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Problem-based learning is helpful in encouraging academic institutions to strive for excellence: perceptions of Sudanese physiologists as an illustration

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Abstract

Background Problem-based learning (PBL) is a well-known teaching method which promotes self-directed learning (SDL) in many medical programs worldwide. This study aimed to examine the perceptions of Sudanese physiologists on applying PBL in teaching their physiology courses or sessions.

Methods A cross-sectional survey was conducted with 82 physiologists (70% of the total Sudanese physiologists). The data were collected using questionnaires that included questions about attitudes towards, effectiveness of, and barriers to PBL implementation. The internal reliability of the questionnaire (over 0.7) was good, as measured by Cronbach's alpha. The Mann–Whitney U test, Kruskal–Wallis test, multiple linear regression and correlation (Spearman) analysis were performed to assess various factors associated with physiologists' perceptions of the research domains.

Results Physiologists generally had a positive attitude (overall score percentage of $76.9 \pm 23.97\%$) towards PBL compared to other teaching methods and had good perceptions of the effects of PBL (overall score percentage of $77.1 \pm 25.13\%$) on the student learning process. Furthermore, physiologists had a notable knowledge gap about common challenges affecting PBL application (overall score percentage was $56.93 \pm 19.43\%$) at their relevant institutes. Physiologists' perceptions of common factors affecting PBL application were significantly related to participants currently working inside or outside Sudan (p value = 0.010) and applying PBL at their relevant institutes (p value = 0.008). In addition, the attitude score was significantly associated with the current workplace (governmental/private) classification ($B = -14.083$, $p = 0.031$). Additionally, attitude toward PBL had a significant positive correlation with age ($r = 0.233$, $p = 0.005$) and the perception score of PBL's effects on students' learning processes ($r = 0.788$, $p < 0.001$).

Conclusion In general, physiologists have good attitudes towards and perceptions of PBL's effectiveness, although they are unaware of the main challenges that PBL faces. The findings of this study can help the Federal Ministry of Higher Education make informed decisions about how to improve teaching methodology by implementing such novel approaches.

Keywords Problem-based learning, PBL, Perceptions, Attitudes, Physiologists, Higher educational institutions

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Background

Problem-based learning (PBL) is a popular teaching technique that promotes self-directed learning (SDL) in many medical programs throughout the world [1]. PBL is an educational method in which students are assigned a problem or trigger, which might take the form of a picture, statement, video, or case. They are then permitted to work together to determine their learning needs while attempting to comprehend the problem; gather, synthesise, and apply information to the problem; and begin working constructively to learn from each other and group tutors [2]. Since its establishment in 1969, PBL has been adopted by many educational institutions throughout the world, including McMaster University's Faculty of Medicine in Canada. It replaced the old methodology, which is often based on lectures, with a student-centred learning approach [3].

Previous research on the usefulness of PBL for student learning can be classified into two categories [4]. The first line of inquiry might be described as exploratory research of instructors' and students' opinions and experiences with the use and/or transition to PBL, as well as the suitability of specific study materials for PBL. These studies, which often employ qualitative research approaches and (satisfaction) questionnaire data, concentrate on the experiences of students and teachers [5–11]. As a result, these studies do not directly address the effectiveness of PBL; rather, they contribute to the overall picture of PBL by addressing attitudes and experiences that might assist users overcome potential challenges and difficulties while adopting or utilising PBL. The second line of research looked at how PBL affected the acquisition of information, skills, and competencies. These studies usually employed a comparative methodology, comparing and contrasting PBL with traditional, lecture-based curriculums. Regarding this line of research, it appears reasonable to conclude that PBL is an effective and satisfactory methodology for medical education and that graduates of PBL-enhanced curricula have certain advantages over graduates of traditional curricula (for example, knowledge, applying medical professionalism, capacity for problem-solving, communicator, graduation on time, lower drop out rates, and the ability to think critically) [12–18]. The main challenge that students face in a PBL classroom is the transfer from a familiar, old mode of learning to a new, unfamiliar methodology [19]. As a result, instructors' roles in the classroom have to change in parallel with those of their students. Overall, it is clear that external factors can provide challenges for teachers, even when they understand what is required to effect such a transition in the classroom [20].

