learning and use prior knowledge to integrate new concepts [12]. Therefore, the authors hypothesized that incorporating CM into PBL could enhance the teaching and learning environment. Consequently, this study was designed to investigate the students' perception towards using CM in the PBL tutorials.

2. Subjects and Methods:

2.1 Study context

The study was conducted at the Faculty of Medicine, Suez Canal University (FOM-SCU) in Egypt, during the academic year 2021-2022. The PBL is one of the learning strategies at FOM-SCU. The students are allocated to 20 PBL classes based on the capacity of the school. The total number of PBL classes for first-year students is 40 classes on two different days. The PBL classes are the places where the students attend both PBL brainstorming and debriefing sessions once per week. Each session lasts for ninety minutes. Each PBL group consists of twelve or thirteen students and a tutor facilitating the session and guiding the students.

2.2 Study design

This study followed a cross-sectional descriptive design. The theoretical framework of the study was aligned with the reaction level of Kirkpatrick's model regarding assessing the participants' perception towards the intervention [13]. Mixed quantitative and qualitative research approaches were used for data collection.

2.3 Target Population and Participants

For the quantitative data collection, a representative sample of 421 participants filled out a self-reported perception questionnaire, out of a total of 510 first-year medical students. Additionally, the authors held two focus group discussions, involving a total of 15 students, with nine in one session and six in the other, to gain a deeper understanding of students' perception.

2.4 Study procedures

In the 2nd term of the academic year 2021-2022, CM was incorporated with the PBL tutorials. Two orientation sessions were prepared and conducted synchronously with PBL tutors and asynchronously for students before applying CM in the PBL tutorials to provide both students and tutors with the required knowledge and skills for how to incorporate CM within the PBL sessions. Then, CM was used within the PBL tutorials during the 2nd module (Respiratory system) and the 3rd module (Cardiovascular system) of the 2nd term of the academic year. Class members had to construct one group concept map for each clinical problem. Concept maps were constructed to summarize, organize, and visualize students' ideas and findings and identify the knowledge gaps.

2.5 Data collection and instrumentation

Mixed quantitative and qualitative data collection tools were used.

Quantitative data collection:

The student perception questionnaire was used, which is a 20-item tool developed by Addae et al. [9]. Each item in the tool was scored on a five-point Likert scale rating from 1 (strongly disagree) to 5 (strongly agree). The tool was chosen for the study due to its comprehensive nature and simplicity in language, making it accessible and easy to use for participants. Furthermore, the questionnaire demonstrated good psychometric properties, with the items exhibiting an acceptable Cronbach's alpha score of (0.86) [14]. Students are invited to use this self-reported questionnaire to assess their perception of the learning experience of using CM activity in the PBL tutorials at the end of the academic year.

Qualitative Data Collection:

The authors conducted focus groups (FGs) with two groups of students. The purpose of the focus group discussion was to gain in-depth information from the students regarding the learning experience of using CM in PBL. The authors invited first-year medical students to participate in focus group discussions. Students voluntarily responded to the invitation and expressed their willingness to participate in the focus group. The number of participants in the focus groups was a representative sample, as the students who accepted the invitation were from six different PBL tutorials. Each focus group comprised an appropriate number of participants, as recommended by Stalmeijer et al. (2014), with eight participants considered optimal [15]. The focus groups followed an inductive approach. The authors constructed a focus group guide to explore the students' perception towards the benefits and challenges of using CM in PBL, the students' feelings during the experience, and their preferences for repeating the experience.

The first focus group discussion was conducted with six students from different classes. Students were led through an open discussion by the moderator. The moderator's goal was to explore different ideas and opinions from the participants in the time allotted (1-1.5 hours). All group members were participating in the discussion. The assistant moderator recorded the session, took notes, and identified participants with codes for anonymous identification of individuals, so the responses made by all participants were kept confidential. The focus group moderator asked all prepared questions sequentially within the time allotted. The focus group was structured around a set of predetermined questions that had undergone face and content validity testing (Annex 1). Two focus group discussions were conducted with medical students who were formally invited based on convenience non-probability sampling method.

