Original Article

Enhancing and impeding factors of problem-based learning in undergraduate medical education: A qualitative study

Reshma Ansari [1*], Nani Nordin [2], Noor Aini Abdul Hamid [3]

[1] Department of Anatomy, Faculty of Medicine, Bioscience and Nursing, MAHSA University Jalan SP 2, Bandar Saujana Putra, Jenjarum Selangor, Malaysia.
[2] Department of Pathology, Faculty of Medicine and Defense Health National Defense University Malaysia (UPNM) Sungai Besi, Kuala Lumpur, Malaysia.
[3] Department of Medical Education, International Medical School, Management & Science University, Shah Alam, Malaysia.

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***Corresponding author:**
Reshma Ansari, Department of Anatomy, Faculty of Medicine, Bioscience and Nursing, MAHSA University Jalan SP 2, Bandar Saujana Putra, Jenjarum Selangor, Malaysia.
Email: reshmaansari77@gmail.com

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Abstract

Background & Objective: With student-centered teaching-learning making the forefront in medical education, this qualitative study was set out to investigate the perceptions of students on the factors that enable or impede the outcome achievement of problem-based method of teaching-learning.

Materials & Methods: Ten students embarking their year 2 Bachelor of Medicine, Bachelor of Surgery (MBBS) study in a private university in Malaysia agreed to participate in this study. The students were subjected to semi-structured, in-depth, one-to-one interviews following their consent. The interview protocol was prepared following guidelines, objectives of the study and from the available literature. The data thus collected was subjected to thematic analysis using NVivo.

Results: Analysis revealed emergence of codes such as student characteristics and perception, facilitators, team factors, content and conduct of problem-based learning. These codes were then collapsed into themes. The major themes or factors that enabled or impeded the outcomes of PBL were student factors, facilitator factors and factors related to the learning environment.

Conclusion: The study concluded that among the various factors that enable or impede PBL teaching-learning method, there are pros and cons among the student, facilitators and learning environment that may facilitate or impede the realisation of PBL outcomes. This study would shed light into the students' perception of PBL and enable facilitators to ensure that PBLs are student-friendly.

Keywords: Medical Education, Feedback, Outcome-Based Education, Student-Centered Learning

Introduction

Problem-based learning (PBL) an initiative of McMaster University, Canada in 1969 is an example of a small-group educational environment where the problem drives learning through understanding, inculcating a positive effect on student learning, problem solving skills and intrinsic motivation (1-3). PBL suits 21st century approach in medical education namely active student learning, critical thinking, self-regulated learning, problem solving skills and teamwork (1, 3-4). PBL is a way to teach students to learn, identify clinical relevance and become reflective practitioners as well as synthesize and integrate foundational knowledge into clinical sciences (5-6). Lecture-based learning is slowly being replaced by PBL owing to its versatility and workplace-based learning culture (7).

Four sub-types of PBL have been recognised by Kwan and Tam (2009). Type I is incorporation of 2-3 PBL cases within a traditional curriculum. Type II is PBL incorporated as tutorials that provide additional knowledge. On the contrary, Type III employs PBL to explain the applied aspect of a lecture-delivered information. On the other end of the spectrum, in type IV PBL is a highly self-directed chief learning platform for

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students. It is supported by uncustomary interactive lectures to enrich the students' learning (8).

PBL is typically a small group teaching method in which a facilitator guides a group of 10-12 students. During the process, the facilitator provides clinical problems to the students who understand the problem by discussions and sharing of knowledge among them. They then recognise key facts, construct hypotheses and identify grey areas of knowledge as their leaning needs or learning issues (5). The role of the facilitators is to provide a safe educational environment and supportive atmosphere to the students in order to identify their learning needs by asking open-ended questions (5).

The advantages of PBL include active participatory learning, flexibility, teamwork, transferrable knowledge from theory to clinical application, meaningful learning without rote memorisation and substantially improved educational environment and leadership skills (2,5 and 9). The universal outcome of PBL is to improve the students' abilities in providing clinical solutions irrespective of their current abilities under minimal to nil facilitator input (10). Despite the above advantages of PBL, disgruntled voices are also heard regarding poor direction by facilitators, difficulty in finding the right resource, uncommitted study groups and inability to be self-learners (5). Moreover, PBL being a resource-intensive teaching method necessitates adequate facilitators, library resources and student learning time (10).

