



# Effective Learning Behavior in Problem-Based Learning: a Scoping Review

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## Abstract

Problem-based learning (PBL) emphasizes learning behavior that leads to critical thinking, problem-solving, communication, and collaborative skills in preparing students for a professional medical career. However, learning behavior that develops these skills has not been systematically described. This review aimed to unearth the elements of effective learning behavior in a PBL context, using the protocol by Arksey and O'Malley. The protocol identified the research question, selected relevant studies, charted and collected data, and collated, summarized, and reported results. We discovered three categories of elements—*intrinsic empowerment, entrustment, and functional skills*—proven effective in the achievement of learning outcomes in PBL.

**Keywords** Student behavior · Effective learning behavior · Problem-based learning · Higher education · Academic outcomes

## Introduction

Problem-based learning (PBL) is an educational approach that utilizes the principles of collaborative learning in small groups, first introduced by McMaster Medical University [1]. The shift of the higher education curriculum from traditional, lecture-based approaches to an integrated, student-centered approach was triggered by concern over the content-driven nature of medical knowledge with minimal clinical application [2]. The PBL pedagogy uses a systematic approach, starting with an authentic, real-life problem scenario as a context in which learning is not separated from practice as students collaborate and learn [3]. The tutor acts

as a facilitator who guides the students' learning, while students are required to solve the problems by discussing them with group members [4]. The essential aspect of the PBL process is the ability of the students to recognize their current knowledge, determine the gaps in their knowledge and experience, and acquire new knowledge to bridge the gaps [5]. PBL is a holistic approach that gives students an active role in their learning.

Since its inception, PBL has been used in many undergraduate and postgraduate degree programs, such as medicine [6, 7], nursing [8], social work education [9], law [10], architecture [11], economics [12], business [13], science [14], and engineering [15]. It has also been applied in elementary and secondary education [16–18]. Despite its many applications, its implementation is based on a single universal workflow framework that contains three elements: problem as the initiator for learning, tutor as a facilitator in the group versions, and group work as a stimulus for collaborative interaction [19]. However, there are various versions of PBL workflow, such as the seven-step technique based on the Maastricht “seven jumps” process. The tutor's role is to ensure the achievement of learning objectives and to assess students' performance [20, 21].

The PBL process revolves around four types of learning principles: constructive, self-directed, collaborative, and

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contextual [19]. Through the constructive learning process, the students are encouraged to think about what is already known and integrate their prior knowledge with their new understanding. This process helps the student understand the content, form a new opinion, and acquire new knowledge [22]. The PBL process encourages students to become self-directed learners who plan, monitor, and evaluate their own learning, enabling them to become lifelong learners [23]. The contextualized collaborative learning process also promotes interaction among students, who share similar responsibilities to achieve common goals relevant to the learning context [24]. By exchanging ideas and providing feedback during the learning session, the students can attain a greater understanding of the subject matter [25].

Dolmans et al. [19] pointed out two issues related to the implementation of PBL: dominant facilitators and dysfunctional PBL groups. These problems inhibit students' self-directed learning and reduce their satisfaction level with the PBL session. A case study by Eryilmaz [26] that evaluated engineering students' and tutors' experience of PBL discovered that PBL increased the students' self-confidence and improved essential skills such as problem-solving, communications, critical thinking, and collaboration. Although most of the participants in the study found PBL satisfactory, many complained about the tutor's poor guidance and lack of preparation. Additionally, it was noted that 64% of the first-year students were unable to adapt to the PBL system because they had been accustomed to conventional learning settings and that 43% of students were not adequately prepared for the sessions and thus were minimally involved in the discussion.

In a case study by Cónsul-giribet [27], newly graduated nursing professionals reported a lack of perceived theoretical basic science knowledge at the end of their program, despite learning through PBL. The nurses perceived that this lack of knowledge might affect their expertise, identity, and professional image.

Likewise, a study by McKendree [28] reported the outcomes of a workshop that explored the strengths and weaknesses of PBL in an allied health sciences curriculum in the UK. The workshop found that problems related to PBL were mainly caused by students, the majority of whom came from conventional educational backgrounds either during high school or their first degree. They felt anxious when they were involved in PBL, concerned about “not knowing when to stop” in exploring the learning needs. Apart from a lack of basic science knowledge, the knowledge acquired during PBL sessions remains unorganized [29]. Hence, tutors must guide students in overcoming this situation by instilling appropriate insights and essential skills for the achievement of the learning outcomes [30]. It was also evident that the combination of intention and motivation to learn and desirable learning behavior determined the quality of learning

outcomes [31, 32]. However, effective learning behaviors that help develop these skills have not been systematically described. Thus, this scoping review aimed to unearth the elements of effective learning behavior in the PBL context.

## Methods

### Scoping Review Protocol

This scoping review was performed using a protocol by Arksey and O'Malley [33]. The protocol comprises five phases: (i) identification of research questions, (ii) identification of relevant articles, (iii) selection of relevant studies, (iv) data collection and charting, and (v) collating, summarizing, and reporting the results.