Several Sudanese medical schools have lately begun to adopt PBL, an integrated, community-oriented curriculum approach, to increase student's knowledge and professional skills. A culture of quality is believed to propel institutes towards excellence through feedback. Multiple feedback surveys at educational institutes help to have a better understanding of institutional performance and curriculum execution. Because problem-based learning is an important component of the integrated curriculum, the stakeholders' (students and tutors) perspectives on its implementation are worth discussing. This study intended to investigate trends in Sudanese physiologists' perceptions of PBL throughout time. The study's findings help decision-makers plan, organise, and ensure the successful implementation of such an approach in the future.

Methodology

Study design and duration

This descriptive cross-sectional study was conducted between February and March 2023.

Study area, population and eligibility criteria

The study was conducted at the Sudanese Physiological Society (SPS). The SPS is the only nonprofit body for which physiologists reside in the Republic of Sudan. The SPS was established in 1994 and is a member of African Associations of Physiological Science [21].

All physiologists registered at the Sudanese Physiological Society (SPS), who are master's students, master's and PhD holders and currently on work, were included. Those who were on their annual vacation or who were taking sick leave were excluded.

Sample size and sample technique

Our study sample covered all Sudanese physiologists (117 in total, as reported by the general SPS secretary's office) who were registered with the Sudanese Physiological Society. As the anticipated sample size is less than 200, census sampling is used.

Data collection tool and procedure

In a similar study, the questionnaire was pretested and validated by seven lecturers [22]. The Cronbach's alpha test, which was used to determine the questionnaire's internal reliability, found that each questionnaire category had an internal reliability of more than 0.7, indicating that the items were appropriate for the study. Before data collection began, three medical education professors from the Master of Health Professions Education (MHPE) Board

Committee of the International University of Africa’s Faculty of Medicine evaluated and approved the questionnaire. The questionnaire has four sections. The first section includes acquiring demographic data from participants. The second section included ten items that assessed lecturers’ attitudes towards problem-based learning in comparison to other educational approaches. The third section consisted of ten statements that asked participants to rate how PBL influences students’ learning from their point of view. In the final section, participants were asked to answer five questions about common difficulties that influenced their usage of PBL at their institutes. The participants were asked to rate the items on a five-point Likert scale, with 1 indicating strongly disagree, 2 indicating disagree, 3 indicating undecided, 4 indicating agree, and 5 indicating strongly agree. The survey has been distributed via multiple emails and social media platforms in English.

Table 1 Shows the study participants demographic information

Items	Studied participants (N= 82)	
	No	%
Age		
Mean ± SD	37.97 ± 9.01	
Median (IQR)	38 (32- 42.5)	
Range	24–75	
Gender		
Male	37	45.1%
Female	45	54.9%
Educational qualification in physiology		
MBBS	8	9.8%
MSc	46	56.1%
Ph.D	27	32.9%
Post doc. Studies	1	1.2%
Current job position		
Assistant professor	15	18.3%
Associate professor	8	9.8%
Full professor	2	2.4%
Lecturer	45	54.9%
Teacher assistant	12	14.6%
Higher educational qualification in health professions education		
Diploma	1	1.2%
Higher Certificate(workshop- courses)	21	25.6%
I have not	18	22.0%
MSc	28	34.1%
Ph.D	11	13.4%
Post doc. Studies	3	3.7%

Data management and analysis

The data were analyzed using SPSS software version 25.0 (IBM Corp. SPSS Inc. Released 2017). The Shapiro-Wilk test confirmed the distribution’s normality. The qualitative data were analysed using percentages (%) and frequencies (N). The quantitative data was characterised using interquartile ranges (IQRs), means, standard deviations, medians, and ranges (minimums and maximums). The Kruskal-Wallis test was used to assess the statistical significance of differences between multiple ordinal variables. To compare categorical variables, we utilised the Mann-Whitney test. A correlation (Spearman) analysis was conducted to determine the correlation between two quantitative variables. Multiple linear regression was employed to determine the relationship between the outcome variables and one or more independent variables.

Table 2 Shows the workplace (medical school) information of the study participants

Items	Studied participants (N= 82)	
	No	%
Current workplace		
Inside Sudan	61	74.4%
Outside Sudan	21	25.6%
Current workplace classification		
Governmental	49	59.8%
Private	33	40.2%
Curriculum adopted in your current medical school		
Integrated/community based	46	56.1%
Modified traditional	15	18.3%
Traditional	15	18.3%
I do not know	6	7.3%
Does PBL applied in your current medical school		
No	32	39.0%
Yes	50	61.0%
If yes How many times per year, you are enrolled in PBL sessions (time per year)		
Mean ± SD	8.55 ± 13.2	
Median (IQR)	4 (2–10)	
Range	1–70	
When you were first time dealt with PBL		
Since you were university student	29	35.4%
When you was worked as : TA, lecturer, assistant professor, associated professor, full professor	27	32.9%
During your postgraduate study	18	22.0%
I did not deal with PBL	8	9.8%
How many years, your experience in teaching physiology courses or session using PBL		
Mean ± SD	7.27 ± 6.84	
Median (IQR)	5 (2–10)	
Range	0.25- 30	