PBL has been merited as a teaching-learning method that enables realisation of the outcomes in Western medical schools but its merit in Asian context is controversial (11). The very traditional nature of teacher-based curriculum of Asian medical schools' conflict with the core of PBL (11). Students in Malaysia have also voiced out that PBLs are time consuming and some students are dominant during the process hindering the benefits of PBL (12). There are some opinions that PBL is not successful as a content delivery technique and requires intense preparation before facilitation to get the correct content across to the students (1). Curricular implementation constraints and resource availability have led to the emergence of different variants of PBL as well (4).

Feedback on the pedagogical approaches help us identify the gaps in implementing the pedagogical techniques, inability to be achieve the intended outcome and facilitator deficiencies necessitating the need for an in-depth investigation into the perception of students (9). Studies that have ascertained the benefits of PBL were quantitative surveys with insignificant response rates (12-13). Providing feedback on one's own progress and the use of a particular pedagogy with their perceived advantages and disadvantages is a challenging exercise. Students tend to sway with the majority and fail to provide their 'true' perceptions in quantitative studies (9). Since PBL is considered to hone student skills irrespective of their cognitive achievement, it is considered imperative to involve students with myriad of background, learning styles and learning achievements to be able to provide feedback on this process (10) in order to identify the factors that are facilitatory or a barrier PBLs. Hence this study was set out to investigate the perceptions of students on the factors that enable or impede the outcome achievement of PBL method of teaching-learning through a qualitative approach.

Materials & Methods

Design and setting(s)

This study which was conducted in a private medical university in Malaysia from July 2022 to December 2022 was approved by the Institutional Ethics committee (MSU-RMC-02/FR01/07/L1/050). Bachelor of Medicine, Bachelor of Surgery (MBBS) study in the university spans for five years with first two years of pre-clinical basic medical sciences and three years of clinical sciences study. The curriculum is partially integrated, during the pre-clinical phase. Though divided into systemic modules, year 1 includes only anatomy, physiology and biochemistry that represents normal body system and functioning. Year 2 modules include pathology, microbiology and pharmacology representative of body diseased states. PBL is introduced in year 2 of MBBS as an integrative approach to basic medical sciences. Among the four types of PBLs, the school adopts PBL type III where the package is used for applying the basic medical science knowledge (13). The PBL package is prepared by content experts and vetted by medical education experts to ensure quality and its appropriateness to the level of learners. Prior to the PBL session, a briefing is given to the facilitators who are basic medical science lectures from various disciplines.

The PBL topic is not revealed to the students explicitly in the timetable, but represented by a catchy phrase that is indicative of the case. Students are divided into groups of 10-12 for the sessions facilitated by a faculty member. The PBL is conducted as two sessions of two hours each. The trigger provided in the first session prompts students to brainstorm the hypothesis and to come up with

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differentials on the case. They move to the examination, investigation, preferential diagnosis of the case to be able to suggest appropriate management. The basic medical sciences of the case are explored during student discussions. The content which doesn't answer students' queries or cognitive conflicts are noted down as learning issues. Once the first session is done, students embark on independent learning and work on the learning issues. The students are also required to prepare a case summary and concept map on the case. The second session is usually conducted after a week's time wherein the students present their case summary and discuss on the learning issues. Any conflicts on the content are sorted out through discussions facilitated by the same faculty member. Finally, the discussion ends with concept map presentation.

Participants and sampling

The factors that facilitate or impede PBL were explored by analysing the perception of students using a basic qualitative approach known as interpretive type of qualitative research which targets to understand a particular point of view from the perspective of those involved (15). An invitation was sent out to students who were currently in their Year 2 of MBBS study explaining the purpose of the study. A purpose-based sampling method was used to select 10 students out of the pool of year 2 MBBS students comprising of seven female and three male students. The students were approached thorough telephone calls to request them to participate in the study. Five students refused to participate in the study. No reasons were provided.

Tools/Instruments

A semi-structured interview protocol was developed based on the guidelines of identifying the pre-requisites for the interviews, retrieval of previous knowledge, suiting the objectives of the study and from the available literature (16) as shown in Table 1. There was no pilot testing.