### Identification of Research Questions

This scoping review was designed to unearth the elements of effective learning behavior that can be generated from learning through PBL instruction. The review aimed to answer one research question: “What are the effective learning behavior elements related to PBL?” For the purpose of the review, an operational definition of effective learning behavior was constructed, whereby it was defined as any learning behavior that is related to PBL instruction and has been shown to successfully attain the desired learning outcomes (i.e., cognitive, skill, or affective)—either quantitatively or qualitatively—in any intervention conducted in higher education institutions.

The positive outcome variables include student viewpoint or perception, student learning experience and performance, lecturer viewpoint and expert judgment, and other indirect variables that may be important indicators of successful PBL learning (i.e., attendance to PBL session, participation in PBL activity, number of interactions in PBL activity, and improvement in communication skills in PBL).

### Identification of Relevant Articles

An extensive literature search was conducted on articles published in English between 2015 and 2019. Three databases—Google Scholar, Scopus, and PubMed—were used for the literature search. Seven search terms with the Boolean combination were used, whereby the keywords were identified from the Medical Subject Headings (MeSH) and Education Resources Information Center (ERIC) databases. The search terms were tested and refined with multiple test searches. The final search terms with the Boolean operation were as follows: “problem-based learning” AND (“learning behavior” OR “learning behaviour”) AND (student OR “medical students” OR undergraduate OR “medical education”).

### Selection of Relevant Articles

The articles from the three databases were exported manually into Microsoft Excel. The duplicates were removed, and the remaining articles were reviewed based on the inclusion and exclusion criteria. These criteria were tested on titles and abstracts to ensure their robustness in capturing the articles related to learning behavior in PBL. The shortlisted articles were reviewed by two independent researchers, and a consensus was reached either to accept or reject each article based on the set criteria. When a disagreement occurred between the two reviewers, the particular article was re-evaluated independently by the third and fourth researchers (M.S.B.Y and A.F.A.R), who have vast experience in conducting qualitative research. The sets of criteria for selecting abstracts and final articles were developed. The inclusion and exclusion criteria are listed in Table 1.

### Data Charting

The selected final articles were reviewed, and several important data were extracted to provide an objective summary of the review. The extracted data were charted in a table, including the (i) title of the article, (ii) author(s), (iii) year of publication, (iv) aim or purpose of the study, (v) study design and method, (iv) intervention performed, and (v) study population and sample size.

### Collating, Summarizing, and Reporting the Results

A content analysis was performed to identify the elements of effective learning behaviors in the literature by A.S.A.G and S.N.H.H, who have experience in conducting qualitative studies. The initial step of content analysis was to read the selected articles thoroughly to gain a general understanding of the articles and extract the elements of

learning behavior which are available in the articles. Next, the elements of learning behavior that fulfil the inclusion criteria were extracted. The selected elements that were related to each other through their content or context were grouped into subtheme categories. Subsequently, the combinations of several subthemes expressing similar underlying meanings were grouped into themes. Each of the themes and subthemes was given a name, which was operationally defined based on the underlying elements. The selected themes and subthemes were presented to the independent researchers in the team (M.S.B.Y and A.F.A.R), and a consensus was reached either to accept or reformulate each of the themes and subthemes. The flow of the scoping review methods for this study is illustrated in Fig. 1.