2.6 Analysis of the data

2.6.1 Statistical analysis of the quantitative data

Quantitative data was analyzed using IBM SPSS software package version 25.0. Descriptive data were illustrated using the frequency distribution of the respondents.

2.6.2 Thematic analysis of the qualitative data

Thematic analysis for the transcripts from the focus groups was performed. The authors analyzed the responses and extracted the Benefits and challenges from the participants' responses. Then they devised a list of themes, which were approved subsequently by all the authors in a second consensus meeting done by the authors. For the thematic analysis, the authors used codes S1-S6 for the 1st focus group students' quotes and S7-S15 for the 2nd focus group students' quotes. Data was presented in tabular and graphic forms.

2.7 Ethical considerations

Approvals were obtained from the faculty administration and the ethical and scientific research committee (approval number 4658). Informed consents were taken from the students willing to participate in the study. Dealing with students' data was with a high degree of confidentiality.

3. Results

3.1 Quantitative data analysis

3.1.1 Background characteristics of the study participants

The study participants were from the same age, academic year, and had the same experience of PBL and concept mapping. 47.7% of students are males, and 52.3% of them are females.

3.1.2 Reliability

The overall Cronbach's alpha for the total questionnaire items was 0.935, which indicates high internal consistency (reliability)

3.1.3 Descriptive analysis of the student perception questionnaire

As shown in Table (1), it should be noted that while students' responses did not uniformly demonstrate positive perception, the responses were predominantly distributed among the scale with a tendency towards agreement. Over 54% of first-year students expressed satisfaction with the overall experience of using concept mapping in PBL. The highest level of agreement (69.1%) was regarding the promotion of teamwork through the use of concept mapping in PBL. Additionally, more than 65% of students agreed that this method promoted critical thinking skills and helped them understand the original written problem. Conversely, the lowest levels of agreement (54.4%) were observed regarding the efficient use of study time during concept mapping in PBL and the ability to integrate concepts from different disciplines using this method..

Table 1: The students' perception towards using concept mapping in Problem-Based Learning (N=421).

N	Items	Disagree	Neutral	Agree
		%	%	%
1	I enjoyed using this method of PBL (using concept mapping in PBL)	15.2	26.6	58.2
2	I learnt a great deal with this method	8.3	31.1	60.8
3	I was engaged in the learning process	7.2	30.4	62.5
4	My time was well spent learning new things	8.3	32.5	59.1
5	This method promoted teamwork	7.6	23.3	69.1
6	This method promoted student participation in the learning process	7.4	29.0	63.7
7	This method promoted critical thinking skills	6.4	28.5	65.1
8	This method made me eager to learn original written problem	6.9	33.7	59.4
9	I found this method useful for my learning	7.4	31.1	61.5
10	This method made learning fun	11.4	28.7	59.9
11	The quality of discussions was good	6.7	29.0	64.4
12	I felt a positive climate for learning	8.5	32.5	58.9
13	During this method, I made efficient use of my study time	11.9	33.7	54.4
14	This method encouraged reflection	12.6	28.5	58.9
15	I understood the original written problem	8.4	26.1	65.6
16	I gained a better understanding of the problem on completing the process	9.3	28.0	62.7
17	Using this method, I learned factual knowledge	7.2	29.0	63.9
18	Using this method, I could integrate concepts from different disciplines	13.1	32.5	54.4
19	This method provided a solid foundation for future learning	8.3	34.4	57.2
20	Using this method, I am optimistic of using the knowledge gained for future use in clinical training	10.7	27.3	62

3.2 Thematic analysis of the focus group discussions

3.2.1 Benefits of using CM in PBL

As shown in Figure (1), according to students' perception, using CM in PBL was highlighted to promote collaboration and teamwork, integration of information, and retention of knowledge which can help with studying and revision. Additionally, it can promote personal development and clinical reasoning skills. Furthermore, it can support the PBL steps.