Table 3 Participant attitudes towards PBL

		Studied participants (N = 82)			
		Frequency (N)	Percentage (%)	Mean	±SD
Physiologists attitudes toward PBL in comparison to other teaching methods					
PBL creates interest in topic	Strongly disagree	11	13.4%	3.98	± 1.34
	Undecided	8	9.8%		
	Agree	24	29.3%		
	Strongly agree	39	47.6%		
PBL makes the topic more interesting and fun	Strongly disagree	11	13.4%	3.89	± 1.33
	Disagree	1	1.2%		
	Undecided	8	9.8%		
	Agree	28	34.1%		
PBL is better than a traditional teaching method	Strongly disagree	11	13.4%	3.49	± 1.40
	Disagree	9	11.0%		
	Undecided	18	22.0%		
	Agree	17	20.7%		
PBL is an effective learning method	Strongly disagree	10	12.2%	3.89	± 1.33
	Disagree	3	3.7%		
	Undecided	8	9.8%		
	Agree	26	31.7%		
PBL encourages students' independent thinking	Strongly disagree	10	12.2%	3.95	± 1.30
	Disagree	1	1.2%		
	Undecided	8	9.8%		
	Agree	27	32.9%		
PBL is students centered learning	Strongly disagree	8	9.8%	3.94	± 1.26
	Disagree	2	2.4%		
	Undecided	13	15.9%		
	Agree	23	28.0%		
PBL is more scientific way of teaching	Strongly disagree	10	12.2%	3.62	± 1.29
	Disagree	4	4.9%		
	Undecided	17	20.7%		
	Agree	27	32.9%		
I am interested in using PBL in my courses	Strongly disagree	10	12.2%	3.80	± 1.31
	Disagree	3	3.7%		
	Undecided	10	12.2%		
	Agree	29	35.4%		
PBL facilitates interaction with peers	Strongly disagree	10	12.2%	3.99	± 1.32
	Disagree	1	1.2%		
	Undecided	8	9.8%		
	Agree	24	29.3%		
PBL encourages students to learn in context	Strongly disagree	11	13.4%	3.90	± 1.35
	Disagree	2	2.4%		
	Undecided	6	7.3%		
	Agree	28	34.1%		
Strongly agree	35	42.7%			
Attitude score				4.85	± 1.2
Attitude score percentage				76.9	± 23.97

Table 4 Participants perceptions of PBL impact on students learning processes

		Studied participants (N= 82)			
		Frequency (N)	Percentage (%)	Mean	±SD
Physiologists perceptions of PBL effects on student learning process					
PBL enhances students' understanding of the subject	Strongly disagree	12	14.6%	3.74	± 1.34
	Disagree	3	3.7%		
	Undecided	5	6.1%		
	Agree	36	43.9%		
	Strongly agree	26	31.7%		
PBL facilitates self-learning	Strongly disagree	11	13.4%	3.85	± 1.32
	Disagree	1	1.2%		
	Undecided	8	9.8%		
	Agree	31	37.8%		
	Strongly agree	31	37.8%		
PBL increases students' involvement in the learning process	Strongly disagree	12	14.6%	3.82	± 1.33
	Undecided	8	9.8%		
	Agree	33	40.2%		
	Strongly agree	29	35.4%		
PBL strengthens students intrinsic motivation	Strongly disagree	12	14.6%	3.76	± 1.35
	Disagree	1	1.2%		
	Undecided	11	13.4%		
	Agree	29	35.4%		
	Strongly agree	29	35.4%		
PBL improves students' problem solving skills	Strongly disagree	12	14.6%	3.93	± 1.37
	Undecided	7	8.5%		
	Agree	26	31.7%		
	Strongly agree	37	45.1%		
PBL helps students to identify their strengths and weaknesses	Strongly disagree	10	12.2%	3.76	± 1.31
	Disagree	3	3.7%		
	Undecided	13	15.9%		
	Agree	27	32.9%		
	Strongly agree	29	35.4%		
PBL increases students' participation in the learning activities	Strongly disagree	11	13.4%	3.87	± 1.33
	Disagree	1	1.2%		
	Undecided	9	11.0%		
	Agree	28	34.1%		
	Strongly agree	33	40.2%		
PBL enhances students' teamwork skills	Strongly disagree	11	13.4%	3.91	± 1.37
	Disagree	2	2.4%		
	Undecided	8	9.8%		
	Agree	23	28.0%		
	Strongly agree	38	46.3%		
PBL improves students' communication skills	Strongly disagree	11	13.4%	3.95	± 1.34
	Undecided	9	11.0%		
	Agree	24	29.3%		
	Strongly agree	38	46.3%		
PBL enhances students' critical thinking skills	Strongly disagree	11	13.4%	3.96	± 1.36
	Disagree	1	1.2%		
	Undecided	7	8.5%		
	Agree	24	29.3%		
	Strongly agree	39	47.6%		
PBL effects score				3.85	± 1.26
PBL effects score percentage				77.1	± 25.13