Table 1. List of questions for interview †

Sections	*Questions*
Section I: Ice-breaking	Introduction Explain the purpose of research Obtain written / oral consent for participating and audiotaping / videotaping the interview.
Section II: Preparation for PBL session	How much knowledge do you have about the concept of PBL? How prepared are you to engage in a PBL session? Elaborate your answer What are the factors that motivate you to participate in the PBL sessions? What factors deter you from preparing yourself for PBL sessions? How does the PBL topic in the timetable intrigue you to identify the PBL case?
Section III: PBL content	What basic science knowledge (anatomy, physiology, biochemistry, microbiology, pathology, pharmacology, ethics) has been enhanced after a PBL session? What basic science knowledge (anatomy, physiology, biochemistry, microbiology, pathology, pharmacology, ethics) do you think should be more represented in PBLs? Which process of the PBL is more challenging to you? (eg. Hypothesis generation, deriving patient information summary PIS1, PIS 2, PIS 3 (investigations) and PIS 4)? What factors encourage you to share your ideas during PBL discussions? What factors discourage you to share your ideas during PBL discussions? How much time do you spend searching for the content for the learning issues? What obstacles do you face while searching for the content of learning resources? What are the preferred sources (eg books, internet) you look into while searching for the learning issues? How do you ensure that you are well versed with all the learning issues before the second sessions? How confident are you in the knowledge gained from a PBL session? Give reasons for your answer. Could you provide instances where you realised discrepancy in knowledge between your group and other PBL groups post second session? What do you think about standardization of content covered between the groups? What do you think is the appropriate time duration for a PBL session? What do you think is the role of the concept map in a PBL session? When do you think is the appropriate time slot for PBL session?
Section IV: Benefits and downsides of PBL	According to you what are the perceived benefits of PBL mode of teaching? According to you what are the downsides of PBL teaching method? What factors make you feel that PBL process is enjoyable? What factors make you feel that PBL process is laborious? How do you think PBL will enhance your history taking and examinations skills during your clinical postings in the future? How do you think will PBL will enhance your case presenting skills in your clinical postings in the future? What soft skills have been enhanced as a result of your participation in PBL sessions? What are skills as a learner (self-directed learning, decision making skills, problem solving skills, critical thinking skills, information management skills) have been enhanced or reduced due to PBL type teaching? What are the advantages and disadvantages of group-learning as in PBL?
Section V: Facilitators of PBL	What factors among lecturers makes them better facilitators during the PBL sessions? What attributes do you think should be inculcated among facilitators to achieve the outcomes of PBL?

†*Questions developed based on the research objectives, and literature review*

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Data collection methods

Semi-structured, in-depth, one-to-one interviews were conducted individually to allow more freedom, avoid bias and to be able to uncover ideas the researcher might not have anticipated (17). Consent was obtained from the participants for voluntary participation and to audio/videotape the session. The research purpose and relevance were explained with assurance of complete confidentiality and anonymity. The interviewer was allowed probing for adequate answers, interaction with the respondents, and to subtly modify the questions during the interview process to achieve the objective of the study and clarify the meaning (15). The interviews which spanned for about 30-45 minutes each were conducted through Google Meet platform (online) and screen audio recorded for data analysis. Verbal and non-verbal probing techniques were used as follow-up questions and field notes were taken during the session. No repeat interviews were conducted.

Data analysis

Data analysis was done concurrently with data collection (15). The responses were transcribed and coded with thematic content analysis performed by two researchers individually (18). This was achieved by using NVivo 12 Pro software. The field notes both descriptive and reflective, were analysed as well. The researchers went through the transcribed data thoroughly and field notes, added reflective remarks to give clarity to the analysis as a vital component of data immersion. The data was analysed by coding, sorting, synthesizing and theorizing (19). The data was analysed until saturation was achieved and no new information emerged. The collected data was validated by interpretive evidence of validity through member-checking (15). The researchers clarified grey areas, addressed miscommunication, identified inaccuracies and obtained additional data by sharing their interpretations of the data with the participants. Consensus in the form of investigator triangulation was also done which ensured reliability (15). It also helped to check on selective perception and cast light on unsighted spots (20). An example of thematic analysis for theme 1 is shown in Appendix 1.

Results

In accordance with the research question, investigation of the factors that facilitate and impede PBL as a teaching learning method was the focus of this study. The interviewees were presented with questions from the interview guide and the course of the interview depended on their answers. As overall feedback, the students enjoy PBL as a teaching learning method. The responses provided by the students were given codes which collapsed into subthemes and then into major themes and categories as shown in Figure 1.