- **Collaboration and teamwork**

Regarding the students' perception towards the benefits of using CM in PBL, five students (S1, S4, S7, S8 & S13) agreed that concept mapping in PBL enhances collaboration and teamwork, "CM in PBL improves collaboration between class members and we work as a team", It improved my participation in the PBL sessions", "It motivates the team members to participate in the discussion and the group concept map", "It improves collaboration between group members.", and "It improves our participation in the Problem-Based Learning class".

Integration of information

Moreover, six students (S2, S3, S4, S6, S7 & S8) reported integration of information as another benefit, "It integrates information between Disciplines. Also, it helps in answering Modified Essay Questions (MEQs).", "It helps in integrating information in our minds", "It integrates information between disciplines as in my brain", "It helps in integrating knowledge", "A way to integrate the different information related to the case", and "Integrate information from different disciplines related to the same topic in a simple way via a visual representation in one paper".

- **Support the PBL steps**

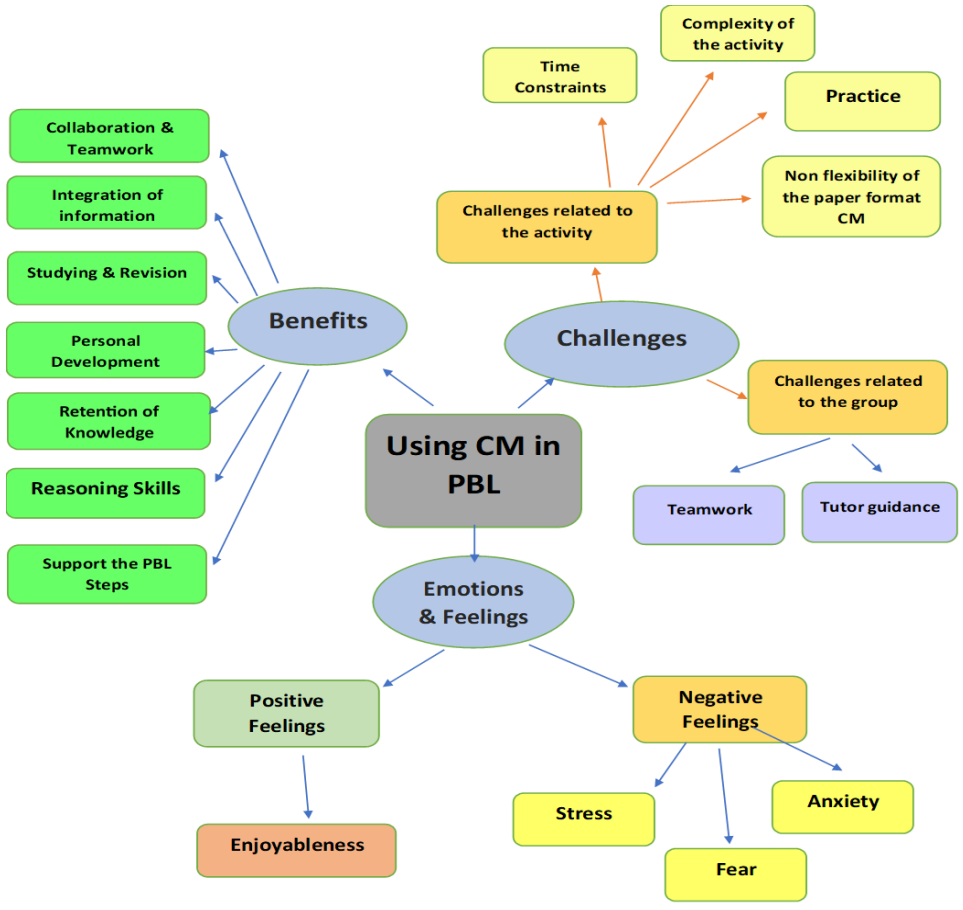
Furthermore, S5, S8, S10, S11 and S13 agreed that CM had the benefit of fostering PBL steps "CM helps in the step of analysis and generating hypothesis in the seven steps of the PBL process and in defining the learning gaps or learning objectives through drawing question marks (?) on the map", "It helps us to go deep in the analysis step of PBL", "It fosters the analysis step of PBL", "CM helped us to formulate the learning objectives related to the case itself, and this minimized the formulation of unneeded objectives", and "To add information in the map during the debriefing session, CM helped us to stick to the objectives answering the problem".