## Results

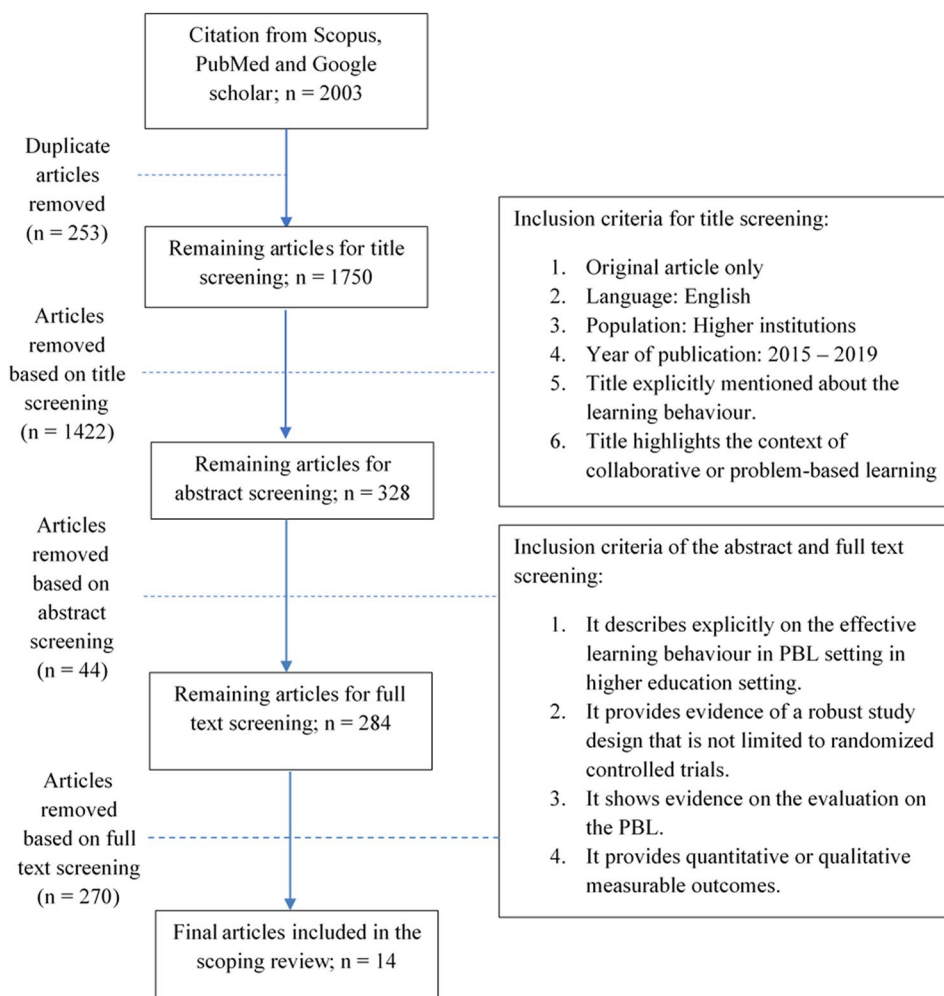
### Literature Search

Based on the keyword search, 1750 articles were obtained. Duplicate articles that were not original articles found in different databases and resources were removed. Based on the inclusion and exclusion criteria of title selection, the eligibility of 1750 abstracts was evaluated. The articles that did not fulfil the criteria were removed, leaving 328 articles for abstract screening. A total of 284 articles were screened according to the eligibility criteria for abstract selection. Based on these criteria, 284 articles were selected and screened according to the eligibility criteria for full article selection. Fourteen articles were selected for the final review. The information about these articles is summarized in Table 2.

**Table 1** Inclusion and exclusion criteria

Criteria	Inclusion criteria	Exclusion criteria
Criteria for abstract selection	<ol style="list-style-type: none"> <li>1. Describe at least one effective learning behaviour in PBL setting in higher education setting</li> <li>2. Provides evidence of a robust study design that is not limited to randomized controlled trials</li> <li>3. Provides evidence of evaluation of a PBL</li> <li>4. Outcomes of the study that are measurable either quantitatively or qualitatively</li> </ol>	<ol style="list-style-type: none"> <li>1. Primary and secondary students’ populations</li> <li>2. Primary and secondary education context</li> </ol>
Criteria for full article selection	<ol style="list-style-type: none"> <li>1. Elaboration on the elements of effective learning behaviour are provided</li> <li>2. Clear methodology on the measurement of the outcome</li> <li>3. PBL context</li> <li>4. Functional element that has been proven to promote learning</li> <li>5. Well design research intervention</li> </ol>	<ol style="list-style-type: none"> <li>1. Review articles, published theses, books, research report, editorial and letters will be excluded from the searching process</li> </ol>

**Fig. 1** The flow of literature search and article selection



## Study Characteristics

The final 14 articles were published between 2015 and 2019. The majority of the studies were conducted in Western Asian countries ( $n = 4$ ), followed by China ( $n = 3$ ), European countries ( $n = 2$ ), Thailand ( $n = 2$ ), Indonesia ( $n = 1$ ), Singapore ( $n = 1$ ), and South Africa ( $n = 1$ ). Apart from traditional PBL, some studies incorporated other pedagogic modalities into their PBL sessions, such as online learning, blended learning, and gamification. The majority of the studies targeted a single-profession learner group, and one study was performed on mixed interprofessional health education learners.

## Results of Thematic Analysis

The thematic analysis yielded three main themes of effective learning behavior: intrinsic empowerment, entrustment, and functional skills. Intrinsic empowerment overlies four proposed subthemes: proactivity, organization, diligence, and resourcefulness. For entrustment, there were four underlying

subthemes: students as assessors, students as teachers, feedback-giving, and feedback-receiving. The functional skills theme contains four subthemes: time management, digital proficiency, data management, and collaboration.