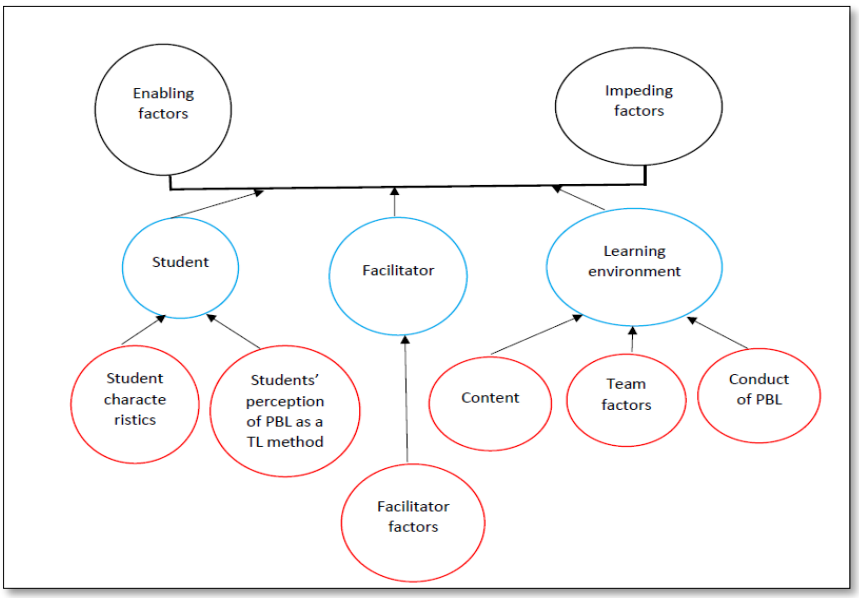

Figure 1. Schematic representation of the data analysis process

The participants were identified by numbers not names, to ensure anonymity. The data was collated into factors. The factors were then grouped into enabling and impeding factors. Open codes were established for both

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enabling and impeding factors while data analysis. 9 codes for enabling factors and 11 codes for impeding factors were progressively established. The team then discussed on the collapse of the codes of both enabling and impeding factors into 5 sub-themes which included students' characteristics, students' perception of PBL as a teaching learning (TL) method, facilitator factors, content, conduct and team factors. The 5 sub-themes were categorised as 3 themes namely student factors (students' characteristics), facilitator factors and elements of the learning environment (content, conduct and team factors) which comprised of both enabling and impeding factors. The final themes were established with consistency of data and findings and consensus of the research team. Appendix 2 shows the overall analysis of students' responses which were collapsed as factors, sub-themes and themes.

Student factors

The inherent intelligence of students with sound knowledge was cited as an important enabling factor in PBL. The students were of the perception that this generally boosted student participatory confidence in PBL. Some students possessed intrinsic motivation which made them curious to know more about the content. On the other hand, uncertainty, poor preparation and participation were viewed as impeding factors.

"My friends who are high scorers know a lot about the PBL content and show increased participation" (Student No 5)

"I make it a point to pre-read before a PBL session for a smoother discussion" (Student No 3)

"I am uncertain of my answers and always have a fear of being wrong" (Student No 2)

On the other hand, PBL promotes autonomous, active learning which is facilitatory but the time taken for it sounds detrimental.

"I like how we search for validated information ourselves. It helps in information management too" (Student No 7)

"It is frustrating that sometimes I take days to search information for one learning issue" (Student No 9)

Facilitator factors

Facilitators are considered very vital for realising the outcomes of PBL. Students expect facilitators to be knowledgeable on the content and conduct of PBL, inclusive, approachable and provide a non-threatening environment for students.

"Some of my facilitators were very friendly and it was very encouraging for me to participate in the PBL" (Student No 4)

"One of my PBL facilitators did not guide us in the right direction which made us lose a lot of time during the session. Since we had only two hours and it was end of the working day, we couldn't think much too. This was a bit disappointing" (Student No 6)

Elements of learning environment

The curricular factors that enable the reduction of cognitive load by integration and knowledge transfer of basic medical sciences to clinical findings are definitely facilitatory for PBL method. The usage of concept maps and case summary presentations help in critical thinking of the students.

"I am able to relate the physiology and pathophysiology to the clinical findings of the PBL case" (Student No 6)

On the other hand, the poor construct of PBL cases with poor representation of some disciplines hinders understanding. Added on, since student learning time (SLT) is more in PBL, they expect good representation of PBL content in assessments failing which, students lose interest in PBL sessions. This could also be due to a highly exam-oriented culture in Asian educational context.