The results were assessed using a 5% significance level. The operational methodology was applied to categorise participants' perceptions of the study domains into good, moderate, and poor levels.

Operational definitions

Participants who scored above or equal to the average (80%) on domain-related questions were classified as having good perceptions on that domain.

Participants who scored between or equal to the average (60–79%) on domain-related questions were classified as having moderate perceptions on that domain.

Participants who scored equal to or below the average (59%) on domain-related questions were classified as having poor perceptions on that domain.

Results

Out of 117 physiologists, 82 agreed to participate in the study, yielding a 70% response rate.

Demographic data

With a female-to-male ratio of 1.2:1, the majority of participants were in their fourth decade of life. Over 50% of them possessed a master's degree and were employed as lecturers in the Department of Physiology. The most commonly used curriculum type was an integrated/community-based curriculum utilized by half of the participants in their PBL implementation at work. The minority group handled the PBL since they were college students and had been using PBL as a teaching strategy for a median of five years. The majority of physiologists hold advanced degrees or certificates in health professions education Tables 1 and 2.

Table 5 Participants perceptions of common challenges influencing PBL implementation in educational institutions

		Studied participants (N = 82)			
		Frequency (N)	Percentage (%)	Mean	±SD
Perceptions of common Factors affecting PBL application					
There is a large number of students in my courses	Strongly disagree	9	11.0%	3.68	± 1.38
	Disagree	10	12.2%		
	Undecided	10	12.2%		
	Agree	22	26.8%		
	Strongly agree	31	37.8%		
The infrastructure at the university does not support the use of PBL	Strongly disagree	13	15.9%	3.35	± 1.47
	Disagree	13	15.9%		
	Undecided	14	17.1%		
	Agree	16	19.5%		
	Strongly agree	26	31.7%		
I do not have the required knowledge of applying PBL	Strongly disagree	23	28.0%	2.35	± 1.21
	Disagree	29	35.4%		
	Undecided	13	15.9%		
	Agree	12	14.6%		
	Strongly agree	5	6.1%		
PBL is not applicable in my courses	Strongly disagree	22	26.8%	2.30	± 1.20
	Disagree	34	41.5%		
	Undecided	12	14.6%		
	Agree	7	8.5%		
	Strongly agree	7	8.5%		
The curriculum does not support the use of PBL	Strongly disagree	22	26.8%	2.54	± 1.34
	Disagree	25	30.5%		
	Undecided	13	15.9%		
	Agree	13	15.9%		
	Strongly agree	9	11.0%		
Perceptions of Common challenges affecting PBL application score				2.85	± 0.97
Challenges score percentage				56.93	± 19.43

Participant’s perceptions of the study domains
The physiologist’s attitude toward PBL versus other approaches

Based on their attitudes, the majority of participants firmly agreed that PBL generates interest in topics, that it is superior to traditional techniques in terms of effectiveness, that it enables students to think independently and learn for themselves and that it is a more scientific approach to teaching. Furthermore, more than two-thirds of the respondents said they would be interested in implementing PBL and thought it promoted students to learn in context and enabled engagement. The overall attitude percentage score was $76.9 \pm 23.97\%$ Table 3.

Physiologists perceptions of how PBL affects students learning process

In this domain, the majority of participants strongly agreed that PBL would improve students’ comprehension of the material, encourage self-learning, increase their level of engagement in the learning process, bolster their motivation, strengthen their ability to solve problems, assist them in identifying their strengths and weaknesses, and increase their participation in learning activities. Participants also strongly agreed that PBL would improve students’ communication, collaboration, and critical thinking abilities. This domain had an overall percentage score of $77.1 \pm 25.13\%$ Table 4.