## Theme 1: Intrinsic Empowerment

Intrinsic empowerment enforces student learning behavior that can facilitate the achievement of learning outcomes. By empowering the development of these behaviors, students can become lifelong learners [34]. The first element of intrinsic empowerment is proactive behavior. In PBL, the students must be proactive in analyzing problems [35, 36] and their learning needs [35, 37], and this can be done by integrating prior knowledge and previous experience through a brainstorming session [35, 38]. The students must be proactive in seeking guidance to ensure they stay focused and confident [39, 40]. Finding ways to integrate content from different disciplines [35, 41], formulate new explanations based on known facts [34, 35, 41], and incorporate

**Table 2** Studies characteristics

Author (year)	Location	Study design/method	Subjects	Intervention	Outcome
Arana-Arexolaleiba et al. [46]	Spain	Quasi-experimental design (one group pretest–posttest design) Questionnaire only	97 undergraduate engineering students and 20 tutors	Assessing PBL learning environment and supervision on student learning approach	Environments with higher constructive variables and supervisor formative assessment stimulate deeper learning approach in students
Khoiriyah et al. [34]	Indonesia	Quasi-experimental design (one group posttest-only design) and semi-structured interview Questionnaire & Interview protocol	310 undergraduate students, 10 tutors and 15 content experts	Evaluating self-assessment scale for active learning and critical thinking (SSACT) in PBL	SSACT improves students critical thinking and self-directed learning
Khumsikiew et al. [37]	Thailand	Quasi-experimental design (one group pretest–posttest design) Questionnaire only	36 undergraduate pharmacy students	Assessing the effect of student competence in PBL with clinical environment	Student clinical skills performance and satisfaction was significantly increase in the PBL with clinical environment
Rakhudu [4]	South Africa	Sequential explanatory mixed method design and focus group discussion Questionnaire	135 undergraduate nursing students (2011–2013 academic year) 21 participate in FGD 114 participate in questionnaire	Evaluating the effect of PBL scenario in quality improvement in health care unit on nursing student	PBL scenario effective in promoting interdisciplinary and interinstitutional collaboration
Tarhan et al. [43]	Turkey	Quasi-experimental design (one group pretest–posttest design) and semi-structured interview Questionnaire and Interviews protocol	36 undergraduate biochemistry course students	Evaluating the effect of PBL on student interest in biochemistry course	PBL Improve students investigating process, associate information's, collaborative skills, responsibility and idea expressions
Chou et al. [48]	China	Sequential explanatory mixed method design Observation checklist and post-PBL homework reflections	45 undergraduate medical students and 44 undergraduate nursing students All students participate All students participate but only the IP groups were analyzed	Assessing the effect interprofessional PBL in learning clinical ethics	The IPE learning through PBL improve respect towards each other and avoid the development of stereotyped behavior
Chung et al. [39]	China	Quasi-experimental design (one group pretest–posttest design) and action research Observation, instructional journal, interviews protocol and questionnaire	51 undergraduate business students	Evaluating the effect of PBL on students learning outcomes of industrial-oriented competences	Significantly enhanced students' learning motivation, learning outcomes and development of instructional knowledge and capability
Geitz et al. [47]	Netherlands	Semi-structured interview Interview protocol	62 undergraduate students and 4 tutors in business administration 8 students (selected randomly) and all 4 tutors were selected for the qualitative study	Evaluating the effect of sustainable feedback on self-efficacy and goal orientation given during the PBL sessions	PBL participants positively valued the feedback, their personal characteristics, previous experience with feedback and concomitant perceptions appeared to have greatly influenced both tutors' and students' specific, individual behavior, and responses

Table 2 (continued)

Author (year)	Location	Study design/method	Subjects	Intervention	Outcome
Dawilal et al. [40]	Thailand	Quasi-experimental design (one group posttest-only design) and interview Questionnaire and interview protocol	29 English foreign language students All participate in the questionnaire 10 students with improvement in writing course were selected for the interview	Evaluating self-regulated learning in problem-based blended learning (PBBL)	PBBL students reported to apply cognitive strategy and effectively used their time and study environment
Gutman [36]	Israel	Quasi-experimental design (non-equivalent control group posttest-only design) Questionnaire only	62 pre-service teachers	Evaluating achievement goal motivation (AGM) and research literacy skills (RL) between PBL process scaffolding with moderator-based learning (OLC + M) and social based learning (OLC + S)	The PBL participants reported to show significant improvement in AGM Only OLC + S showed significant improvement in RL
Li [35]	China	Semi-structured interview Interview protocol	14 students	Evaluating student learning outcome and attitude between single disciplinary course PBL and lecture	The PBL participants reported to have better outcome in interdisciplinary learning, self-directed learning, problem solving, creative thinking, communication and knowledge retentions. They also showed positive attitude of PBL is they recognize its effectiveness in skill development rather than exam oriented
Asad et al. [41]	Saudi Arabia	Cross-sectional study (period cross sectional) Questionnaire only	120 undergraduate medical students	Evaluating student opinion on effectiveness of PBL and interactive lectures	The PBL participants reported to have better outcome in modes of learning facilitation, professional development, learning behavior, and environment
Hursen [44]	Cyprus	Quasi-experimental design (one group pretest–posttest design) and interview Questionnaire and interview protocol	25 students	Evaluating the effect of using Facebook in PBL on adults' self-efficacy perception for research inquiry	The PBL participants reported to have positive increase in perception of self-efficacy for sustaining research
William et al. [38]	Singapore	Quasi-experimental design (non-equivalent control group posttest-only design) Questionnaire only	149 students	Evaluating the effect of supply chain game in PBL environment	The game based PBL reported to increase score on metacognition function and motivation function. The game based PBL also showed significant correlation between motivation and positive game experience with the students' perceived learning

hands-on activity [35, 39, 42] during a PBL session are also proactive behaviors.