- **Retention of knowledge**

Additionally, S4 and S12 acknowledged the retention of knowledge as one of the benefits of using CM in PBL, "Retention of knowledge as a picture is better than thousand words." and "It helped us to organize ideas in one picture. It was used as a scheme containing keys for information retention".

- **Studying and revision**

Over and above, S5, S6, S9, S14 and S15 agreed that CM was a tool for studying and revision, "It helps in revision before the exam", "A tool for studying during the module and a tool for revision before the exam", "It is a tool for studying and revision", "Tool helped me in the pre-exam revision", "It helps us in summarizing the information related to the clinical problem in one page that enhances information retrieval and revision before the exam", and "One of the tools that aid in pre-exam revision".



Fig, (1): The thematic analysis of the qualitative students' perception towards using concept mapping in Problem-Based Learning.

- **Personal development**

S1 and S13 acknowledged their personal development by reporting being motivated during the experience, “It was a motivated way for studying and revision”, and “I was motivated to explore the new learning experience”.

- **Clinical reasoning skills**

Enhancing the clinical reasoning was acknowledged to be one of the benefits of using CM in PBL. As S7 mentioned, “During participating in constructing a concept map for the whole case scenario and reaching the final product, I felt like thinking as a physician”. Finally, S8 added, “CM helped us in analyzing the problem, suggesting and interpreting the needed investigation to reach a diagnosis of the case”.

3.2.2 Challenges of using CM in PBL

Regarding the challenges of using concept mapping in PBL, participants reported challenges from the activity and the group.

- **Challenges related to the activity**

The students acknowledged some challenges from using CM in PBL, such as time constraints, complexity of the activity, which needs practice, non-flexibility of paper concept maps, and tutor guidance.

Regarding the challenges from the activity, eight participants (S1, S2, S3, S4, S7, S9, S10 & S12) agreed that CM in PBL was a time-consuming activity “Time consumption is the basic challenge for concept mapping”, “It takes time to organize the ideas on the map during the brainstorming session. Also, the time constraints in the debriefing session due to the time needed for presentation”, “it is a time-consuming activity as it takes time to agree on an idea to be included in the map due to diversity of ideas”, and “It consumes a lot of time”.

Additionally, S1, S5, S6 and S10 argued that non-flexibility of the paper format concept map was one of the challenges facing them during the activity “Paper format concept map is not flexible for modifications or to add a picture or diagram”, “It is difficult to modify on the paper format concept map, it should be substituted with whiteboards or using applications”, “Drawing concept map on a paper is a challenge”, and “Paper format Concept map is not flexible for organization compared to the computer format”. Moreover, S1& S9 found that CM in PBL needs more practice, “It needs more practices and trials”, and “It takes several times to improve the design of our map”. Finally, S1 and S11 argued that it was a complex activity, “In the brainstorming session, the lack of information makes CM a complex activity” and “It was a complex activity to organize the information on the design, and this needs extra effort”.

- **Challenges related to the group**

Regarding the challenges from the group, S1, S10 and S12 acknowledged having no tutor guidance to be one of the challenges faced them “Another challenge is having no substantial tutor that may force us to join other class members. Guidance of our tutor was valuable", “Concept map construction needs tutor facilitation, so, reserve tutor is a challenge", and “It needs good guidance and facilitation by a tutor familiar with us”.