"PBL content in exams motivates me to learn about the case better" (Student No 7)

Students consider team dynamics as an important factor that enables or impedes PBL. The time and mode of conduct of PBL also influences students' interest. Online PBLs and PBLs slotted at the end of the working day dampens students' enthusiasm.

"Some of my team members are free riders and that leads to some of us doing extra work during and after the PBL sessions. Same goes to students who are silent during the sessions" (Student No 3)

Discussion

The results of our study show that there are three factors that enable or impede the achievement of PBL outcomes namely, student factors, facilitator factors and elements of learning environment.

Student factors

Student inherent characteristics and their perception of PBL as a teaching-learning method contribute to the achievement of outcomes. Positive student personalities, active, independent learning methods and knowledge of the benefits enable PBL outcomes. On the contrary, fear,

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self-doubt, lack of preparation, time consuming process and cognitive overload impede the outcomes.

PBL is the cornerstone of life-long learning, essential in medical education by making students take responsibility for their own learning with minimal rote learning (3 and 6) and active participation (21). PBL promotes student-centred learning in the sense that critical thinking and group discussion aids in active, independent learning outside the traditional classroom (6). Previous research has shown that PBL enhances critical thinking skills in male students, better content knowledge, and improved exam results (11). The students have been reported to have better clinical case-based discussions and report higher satisfaction with this teaching-learning method (11). However, as our participants mentioned, lack of prior knowledge is an important student factor that hinders the PBL process (3). Moreover, packed student learning time with lectures, or other student activities jeopardises students' motivation and quest for meaningful self-directed learning (14).

Chang in 2016 via his commentary goes on to explain that effective information management is a vital process in PBL which has been also voiced out by the participants in this study. Another interesting point elucidated by Chang (6) is that a more knowledgeable student would contribute less to the group discussion. It has been opined that the main reason students hesitate to speak up during PBL is the fear of being wrong as shared by our participants. Communication skills of medical students is considered above standard and hence expression of both right and wrong concepts should be encouraged for better understanding according to Chang (5). Excess time consumption and information overload, can be attributed to the confusion of students regarding the information fed to them through lectures and self-directed learning promoted by PBL (14). This could be combated by clear briefing to students on the principles and outcomes of various teaching learning methods to prevent students despising PBL (14).

Though students are encouraged to ask questions, searching for relevant references and arriving at logical answers, cognitive overload, irrelevant, uncertain knowledge and inability to gauge the required depth of knowledge are troublesome (21). Students in a medical school in Nepal, wished to discuss physiology, pathology, and pharmacology-related concepts through PBL. Anatomy, biochemistry, and microbiology-related topics were preferred to be delivered as lectures due to their poor understanding in PBLs (21). Students also wanted a conceptual lecture of PBL topics for better understanding (21). This could be due to the exam-oriented approach of Asian students and the failure of validation of knowledge during PBL by lecturers (22).

Facilitator factors

The participants are of the opinion that facilitators are the fulcrum of PBL who ease the environment, validate knowledge and inculcate interest. However, factors like discipline orientation, teaching instead of guiding and lack of standardization impedes the PBL process. Implementing and reaping the benefits of PBL in Asian setup was and is an uphill task owing to the teacher-centred curricular setup (3). Though faculty-shortage is one the prime reasons to abandon PBL as a teaching-learning method, exam-oriented culture that steers students away from application of prior knowledge and lack of peer-learning are reasons for poor student participation in PBL (3). It is a misunderstood concept that the role of teachers is lost in PBL. The truth is that, the role of the teacher undergoes a metamorphosis to provide a safe, cooperative, participative and constructive learning environment (3).

Previous studies indicate that discrepancy in knowledge between small groups can be effectively combated by a large group discussion following the second session of PBL as practised in Harvard medical school (6). Though this is criticised to be opposite to PBL's philosophy, pre-lectures aid in complementing trigger with further scaffolding and post-lectures aid in summarising interdisciplinary knowledge and exposes the students to impacting research in the field (14). Students have various preferences of tutors for varied reasons which includes peer-tutors for co-operative learning, meaningful feedback, social and cognitive congruence and faculty tutors for validation of knowledge (22). Lecturers do find it laborious to prepare for PBL especially if it is not their expertise on top of their other teaching, research and administrative commitments (22). In medical school set ups with lack of faculty development programs on PBL, facilitators tend to intervene with their didactic questions and teach the answers jeopardising the PBL process (14).