Physiologist’s perceptions about the typical challenges influencing their application of PBL

Regarding this domain, the majority of participants firmly agreed that the primary reasons physiologists do not employ PBL in their courses are the large number of students and inadequate classroom infrastructure. Furthermore, a lower percentage of participants thought that PBL was irrelevant for their courses or that they lacked the necessary understanding to implement it. Furthermore, a far smaller percentage of respondents said that PBL was not supported by the curriculum in terms of teaching and learning activities. The total percentage score for this domain was $56.93 \pm 19.43\%$ Table 5.

Operational cutoff points

Based on the operational cutoff points, participants were categorized into three levels that corresponded to three distinct study domains. Approximately half of the participants had positive attitudes, positive perceptions of PBL effects, and poor perceptions about the common problems encountered when applying PBL at the respective institutions Fig. 1.

PBL application at the current workplace (within or outside of Sudan) and physiologists’ perceptions of common factors impacting PBL application were shown to be significantly correlated according to the results of the Mann–Whitney U test and the Kruskal–Wallis test. Table 6 The domains of attitude and perceptions of PBL’s effects on the learning process did not significantly correlate with participant characteristics ($p > 0.05$). To

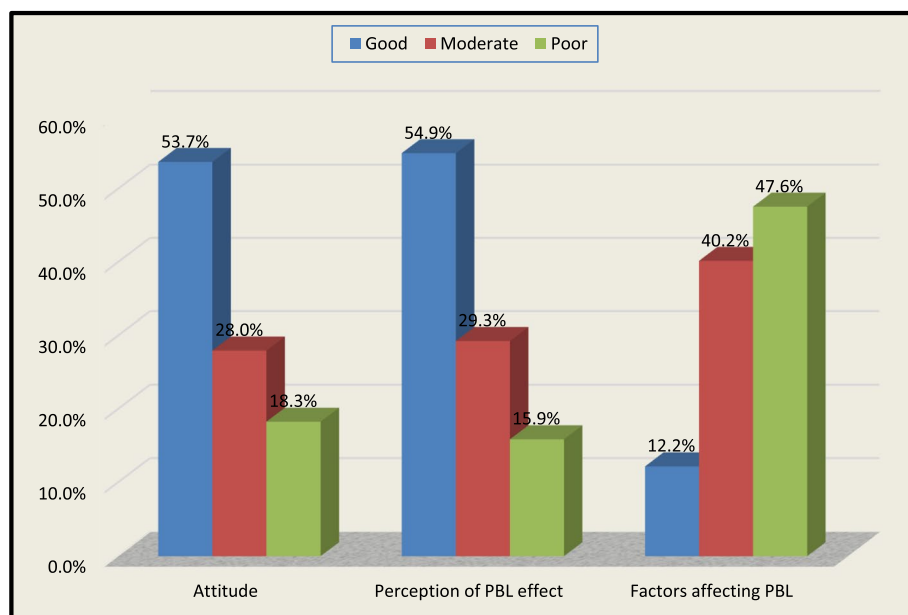


Fig. 1 Distribution of the study participants with respect to the three domain scores

Table 6 Relationships between participants characteristics and common factors affecting PBL application at their institutes

Items	Effect of PBL			P value	
	N	Mean	SD		
Gender	Male	45	2.78	0.89	0.403
	Female	37	2.92	1.07	
Educational qualification in physiology	Bachelor	8	2.70	0.59	0.402
	MSC	46	2.90	0.97	
	PHD	27	2.87	1.04	
	Post doc. Studies	1	1.00	.	
Current job position	Assistant professor	15	2.64	1.19	0.310
	Associate professor	8	3.18	1.01	
	Full professor	2	2.00	1.13	
	Lecturer	45	2.96	0.97	
	Teacher assistant	12	2.62	0.51	
Higher educational qualification in health professions education	Diploma	1	2.40	.	0.930
	Higher Certificate (workshop- courses)	21	2.76	0.98	
	I have not	18	3.08	1.11	
	MSC	28	2.81	0.95	
	PHD	11	2.80	0.97	
Current workplace (medical school)	Post doc. Studies	3	2.67	0.61	0.010
	Inside Sudan	61	3.02	0.91	
Current workplace classification	Outside Sudan	21	2.34	0.98	0.879
	Governmental	49	2.85	1.03	
Curriculum adopted in your current medical school	Private	33	2.84	0.89	0.124
	Integrated/community based	6	3.03	0.87	
Does PBL applied in your current workplace	Modified traditional	46	2.70	0.90	0.008
	Traditional	15	2.67	1.16	
	I do not know	15	3.40	0.88	
	No	32	3.19	0.92	
	Yes	50	2.62	0.94	