Over and above, three students S12, S13 and S14 suggested teamwork to be one of the challenges faced them while using CM in PBL, “The ease of the task depends on the team members' knowledge, their participation, and the interaction between members to agree on the concept included in the map”, “The difference in personalities of group members is a challenge. For example, introverted and shy people contribute less to the discussion even if they have good information. CM improved those students’ participation to some extent”, and “To be motivated to participate in even the PBL discussion or concept map construction, it needs a good environment inside the class and good interaction between the team members”.

3.2.3 Emotions and feelings

Regarding the students’ emotions and feelings during the learning experience of using concept mapping in PBL, most of the students described their feelings as different between the beginning and the end of the learning experience.

- **Negative feelings**

The students described the feelings of fear, anxiety, and stress at the beginning. Followed by describing the positive modifications of feelings by the time and trials. S1, S2 and S12 described the anxiety as their feeling at the beginning of the experience, “First, I was anxious because of the difficulty of the task. Then it became an enjoyable activity, with experience”, “Anxious in brainstorming sessions but in the debriefing session, the anxiety was relieved due to having knowledge base” and “First I was anxious for the difficulty of the task. With experience it becomes easier”.

Moreover, S3 described the fear as his feeling at the beginning of the learning experience, “I intended to be absent the first session after the faculty announced the application of CM in PBL. This was due to the fear of the new activity. However, with the practice of CM in PBL tutorials, it became an easy task”. Furthermore, S4, S5 and S6 described the activity as being stressful one, “First it was a stressful task to select the words representing the concepts especially in the analysis step. Then the positive feedback from the tutor motivated me to construct the following maps in a better way”, “First, it was a difficult and complex task to perform it individually in the musculoskeletal module. With practicing CM in PBL, it

becomes not so difficult task but needs concentration. With time it improves my self-confidence to participate in the activity", and S15 mentioned that it was a stressful task along the whole experience, "It was a stressful activity with overload".

- **Positive feelings**

On the other hand, many students had positive feelings during the experience, as S1, S6 and S10 said, "It is a stressful task first. Then it becomes an enjoyable task", and "I was excited with participation in the activity, which made it an enjoyable learning activity". Furthermore, S4, S7 and S11 mentioned, "The active participation in the map construction makes me satisfied about my activity in the class", and "With time, it improves my self-confidence to participate in the activity".

3.2.4 Preferences of repeating the experience

The majority of the students preferred to repeat the learning experience. While only one student did not prefer to repeat the learning experience. However, some of the students preferred to apply it in the debriefing session only of PBL tutorials. However, While the study's findings are promising, further research is needed to explore the broader applicability of CM across different learning contexts.

Regarding their preferences of repeating the learning experience, eleven students S1, S3-S12 preferred to repeat the experience either with or without conditions, "Yes, I prefer to repeat it as a group activity is easier than the individual task", "Yes, to benefit from its advantages and with controlling its challenges", "Yes, I prefer the experience to be repeated with the same peers and tutor", "Yes, as it fosters the steps of PBL." and "Yes, as I have a good team to work with and learn from".

Moreover, three students S2, S13 and S14 preferred CM to be applied in the debriefing session only, "In the debriefing session only to have an information base", "In brainstorming, it is a load. I suggest being used in the debriefing session as it needs an information base" and "CM is a challenging task; I prefer to be used in the debriefing session to be conducted with prior knowledge and to manage the time constraints in the brainstorming session". On the other hand, only one student did not prefer to repeat the experience, "No, as it was a stressful task making cognitive load and time-consuming activity".

4. Discussion:

This study aimed to explore students' perception of using CM This study aimed to explore students' perception of using CM in PBL tutorials. The findings reveal that students had a positive view of their learning experience with CM in PBL. Interestingly, Collaboration and teamwork were argued by students in both the focus group discussions and questionnaire as one of the key benefits of using concept mapping in PBL. This finding was interpreted as collaborative CM helps students maintain shared awareness and attention during group interactions and collaboration. In collaborative CM, participants co-construct meanings, externalize their propositional frameworks, and negotiate for agreement on the product, as noted by Murdiyah et al. [16]. Similarly, Addae et al. (2012) found that CM in PBL improves interpersonal skills [9]. CM technique has the potential to bring about high-quality interaction and lead to better learning outcomes and knowledge construction in groups, as noted by Morgan et al. [17].