The second element identified is “being organized” which reflects the ability of students to systematically manage their roles [43], ideas, and learning needs [34]. The students also need to understand the task for each learning role in PBL, such as chairperson or leader, scribe, recorder, and reflector. This role needs to be assigned appropriately to ensure that all members take part in the discussion [43]. Similarly, when discussing ideas or learning needs, the students need to follow the steps in the PBL process and organize and prioritize the information to ensure that the issues are discussed systematically and all aspects of the problems are covered accordingly [34, 37]. This team organization and systematic thought process is an effective way for students to focus, plan, and finalize their learning tasks.

The third element of intrinsic empowerment is “being diligent.” Students must consistently conduct self-revision [40] and keep track of their learning plan to ensure the achievement of their learning goal [4, 40]. The students must also be responsible for completing any given task and ensuring good understanding prior to their presentation [40]. Appropriate actions need to be undertaken to find solutions to unsolved problems [40, 44]. This effort will help them think critically and apply their knowledge for problem-solving.

The fourth element identified is “being resourceful.” Students should be able to acquire knowledge from different resources, which include external resources (i.e., lecture notes, textbooks, journal articles, audiovisual instructions, the Internet) [38, 40, 45] and internal resources (i.e., students’ prior knowledge or experience) [35, 39]. The resources must be evidence-based, and thus should be carefully selected by evaluating their cross-references and appraising them critically [37]. Students should also be able to understand and summarize the learned materials and explain them using their own words [4, 34]. The subthemes of the intrinsic empowerment theme are summarized in Table 3.

### Theme 2: Entrustment

Entrustment emphasizes the various roles of students in PBL that can promote effective learning. The first entrusted

role identified is “student as an assessor.” This means that students evaluate their own performance in PBL [46]. The evaluation of their own performance must be based on the achievement of the learning outcomes and reflect actual understanding of the content as well as the ability to apply the learned information in problem-solving [46].

The second element identified in this review is “student as a teacher.” To ensure successful peer teaching in PBL, students need to comprehensively understand the content of the learning materials and summarize the content in an organized manner. The students should be able to explain the gist of the discussed information using their own words [4, 34] and utilize teaching methods to cater to differences in learning styles (i.e., visual, auditory, and kinesthetic) [41]. These strategies help capture their group members’ attention and evoke interactive discussions among them.

The third element of entrustment is to “give feedback.” Students should try giving constructive feedback on individual and group performance in PBL. Feedback on individual performance must reflect the quality of the content and task presented in the PBL. Feedback on group performance should reflect the ways in which the group members communicate and complete the group task [47]. To ensure continuous constructive feedback, students should be able to generate feedback questions beforehand and immediately deliver them during the PBL sessions [44, 47]. In addition, the feedback must include specific measures for improvement to help their peers to take appropriate action for the future [47].

The fourth element of entrustment is “receive feedback.” Students should listen carefully to the feedback given and ask questions to clarify the feedback [47]. They need to be attentive and learn to deal with negative feedback [47]. Also, if the student does not receive feedback, they should request it either from peers or teachers and ask specific questions, such as what aspects to improve and how to improve [47]. The data on the subthemes of the entrustment theme are summarized in Table 4.

### Theme 3: Functional Skills

Functional skills refer to essential skills that can help students learn independently and competently. The first element identified is time management skills. In PBL, students must

**Table 3** Intrinsic empowerment subtheme with the learning behavior elements

Intrinsic empowerment			
Proactive	Being organized	Being diligent	Resourceful
<ul style="list-style-type: none"> <li>Analyze problems and learning needs</li> <li>Seek guidance</li> <li>Integrate subjects from different disciplines</li> <li>Incorporate hands on activities</li> </ul>	<ul style="list-style-type: none"> <li>Organize PBL team by assigning roles</li> <li>Organize discussed ideas or learning needs</li> <li>Prioritize ideas or learning needs</li> </ul>	<ul style="list-style-type: none"> <li>Consistent in self-study</li> <li>Keep track with plans</li> <li>Responsible in completing the task</li> <li>Responsible in understanding the learning materials</li> </ul>	<ul style="list-style-type: none"> <li>Use various resources</li> <li>Appraise the resources</li> <li>Use evidence-based resources</li> <li>Paraphrase the resources</li> </ul>

**Table 4** Entrustment subtheme with the learning behavior elements

Entrustment			
Student as assessor	Student as teacher	Give feedback	Receive feedback
<ul style="list-style-type: none"> <li>• Evaluate individual performance</li> <li>• Evaluate group performance</li> </ul>	<ul style="list-style-type: none"> <li>• Prepare teaching materials</li> <li>• Use various learning styles</li> </ul>	<ul style="list-style-type: none"> <li>• Give feedback on individual task</li> <li>• Give feedback on group learning process</li> <li>• Prepare feedback questions beforehand</li> <li>• Suggest measures for future improvement</li> </ul>	<ul style="list-style-type: none"> <li>• Clarify feedback</li> <li>• Request feedback from peers and teachers</li> </ul>

know how to prioritize learning tasks according to the needs and urgency of the tasks [40]. To ensure that students can self-pace their learning, a deadline should be set for each learning task within a manageable and achievable learning schedule [40].