A P value < 0.05 was considered to indicate statistical significance, and analysis was performed with the Mann–Whitney U test and Kruskal–Wallis test

investigate how various parameters contributed to the variance in the results for the three research domains, multiple linear regression analyses were run. The attitude score and the current workplace classification (private/governmental) were strongly correlated. Additionally, the score related to common challenges affecting PBL application at relevant institutes was strongly correlated with the current workplace and the use of PBL in this workplace Table 7.

Spearman correlation analysis revealed a strong positive correlation between the participants attitude toward PBL and their age ($r = 0.233, p = 0.005$) as well as with the perception score of PBL effects on students' learning processes ($r = 0.788, p < 0.001$). Figs. 2 and 3.

Discussion

This study investigated physiologist's perspectives on problem-based learning (PBL) in comparison to other teaching methodologies, as well as how they perceive

PBL's effects on students learning processes and the challenges they faced when implementing PBL in their institutions. It also investigated whether the characteristics of the participants influenced their responses in any meaningful way.

Our study revealed that physiologists had a positive attitude towards PBL. Most believe that PBL makes topics more interesting, is superior to and more effective than traditional techniques, enables students to think and learn independently, and is a more scientific way to educate. These results were consistent with those of Van Den Bossche, P., et al., who discovered that PBL students outperformed traditional lecture-based education students in terms of performance [23]. Additionally, Mahmood, S. U., et al. found that PBL promotes higher-order thinking [24], and Katwa, J. K., et al. concluded that one of the elements of PBL—self-directed learning—helped students evolve into lifelong learners [25]. Likewise, more than two-thirds of the participants reported an interest

Table 7 Multiple linear regression analysis examining the scores of the three study domains

		Unstandardized Coefficients		Standardized Coefficients	t	P value
		B	Std. Error			
Attitudes towards PBL	Gender	-1.290	5.488	-0.027	-0.235	0.815
	Educational qualification in physiology	-8.678	8.610	-0.233	-1.008	0.317
	Current job position	-0.851	5.274	-0.033	-0.161	0.872
	Higher educational qualification in health professions education	1.196	1.979	0.077	0.604	0.548
	Current workplace	-1.978	6.750	-0.036	-0.293	0.770
	Current workplace classification	-14.083	6.388	-0.290	-2.205	0.031
	Curriculum adopted in your current workplace	-4.570	3.436	-0.158	-1.330	0.188
	Does PBL applied in your current workplace	-3.326	5.729	-0.068	-0.580	0.563
Perception of PBL effects on student learning process	Gender	-0.683	5.872	-0.014	-0.116	0.908
	Educational qualification in physiology	-3.353	9.212	-0.086	-0.364	0.717
	Current job position	-0.539	5.643	-0.020	-0.096	0.924
	Higher educational qualification in health professions education	1.044	2.118	0.064	0.493	0.624
	Current workplace	-7.379	7.223	-0.129	-1.022	0.310
	Current workplace classification	-10.941	6.835	-0.215	-1.601	0.114
	Curriculum adopted in your current workplace	-2.890	3.677	-0.095	-0.786	0.434
	Does PBL applied in your current workplace	-6.841	6.130	-0.134	-1.116	0.268
Factors affecting PBL application	Gender	-3.049	4.132	-0.079	-0.738	0.463
	Educational qualification in physiology	5.350	6.482	0.177	0.825	0.412
	Current job position	-0.179	3.971	-0.009	-0.045	0.964
	Higher educational qualification in health professions education	-2.560	1.490	-0.203	-1.718	0.090
	Current workplace	-16.797	5.082	-0.380	-3.305	0.001
	Current workplace classification	-3.493	4.809	-0.089	-0.726	0.470
	Curriculum adopted in your current workplace	-2.279	2.587	-0.097	-0.881	0.381
	Does PBL applied in your current workplace	-11.899	4.313	-0.301	-2.759	0.007

A P value < 0.05 was considered to indicate statistical significance

B Beta, t t test

in implementing PBL in their classrooms because they believed it improved student engagement and contextual learning. These findings are comparable with those of Orfan, S. N., et al., Aboonq, Ahmed, Z., and Malik, who reported that their participants had positive perceptions towards the use of PBL in various kinds of instructional and learning activities [22, 26, 27].