Additionally, students suggested that using CM in PBL enhances deep understanding and integrate knowledge. This finding was aligned with the results of the perception questionnaire, which supports that CM in PBL promotes critical thinking and integration of knowledge between disciplines. CM helps students to represent, organize knowledge, and structure information in a way that makes it easier to understand and remember. Inline, the study of Sarker (2015) on civil engineering students using CM in PBL found concept maps helpful in understanding the key concepts and their associations in solving problems [18]. Similarly, students make meaningful connections between information from different disciplines during the CM activity [19]. For example, how the mechanism of action of a drug contributes to managing the signs or symptoms mentioned in the case [20, 21]. Concept maps are grounded in constructivism, a learning theory that focuses on how individuals think and perceive relationships between different pieces of knowledge. It also highlights the importance of meaningful learning [22]. Novak built upon Ausubel's theory, emphasizing that meaningful learning occurs when new ideas are integrated into existing cognitive structures. Additionally, cross-links in concept maps demonstrate how seemingly unrelated concepts are interconnected, highlighting the interdisciplinary nature of knowledge. This aligns with the integration of CM and PBL, allowing for interdisciplinary levels of understanding [23]. According to Harden's Ladder of Integration, this approach fosters deeper connections across different subject areas [24].

Moreover, students argued that CM helped them retrieve information, and used it as a tool for revision before an exam. This finding is explained when students store information interconnected in their long-term memory; it is easy to retrieve them as a chunk at the time of exposure to a contextualized learning experience [25-28]. These findings can be understood through Information Processing Theory (IPT) and Chunking Theory. IPT, a cognitive theory, explains how the human mind processes, stores, and retrieves information. It has been applied to explain complex phenomena like learning, decision-making, and memory recall, and can be used to enhance educational practices and design more effective problem-solving strategies. Chunking Theory, on the other hand,

involves grouping related pieces of information together, making them easier to remember and improving cognitive efficiency [29].

Furthermore, students agreed on concept mapping in PBL to enhance the clinical reasoning skills of students. This finding may be due to the fact that CM helps students analyze the problem, suggest and interpret the needed investigations to reach a diagnosis of the case in addition to thinking like a doctor. Inline, several studies argued that concept mapping fosters the students' reasoning and learning skills and their understanding [30-33].

Despite the acknowledgment of different benefits from the learning experience of using CM in PBL, the students highlighted some challenges faced them related to the activity, for example, time constraints, complexity, and limited experience with CM activity. These challenges may be due to the scheduling of PBL tutorials at the end of the academic day when many students were exhausted and had diminished attention or activity levels. Another reason could be that creating the concept map involves time-consuming processes such as sharing ideas, negotiating with team members, agreeing on concepts, links and cross-links, and deciding where to place them on the map. This finding is aligned with the study of Baker and Ginn (2023) who found that the major drawback of using concept maps was the time the students took to create them [34]. In the current study, to overcome the time constraints, some students suggested applying CM in the debriefing session only arguing that having knowledge from self-study eases the construction of the map. This finding was consistent with Ravindranath et al. (2016) who recommend using CM as a tool for summarizing the PBL discussion in the debriefing session only [35].

While the complexity of the activity may be due to the variation of clinical scenarios complexity or differences in student learning styles. Additionally, it may be due to the novelty of the tool to be used by the students that it may lead to excessive cognitive load as the students indicated that CM activity needs more training. Their success in mastering the CM activity may depend on the degree of familiarity with this learning method. This finding is consistent with Ullah and Ahmad (2021) and Pestana et al. (2023), who recommended regular training should be provided to teachers and students [36, 37]. In contrast, Hu and Wu (2012) found that using CM activity helped the students reduce their mental loads during learning through categorizing and chunking information [38]. The use of paper format may have increased the complexity of the activity, as students reported it to be inflexible. Drawing a map using paper and pencil restricts the flexibility of the task, especially when modifications or updates are mandatory. This observation is consistent with findings by Leng and Gijlers (2015), who noted that computerized concept maps offer greater flexibility compared to paper-based ones [39].