Furthermore, students should have digital proficiency, the ability to utilize digital devices to support learning [38, 40, 44]. The student needs to know how to operate basic software (e.g., Words and PowerPoints) and the basic digital tools (i.e., social media, cloud storage, simulation, and online community learning platforms) to support their learning [39, 40]. These skills are important for peer learning activities, which may require information sharing, information retrieval, online peer discussion, and online peer feedback [38, 44].

The third functional skill identified is data management, the ability to collect key information in the PBL trigger and analyze that information to support the solution in a problem-solving activity [39]. Students need to work either individually or in a group to collect the key information from a different trigger or case format such as text lines, an interview, an investigation, or statistical results [39]. Subsequently, students also need to analyze the information and draw conclusions based on their analysis [39].

The fourth element of functional skill is collaboration. Students need to participate equally in the PBL discussion [41, 46]. Through discussion, confusion and queries can be addressed and resolved by listening, respecting others' viewpoints, and responding professionally [35, 39, 43, 44]. In addition, the students need to learn from each other and reflect on their performance [48]. Table 5 summarizes the data on the subthemes of the functional skills theme.

**Table 5** Functional skills subtheme with the learning behavior elements

Functional skills			
Time management	Digital proficiency	Data management	Collaborative skill
<ul style="list-style-type: none"> <li>• Create learning schedule</li> <li>• Set up deadline for each task</li> <li>• Prioritize work for each task</li> </ul>	<ul style="list-style-type: none"> <li>• Use digital devices</li> <li>• Use digital tools</li> </ul>	<ul style="list-style-type: none"> <li>• Collect data</li> <li>• Analyze data</li> </ul>	<ul style="list-style-type: none"> <li>• Discuss professionally</li> <li>• Learn from each other</li> </ul>

## Discussion

This scoping review outlines three themes of effective learning behavior elements in the PBL context: intrinsic empowerment, entrustment, and functional skills. Hence, it is evident from this review that successful PBL instruction demands students' commitment to empower themselves with value-driven behaviors, skills, and roles.

### Theme 1: Intrinsic Empowerment

In this review, intrinsic empowerment is viewed as enforcement of students' internal strength in performing positive learning behaviors related to PBL. This theme requires the student to proactively engage in the learning process, organize their learning activities systematically, persevere in learning, and be intelligently resourceful. One of the elements of intrinsic empowerment is the identification and analysis of problems related to complex scenarios. This element is aligned with a study by Meyer [49], who observed students' engagement in problem identification and clarification prior to problem-solving activities in a PBL session related to multiple engineering design. Rubenstein and colleagues [50] discovered in a semi-structured interview the importance of undergoing a problem identification process before proposing a solution during learning. It was reported that the problem identification process in PBL may enhance the attainment of learning outcomes, specifically in the domain of concept understanding [51].

The ability of the students to acquire and manage learning resources is essential for building their understanding



of the learned materials and enriching discussion among team members during PBL. This is aligned with a study by Jeong and Hmelo-Silver [52], who studied the use of learning resources by students in PBL. The study concluded that in a resource-rich environment, the students need to learn how to access and understand the resources to ensure effective learning. Secondly, they need to process the content of the resources, integrate various resources, and apply them in problem-solving activities. Finally, they need to use the resources in collaborative learning activities, such as sharing and relating to peer resources.

Wong [53] documented that excellent students spent considerably more time managing academic resources than low achievers. The ability of the student to identify and utilize their internal learning resources, such as prior knowledge and experience, is also important. A study by Lee et al. [54] has shown that participants with high domain-specific prior knowledge displayed a more systematic approach and high accuracy in visual and motor reactions in solving problems compared to novice learners.

During the discussion phase in PBL, organizing ideas—e.g., arranging relevant information gathered from the learning resources into relevant categories—is essential for communicating the idea clearly [34]. This finding is in line with a typology study conducted by Larue [55] on second-year nursing students' learning strategies during a group discussion. The study discovered that although the content presented by the student is adequate, they are unable to make further progress in the group discussion until they are instructed by the tutor on how to organize the information given into a category [55].