According to our study, the majority of physiologists were well informed about the ways in which PBL influences students' learning processes. They also held the view that PBL would improve students' comprehension of the material, encourage self-learning, boost their engagement in the process, strengthen their motivation, strengthen their ability to solve problems, assist them in identifying their strengths and weaknesses,

and increase their participation in learning activities. These results are consistent with those of Torp, L., and Sage, S., who stated that PBL fosters a learning environment in which teachers mentor students' inquiry and coach their thinking, enabling them to comprehend the material at a deeper level [28]. Additionally, Watson, G. H., discovered that PBL helps students learn new material and develop their critical thinking, reasoning, and self-evaluation abilities [29]. Furthermore, Mahmood, S. U., et al., reported that PBL increased students' motivation [24], Argaw, A. S., et al., reported that students had better problem-solving skills when taught through PBL than when taught through traditional lectures [30], and Watson, G. H. reported that PBL helps students develop their communication skills [29]. Physiologists believe that

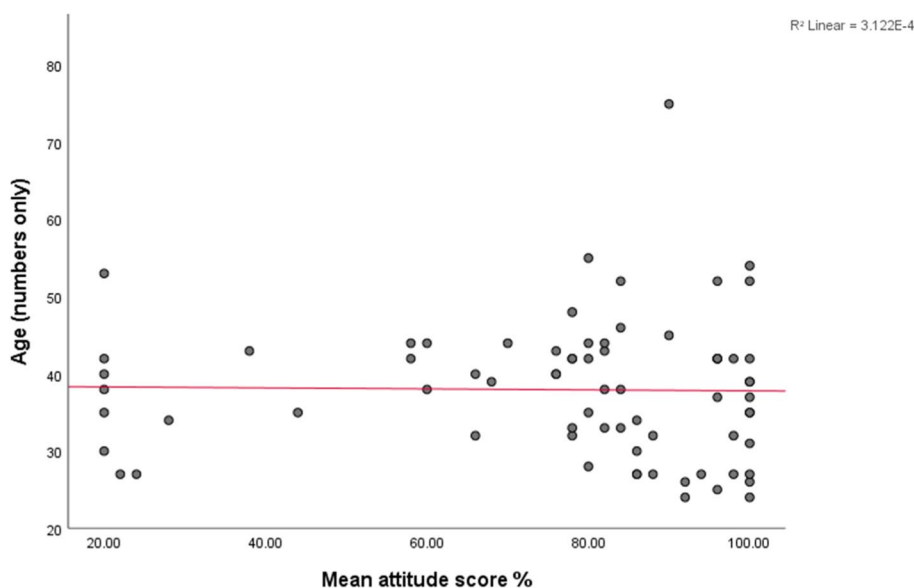


Fig. 2 A scatter plot demonstrating a positive correlation between attitudes toward PBL and age

PBL enhances students’ critical thinking, collaboration, and communication skills. These results are consistent with those of Azman, N., and Shin, L. K., who found that PBL fosters students’ ability to collaborate with others [31], and with those of Ghimire, S. R., and Bhandary, S., who found that PBL enhances generic abilities, which are important for securing future employment [32]. Additionally, research by Aziz, A., et al. and Abdelkarim, A.,

et al., documented the broad benefits of PBL for students’ learning processes [33, 34].

According to our study, a significant portion of physiologists had negative perceptions about the typical difficulties encountered when implementing PBL in their institutions. Moreover, more than 50% of them thought that the main barriers to implementing PBL in the classroom were a high student body and inadequate classroom infrastructure. These outcomes are comparable to