Our students had mentioned that facilitators tend to sway towards their disciplines and also find difficulty in 'guiding' and slip into 'teaching' mode. This could be due to the fact that traditional lecturers tend to resist PBL due to the loss of control over the didactic classrooms (14). This is based on the belief system that knowledge can be transmitted vertically rather than through critical reflection and inquiry (14). Dedicated staff training

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sessions are needed at regular intervals to be able to reinforce PBL skills in providing seamless facilitation.12 Strong, supportive leadership aids in propagation and maintenance of change and prevention of reverting into traditional practices (14). Tutors favour PBL teaching when they are adequately trained with adequate administrative support and infrastructure. Otherwise PBLs can cause undue anxiety, strained work relationships and unhappy work environments necessitating wide resources and immense teacher effort (23).

Elements of learning environment

PBL varies from Case-based learning (CBL) and Team-based learning (TBL) in the concept that it is a curricular model on its own necessitating a safe and sound learning environment (14). The content, conduct and team factors play a vital role in impeding or enabling PBL outcomes. Though students have expressed dissatisfaction over online PBL, previous research has proved that blended PBL enhances satisfaction, self-reliance and ensures committed students (3). Blended PBL must ensure the decreased need for tutor support and provide a mastery simulation to enhance student learning experience (3). Another way to ensure that learning happens in PBL is to conduct quizzes on the content (3). Each student might have varied levels of understanding after group discussions. Hence it is paramount to do independent study after every PBL session (6). The most important feature of PBL is the discussion of students in a safe and encouraging educational environment (7). Achieving positive group dynamics is challenging, but results in exploring one's own strengths and weaknesses (7) as individual student characteristics is the core of group dynamics (6).

Group dynamics though is vital, reports indicate that the burden of PBL falls mostly on few hardworking students (21). This hinders the attainment of the objective of collaborative learning. Students have also voiced out the lack of time for certain sessions (21). Hence teamwork dynamics, time allocation, tutor involvement and resource availability are factors that influence PBL (21). Students also prefer the continuity of PBL tutors rather than multiple tutors for ease of facilitation and safe learning environment (22). PBL's success as a teaching-learning method relies on group size (small), use of realistic case scenarios and group dynamics while poor understanding of the objectives, methods and assessment, poorly organized sessions, untrained facilitators and lack of standardisation lead to failure (23).

Conclusion

The current study elucidates the factors that impede and enable PBL method of teaching-learning among medical students in a Malaysian medical school through a qualitative study. The main themes that emerged from the study are student factors, facilitator factors and elements of learning environment. The understanding of these factors would enable the faculty to make achieve the PBL outcomes efficiently. Since PBLs incurs a lot of cost in terms of manpower and facilities, their outcomes must be realisable. It is suggested that necessary changes must be incorporated in PBLs based on the above study following which students must be interviewed again as a post-interventional study.

This study is a single institutional study and the collected data might be reflective of the PBL practise in the respective university. Nevertheless, the data can be extrapolated to most of the institutions with PBL as a teaching method to be able to identify the fallacies and continuous quality improvement.

Ethical considerations

This study which was conducted in a private medical university in Malaysia from July 2022 to December 2022 was approved by the Institutional Ethics committee (MSU-RMC-02/FR01/07/L1/050).

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Disclosure

The study did not receive any funding or grant. The authors disclose no conflict of interest.

Author contributions

The researchers/authors of this study are RMA, NN and NAH, all three authors are of female gender and employed as lecturers in a private medical school in Malaysia where the study was conducted. They were lecturers to the participant pool. Apart from that no relationship was established prior to study commencement. RMA and NAH are medical doctors with anatomy and biochemistry as their specializations. They further expanded their field into medical education. NN, a medical doctor teaches pathology to medical students. The research interest of the researchers is medical education especially in curriculum and assessment. The idea for this study was conceived by all three authors as feedback from students regarding the

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conduct of PBL and its improvisation following curriculum review. The proposal was prepared by RA and corrected by NN and NAH. The interviews were conducted by RMA. The collected data was analysed by RMA and NN. NAH performed the investigator triangulation. The manuscript was prepared by all three authors.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [RMA] upon reasonable request.