Hence, the empowerment of student intrinsic behavior may enhance students' learning in PBL by allowing them to make a decision in their learning objectives and instilling confidence in them to achieve goals. A study conducted by Kirk et al. [56] proved that highly empowered students obtain better grades, increase learning participation, and target higher educational aspirations.

## Theme 2: Entrustment

Entrustment is the learning role given to students to be engaging and identify gaps in their learning. This theme requires the student to engage in self-assessment, prepare to teach others, give constructive feedback, and value the feedback received. One of the elements of entrustment is the ability to self-assess. In a study conducted by Mohd et al. [57] looking at the factors in PBL that can strengthen the capability of IT students, they discovered that one of the critical factors that contribute to these skills is the ability of the student to perform self-assessment in PBL. As mentioned by Daud, Kassim, and Daud [58], the self-assessment may be more reliable if the assessment

is performed based on the objectives set beforehand and if the criteria of the assessment are understood by the learner. This is important to avoid the fact that the result of the self-assessment is influenced by the students' perception of themselves rather than reflecting their true performance. However, having an assessment based on the learning objective only focuses on the immediate learning requirements in the PBL. To foster lifelong learning skills, it should also be balanced with the long-term focus of assessment, such as utilizing the assessment to foster the application of knowledge in solving real-life situations. This is aligned with the review by Boud and Falchikov [59] suggesting that students need to become assessors within the concept of participation in practice, that is, the kind that is within the context of real life and work.

The second subtheme of entrustment is “students as a teacher” in PBL. In our review, the student needs to be well prepared with the teaching materials. A cross-sectional study conducted by Charoensakulchai and colleagues discovered that student preparation is considered among the important factors in PBL success, alongside other factors such as “objective and contents,” “student assessment,” and “attitude towards group work” [60]. This is also aligned with a study conducted by Sukrajh [61] using focus group discussion on fifth-year medical students to explore their perception of preparedness before conducting peer teaching activity. In this study, the student in the focus group expressed that the preparation made them more confident in teaching others because preparing stimulated them to activate and revise prior knowledge, discover their knowledge gaps, construct new knowledge, reflect on their learning, improve their memory, inspire them to search several resources, and motivate them to learn the topics.

The next element of “student as a teacher” is using various learning styles to teach other members in the group. A study conducted by Almomani [62] showed that the most preferred learning pattern by the high school student is the visual pattern, followed by auditory pattern and then kinesthetic. However, in the university setting, Hamdani [63] discovered that students prefer a combination of the three learning styles. Anbarasi [64] also explained that incorporating teaching methods based on the student's preferred learning style further promotes active learning among the students and significantly improved the long-term retrieval of knowledge. However, among the three learning styles group, he discovered that the kinesthetic group with the kinesthetic teaching method showed a significantly higher post-test score compared to the traditional group with the didactic teaching method, and he concluded that this is because of the involvement of more active learning activity in the kinesthetic group.

The ability of students to give constructive feedback on individual tasks is an important element in promoting

student contribution in PBL because feedback from peers or teachers is needed to reassure themselves that they are on the right track in the learning process. Kamp et al. [65] performed a study on the effectiveness of midterm peer feedback on student individual cognitive, collaborative, and motivational contributions in PBL. The experimental group that received midterm peer feedback combined with goal-setting with face-to-face discussion showed an increased amount of individual contributions in PBL. Another element of effective feedback is that the feedback is given immediately after the observed behavior. Parikh and colleagues survey student feedback in PBL environments among 103 final-year medical students in five Ontario schools, including the University of Toronto, McMaster University, Queens University, the University of Ottawa, and the University of Western Ontario. They discovered that there was a dramatic difference between McMaster University and other universities in the immediacy of feedback they practiced. Seventy percent of students at McMaster reported receiving immediate feedback in PBL, compared to less than 40 percent of students from the other universities, in which most of them received feedback within one week or several weeks after the PBL had been conducted [66]. Another study, conducted among students of the International Medical University of Kuala Lumpur examining the student expectation on feedback, discovered that immediate feedback is effective if the feedback is in written form, simple but focused on the area of improvement, and delivered by a content expert. If the feedback is delivered by a content non-expert and using a model answer, it must be supplemented with teacher dialogue sessions to clarify the feedback received [67].

Requesting feedback from peers and teachers is an important element of the PBL learning environment, enabling students to discover their learning gaps and ways to fill them. This is aligned with a study conducted by de Jong and colleagues [68], who discovered that high-performing students are more motivated to seek feedback than low-performing students. The main reason for this is because high-performing students seek feedback as a tool to learn from, whereas low-performing students do so as an academic requirement. This resulted in high-performing students collecting more feedback. A study by Bose and Gijsselaers [69] examined the factors that promote feedback-seeking behavior in medical residency. They discovered that feedback-seeking behavior can be promoted by providing residents with high-quality feedback to motivate them to ask for feedback for improvement.