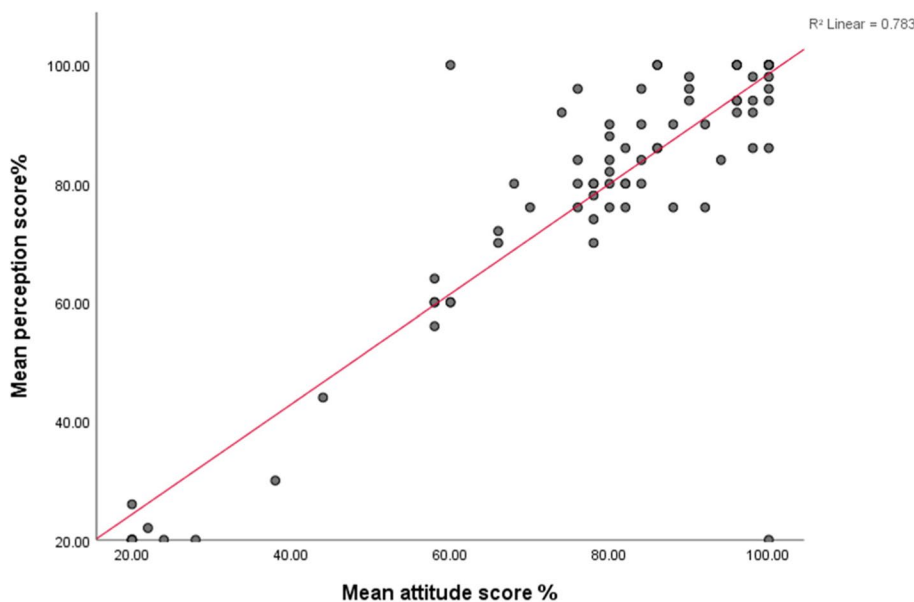


Fig. 3 Scatter plot showing the positive correlation between attitudes toward PBL and perceptions of the effects of PBL on students’ learning processes

those of Orfan, S. N., et al., who reported identical findings [22]. Furthermore, our research showed that fewer participants thought that PBL was appropriate in their courses or that they had the necessary understanding to implement it. These results contrast with those of Orfan, S. N., et al., who stated that the majority of study participants were unable to apply PBL since they were unaware of its use in courses [22]. Additionally, a far smaller percentage of physiologists thought that the use of PBL was not supported by the curriculum. This is explained by the tiny number of physiologists who felt that they lacked the necessary skills to apply PBL.

The attitudes of physiologists and their current occupation classification (governmental vs. private) were found to be significantly correlated. Additionally, the use of PBL at these workplaces and the common characteristics affecting PBL application at relevant institutes were strongly correlated with the current area of practice (inside/outside of Sudan). These results might stem from the necessity of holding more professional development activities (symposia, workshops, etc.), particularly for government employees and those working inside Sudan, who are likely to have fewer opportunities than others to engage in PBL.

This study not only shed the light on the physiologist's satisfaction with PBL over time, but it also highlighted the significance of considering tutors' and students' perspectives when implementing new curriculum changes in any educational institution globally. In reality, medical schools that foster a great culture of responding to feedback keep their curricula up to date and have satisfied stakeholders, which helps them rank among the best higher educational institutions.

Strengths, limitations, and future prospects

One of our study's advantages is that it is the first to explore how Sudanese physiologists perceive the PBL. However, our study has a few limitations. First, the study's conclusions may not be generalisable due to the limited sample size. Second, because only physiologists participated in this study, the findings may not apply to educators in other departments. Response bias and changes in perception over time are two further constraints. In the near future, professional development activities (such as extra training, workshops, and mentorship) that address often encountered challenges in the use of PBL and how to overcome them must be planned and executed. It is also recommended that future studies use a more diversified sample of physiologists from other areas and departments to increase the findings generalisability. The findings of this study may also be valuable to the Federal Ministry of Higher

Education in deciding whether to apply this unique technique to improving teaching methods.

Conclusions

The study found that physiologists had a positive attitude towards PBL in comparison to other teaching approaches and had good perceptions of its benefits on student learning. Furthermore, physiologists had experience with the common challenges that hinder PBL implementation at their respective institutions. The gender, qualifications, job position, and curriculum used by physiologists have no significant effect on their responses. As PBL has proven to be an effective educational approach for equipping students and assisting them in their future careers and employment, old and new medical schools need to develop and implement PBL-integrated curricula, as well as frequently address encountered challenges in the use of PBL and how to overcome them to ensure a quality educational process.

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Authors' contributions

Muaath A. M. contributed to conceptualization, methodology, data collection, formal analysis, and writing and editing of the initial and final manuscript. Ibrahim A. Ali contributed substantially to the study design, drafted and reviewed the initial and final manuscript, and supervised the entire study. All the authors have read and approved the final version of the manuscript.

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Data availability

Upon reasonable request, the datasets utilized and analyzed for this research can be obtained from the corresponding author.

Declarations

Ethics approval and consent to participate

All procedures performed in this study involving human participants conformed to the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards. The study was approved by The International University of Africa (IUA), Master of Health Professions Education (MHPE) Board and Educational Development Center (EDC) Ethics Committee. All participants provided informed and signed consent. Every participant had the option to leave the study at any time, and participation was entirely voluntary.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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