These benefits and challenges led many students to express differing feelings from the beginning to the end of the learning experience. At the beginning of the learning experience, students expressed fear and anxiety during the activity and acknowledged using CM to be a stressful activity with overload. This was aligned with their perceptions, as the majority of the students disagreed that the CM is an enjoyable task. As student motivation plays an important role in achieving any learning task, it may have a reciprocal effect on the learning process. Although Wang (2020) and Alt et al. (2021) suggested the use of concept maps as a tool to motivate a student to learn and participate actively [40, 41], students' motivation to learn physics remains vague after using CM as reported by Argaw et al. [42].

Despite being one of the benefits of using CM in PBL, teamwork is considered to be a challenge in certain circumstances. First, with the presence of insufficient tutor suboptimal ability to manage the group or indirectly from students' low motivation to actively engage in learning activities. Inline, lack of coordination among group members is one of the challenges reported by Nath et al. [28]. Similarly, Ali and Mittal argued that the role of the tutor is to help the students maintain group dynamics and guide the group through the task [43].

Overall, the findings of the current study are underpinned by the strength of the integration of mixed research methodologies. This approach offers flexibility, enabling the acquisition of diverse information to paint a comprehensive picture of the study and its factors from various angles. It also serves to mitigate the limitations inherent in relying solely on one type of methodology. Moreover, the inclusion of a relatively large sample size enhances the potential generalizability of our findings beyond the confines of our specific study context, lending greater credibility to the results.

On the other hand, several limitations are worth noting. One significant limitation pertains to the short period of intervention (only two modules) that may hinder measuring the short-term, intermediate, or long-term outcomes of the experience on the students. Moreover, there are potential confounding factors that may affect the students' perceptions. Furthermore, the researcher analyzed the qualitative data, which introduces the potential for bias influenced by personal values and beliefs. Although bracketing and reflexivity techniques were employed to mitigate such biases.

5. Conclusion & recommendation:

The combination of findings supports the positive perception of students towards using CM in the PBL. The results highlight the technique's potential to enhance collaboration and teamwork. By promoting teamwork and deep understanding, CM supports knowledge construction and enhances clinical reasoning. Despite these benefits, challenges such as time constraints, task complexity, and limited student experience with CM were reported, suggesting the need for better training and structured support for both students and tutors.

These insights can inform future instructional design, emphasizing the need for strategies that optimize student engagement while addressing logistical and cognitive load challenges in PBL settings. Therefore, it is recommended to anchor CM activity in the PBL system to benefit from its advantages. Additionally, continuously train tutors and students to apply CM effectively in PBL. Regular practice with CM can potentially reduce the challenges students face during the activity. Furthermore, investigating the tutors' perceptions towards this learning experience will be of good value for assessing the experience from the facilitator's perspective.

Annex: Focus group questions:

Opening discussion about the learning experience of using concept mapping in Problem Based Learning.

Exploration Questions
1.What are the benefits of using concept mapping in Problem Based Learning?
2.What are the challenges of using concept mapping in Problem Based Learning?
3.Describe your emotions or feelings during the experience of using concept mapping in Problem Based Learning.
Exit question:
4.Why do or don't you prefer to repeat the same experience the next year? And is there anything else you would like to say?

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Conflict of interests:

The authors declare that they have no conflict of interest.

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Authors contributions:

This work was carried out in collaboration among all authors. TM prepared the proposal and reviewed the literature with EA. TM collected the data to make the analysis and then prepared the first draft of the manuscript. EA reviewed and prepared the last version of the manuscript and shared in the data interpretation and discussion writing. NH, MG, and WT shared in preparing the proposal and revision of the whole work with their valuable feedback throughout the study. All authors read and approved the final manuscript

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