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Appendix 1. Method of induction and data analysis

Themes	Sub-themes	Codes Enable	Factors Enable	Student statements	Codes Impede	Factors Impede	Student statements
1. Student factors	**1. Student characteristics**	**1. Inherent capabilities**	-Sound knowledge -Intrinsically motivated to gain new perspectives from others -Curious	*Pre-reading by peers helps identify the topic of discussion (Student No 2)* *I prefer to listen to the discussion by my peers as it increases my knowledge and opens up new ideas (Student No 1)* *I am curious to know about the case as I would use in my clinicals (Student No 7)*	**1. Inherent capabilities**	-Language issues	*I have had issues in hypothesis generation due to difficulty in conversing in English (Student No 9)*
					2. Participation	-Lack of preparation -Poor participation	*I always have difficulty in PBL participation if I am not well-prepared (Student No 5)* *PBL is laborious if there is poor contribution from team members (Student No 3)*
		2. Personality	-Extrovert personality who prefers to discuss with teammates -Motivated	*The discussion is always lively when extroverted students are in the team (Student No 9)* *I am always motivated to know the trigger and case before the PBL commences (Student No 4)*	**3. Fear of unknown**	-Uncertainty about what to expect in PBL -Fear of being wrong	
	2. Students' perception of PBL as TL method	**3. Skill development**	-Development of communication skill, critical thinking, collaborative learning, presentation and decision-making skills	*PBL helps me to communicate confidently with my peers on the content (Student No 6)* *The process of hypothesis generation has helped me to develop critical thinking (Student No 7)* *I would use decision making skills learnt in PBL during clinical phase (Student No 10)*	**4. Laborious task**	-Time consuming to search for learning issues -Information overload	*It is difficult for me to search for the content for learning issues especially for the second session. (Student No 2)* *Sometimes the content of PBL is too heavy that I don't know which is relevant to the case. I end up reading the unnecessary material which confuses me (Student no 8)*
		4. Enjoyable learning process	-Active learning/independent, self-directed learning -Autonomy	*I am interested in PBL as it allows me to search for the content myself with the lecturer validating the knowledge (Student no 8)*			

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Appendix 2. Factors that enable and impede PBL outcomes

Themes	Sub-themes	Codes	Factors	Codes	Factors
		Enable	**Enable**	**Impede**	**Impede**
1. Student factors	**1. Student characteristics**	**1. Inherent capabilities**	-Sound knowledge -Intrinsically motivated to gain new perspectives from others -Curious	**1. Inherent capabilities**	-Language issues
				2. Participation	-Lack of preparation -Poor participation
		2. Personality	-Extrovert personality who prefers to discuss with teammates -Motivated	**3. Fear of unknown**	-Uncertainty about what to expect in PBL -Fear of being wrong
	2. Students' perception of PBL as TL method	**3. Skill development**	-Development of communication skill, critical thinking, collaborative learning, presentation and decision-making skills	**4. Laborious task**	-Time consuming to search for learning issues -Information overload
		4. Enjoyable learning process	-Active learning/independent, self-directed learning -Autonomy		
2. Facilitator factors		**5. Facilitator features**	-Inculcates interest -Provide conducive, non-threatening learning experience -Facilitates to connect the dots in the case	**5. Facilitator preparedness**	-Does not probe effectively -Lack of standardization of facilitation between groups -Facilitator does not validate content or sources.
				6. Facilitator mindset	-Give importance to own disciplines than holistic integration. -Teach rather than guide -Judgmental
3. Elements of learning environment	**3. Content**	**6. Reduction of cognitive load**	-Enables knowledge transfer -Effective integration of basic medical knowledge in a clinical scenario	**7. Curricular factors**	-Some disciplines are not well represented eg: biochemistry -More theoretical aspects focused in certain disciplines. Eg: Poor clinical anatomy representation
		7. Content management	-Concept map and case summary ensure critical thinking	**8. Valuing student learning time**	-Poor representation of PBL content in assessments -Too many other student-centered activities
	4. Team factors	**8. Team building**	-Efficient group work	**9. Team-work hinderance**	-Poor group dynamics -Non-participatory team members
	5. Conduct of PBL	**9. Workplace simulation**	-Provide glimpse of workplace -Case summary similar to case presentation in clinical postings	**10. Mode of PBL**	-Online mode of PBL -Time of class, especially in at the end of a working day.
				11. Interest inculcation	-Time consuming -Absence of fun factor -Non-challenging learning issues

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