By assigning an active role to students as teachers, assessors, and feedback providers, teachers give them the ownership and responsibility to craft their learning. The learner will then learn the skills to monitor and reflect on their learning to achieve academic success. Furthermore, an active role encourages students to be evaluative experts in their own learning, and promoting deep learning [70].

### Theme 3: Functional Skills

Functional skills refer to essential abilities for competently performing a task in PBL. This theme requires the student to organize and plan time for specific learning tasks, be digitally literate, use data effectively to support problem-solving, and work together efficiently to achieve agreed objectives. One of the elements in this theme is to have a schedule of learning tasks with deadlines. In a study conducted by Tadjer and colleagues [71], they discovered that setting deadlines with a restricted time period in a group activity improved students' cognitive abilities and soft skills. Although the deadline may initially cause anxiety, coping with it encourages students to become more creative and energetic in performing various learning strategies [72, 73]. Ballard et al. [74] reported that students tend to work harder to complete learning tasks if they face multiple deadlines.

The students also need to be digitally literate—i.e., able to demonstrate the use of technological devices and tools in PBL. Taradi et al. [75] discovered that incorporating technology in learning—blending web technology with PBL—removes time and place barriers in the creation of a collaborative environment. It was found that students who participated in web discussions achieved a significantly higher mean grade on a physiology final examination than those who used traditional methods. Also, the incorporation of an online platform in PBL can facilitate students to develop investigation and inquiry skills with high-level cognitive thought processes, which is crucial to successful problem-solving [76].

In PBL, students need to work collaboratively with their peers to solve problems. A study by Hidayati et al. [77] demonstrated that effective collaborative skills improve cognitive learning outcomes and problem-solving ability among students who undergo PBL integrated with digital mind maps. To ensure successful collaborative learning in PBL, professional communication among students is pertinent. Research by Zheng and Huang [78] has proven that co-regulation (i.e., warm and responsive communication that provides support to peers) improved collaborative effort and group performance among undergraduate and master's students majoring in education and psychology. This is also in line with a study by Maraj and colleagues [79], which showed the strong team interaction within the PBL group leads to a high level of team efficacy and academic self-efficacy. Moreover, strengthening communication competence, such as by developing negotiation skills among partners during discussion sessions, improves student scores [80].

PBL also includes opportunities for students to learn from each other (i.e., peer learning). A study by Maraj et al. [79] discovered that the majority of the students in their study perceived improvement in their understanding of the learned

subject when they learned from each other. Another study by Lyonga [81] documented the successful formation of cohesive group learning, where students could express and share their ideas with their friends and help each other. It was suggested that each student should be paired with a more knowledgeable student who has mastered certain learning components to promote purposeful structured learning within the group.

From this scoping review, it is clear that functional skills equip the students with abilities and knowledge needed for successful PBL. Studies have shown that strong time management skills, digital literacy, data management, and collaborative skills lead to positive academic achievement [77, 82, 83].

## Limitation of the Study

This scoping review is aimed to capture the recent effective learning behavior in problem-based learning; therefore, the literature before 2015 was not included. Without denying the importance of publication before 2015, we are relying on Okoli and Schabram [84] who highlighted the impossibility of retrieving all the published articles when conducting a literature search. Based on this ground, we decided to focus on the time frame between 2015 and 2019, which is aligned with the concepts of study maturity (i.e., the more mature the field, the higher the published articles and therefore more topics were investigated) by Kraus et al. [85]. In fact, it was noted that within this time frame, a significant number of articles have been found as relevant to PBL with the recent discovery of effective learning behavior. Nevertheless, our time frame did not include the timing of the coronavirus disease 19 (COVID-19) pandemic outbreak, which began at the end of 2019. Hence, we might miss some important elements of learning behavior that are required for the successful implementation of PBL during the COVID-19 pandemic.

Surprisingly, the results obtained from this study are also applicable for the PBL sessions administration during the COVID-19 pandemic situation as one of the functional skills identified is digital proficiency. This skill is indeed important for the successful implementation of online PBL session.

## Conclusion

This review identified the essential learning behaviors required for effective PBL in higher education and clustered them into three main themes: (i) intrinsic empowerment, (ii) entrustment, and (iii) functional skills. These learning behaviors must coexist to ensure the achievement of desired learning outcomes. In fact, the findings of this study indicated two important implications for future practice. Firstly,

the identified learning behaviors can be incorporated as functional elements in the PBL framework and implementation. Secondly, the learning behaviors change and adaption can be considered to be a new domain of formative assessment related to PBL. It is noteworthy to highlight that these learning behaviors could help in fostering the development of lifelong skills for future workplace challenges. Nevertheless, considerably more work should be carried out to design a solid guideline on how to systematically adopt the learning behaviors in PBL sessions, especially during this COVID-19 pandemic situation.

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## Declarations

**Ethics Approval** The study has received an ethical approval from the Human Research Ethics Committee of Universiti Sains Malaysia.

**Informed Consent** No informed consent required for the scoping review.

**Conflict of Interest** The authors declare no competing interests.

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