

The Effectiveness of Problem-based Learning in Acquisition of Knowledge, Soft Skills During Basic and Preclinical Sciences: Medical Students' Points of View

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ABSTRACT

Background: Students' opinions about their medical curriculum is essential process for evaluating program strength and weakness. Aim: We aimed to assess the benefits and effectiveness of PBL in acquisition of knowledge and soft skills during basic (Phase I) and preclinical (Phase II) sciences.

Methods: Across-sectional study was conducted at the University of Bisha, College of Medicine, Saudi Arabia. Students at Phase I and Phase II were involved. A validated self-administered questionnaire used for data collection. Responses to the questionnaire items regarding PBL benefits, preferences and effectiveness in acquisition of knowledge and soft skills were ordinal following a four-point Likert scale format. Independent and paired t tests were used to compare between the means and SD of each two variables. A p value ≤ 0.05 considered as statistically significant. **Results:** Most of students (86.3%) reported a positive perception on all the items assessing the benefits of PBL approach. Students' responses on PBL relating to the acquisition of knowledge (3.27 ± 0.46) and soft skill (3.32 ± 0.45) were high. There were no significant differences determined in the mean score and SD of acquisition of knowledge ($p=0.768$) and soft skills ($p=0.297$) between second and third year students. PBL was preferred in Phase II comparable to Phase I modules (3.371 ± 0.299 vs. 3.026 ± 0.627 ; $p=0.001$). **Conclusion:** Effectiveness of PBL found to be high and increasing after taking a series of modules. Although PBL methodology has impact in acquisition of knowledge and skills, intended program outcome should be determined to assess the effects of PBL.

Keywords: Problem-Based Learning, methods, statistics and numerical data.

1. INTRODUCTION

The number of medical schools implementing problem based learning approach has grown progressively all around the globe with many forms and strategies (1). The major educational objectives of PBL include the acquisition of relevant knowledge, skills, and behaviors rather than factual learning and use them in a clinical context (2, 3). Works through PBL strategy motivate students to think critically, generate ideas and acquire the knowledge, skills, and behavior required to become competent doctors (4, 5).

The University of Bisha, College of Medicine (UBCOM) established in 2014 with the rationale to participate in the development of health status in the Saudi Arabia. UBCOM select hybrid PBL curriculum that almost adopted by many medical school in Saudi Arabia to integrate the learning of basic sciences and clinical disciplines (6). A six-year

PBL curriculum is offered in UBCOM to the undergraduate medical students. This integrated curriculum composed of second year of basic sciences (Phase I), third and fourth years of preclinical phase (Phase II) and a clerkship in year fifth and sixth (Phase III). These are proceeding by the first year. UBCOM has recently introduced the problem PBL curriculum during Phase I and II.

Medical students are a core part to take into account for planning and assessing the value of teaching and learning methods (7). It well known that evaluation the effects of PBL approach is necessary to introduce into the medical curriculum completely (8). Numerous studies have been conducted to assess the PBL concerning acquiring knowledge, development of core competencies and attitudes (9, 10). Researches indicated that medical students' opinions about their curriculum have a substantial impact on their aca-

demographic success and can be an essential process for evaluating medical program strength and weakness (11). Since UBCOM is a new medical college implementing the PBL approach, it is important to determine the flow and the worth of this method for future improvements. Therefore, the aims of this study were to assess the benefits and effectiveness of PBL in acquisition of knowledge and soft skills during basic medical science and preclinical phases (Phase I and Phase II) from students' points of view.

2. MATERIALS AND METHODS

Study design and setting

Across-sectional study was conducted during academic year 2016-2017 at the UBCOM in Bisha province, Saudi Arabia. Every academic year, up to 40 students at UBCOM registered for MBBS program.

Phase I modules make up the first cycle of the medical curriculum in UBCOM, which is introducing the basis of medical practice in terms of basic level knowledge of human body structure and function in health and disease. It also gives an overview of the processes of diseases, the therapeutic strategies, and understanding of the ethical and cultural dimensions of contemporary medical care. Phase II helps students integrate the knowledge they have acquired during Phase I and prepare them for the subsequent Phase III. Eight modules of body organs/systems and other six modules for covering certain areas in the curriculum are introduced in Phase II.

Study subjects

The study subjects consisted of two groups of medical students. The first group was the students of the second year and were successfully completed eight modules of Phase I. This including, introduction to medicine and medical education, molecular biology and genetics, structure and function of the human body, basic biochemistry man and his environment, growth and development, behavioral science and doctoring and principle of diseases. The second group was comprised of the third-year students those were completed Phase I courses and seven modules of Phase II, including hematology, immunology, musculoskeletal system, nutrition and metabolism, gastrointestinal system, respiratory system and cardiovascular system.

Instrument and collection of data

A self-administered questionnaire was developed and used as a tool to measure specific items that met student's perception and satisfaction on PBL as an instructional method as described in the literature (11, 12). It consisted of three parts; the first part comprised of 16 items dealing with the student's perception of PBL session's benefits during Phase I and Phase II. The second part is consisting of 12 items to evaluate students' satisfaction regarding knowledge and soft skill. While the third part consisted of 15 items related students' preferences of PBL among Phase I and II modules.

The questionnaire forms were distributed among the students at the end of the academic year of 2016-2017 and were asked to return the completed questionnaire within three days. The students have been invited to indicate agreement on a four-point Likert scale to increase the chance of obtaining either a positive or negative perception of the activity. This arranged as strongly agree (4), agree (3), disagree (2) and strongly disagree (1). The higher score, the more likely

the students considered PBL approach is effective. The questionnaire items have been tested for its reliability and validity and to be sure the questions were measuring the same underlying concept prior the study.

Statistical analysis

Data entry and analysis was performed using Statistical Package for Social Science (SPSS; version 16). The frequency response of the Likert scores was calculated, the relative frequency of scores 4-3, represent a positive agreement and 2-1 scores represent disagreement with question statement. Outcome data of students' perception about PBL approach in term of acquisition of knowledge, learning process and soft skills were tabulated in the form of proportions; mean scores \pm standard deviations (SD). The independent t-test was applied to compare between second and third-year students' perception about the benefits and effectiveness of PBL. Comparison students' preference of PBL during Phase I and II modules was determined using paired t test. All p values \leq 0.05 were considered as statistically significant

Ethical approval

Ethical approval was obtained the research committee at UBCOM. Informed consent had been taken verbally from all the students before data collection. The privacy and confidentiality of the data were considered as the data were collected and manipulated anonymously.

3. RESULTS

Instrument reliability and validity

The Internal consistency (Cronbach's alpha) for the three

Statement	No. (%) of positive response 4 and/or 3 Likert scale	Mean \pm SD of student response
Stimulating to learn basic science contents	60 (89.6)	3.313 \pm 0.656
Gathering of knowledge and information	57 (85.1)	3.254 \pm 0.704
Understanding general principle	58 (86.6)	3.164 \pm 0.687
Improving learning ability	57 (85.1)	3.105 \pm 0.631
Increasing personal satisfaction and enjoyment	58 (86.6)	3.224 \pm 0.755
Promoting level of motivation	56 (83.6)	3.134 \pm 0.672
Stimulating interest in the subject	56 (83.6)	3.179 \pm 0.737
Developing interpersonal relationship	62 (92.5)	3.343 \pm 0.617
Enhancing teamwork and working in small groups behavior	60 (89.6)	3.358 \pm 0.753
Developing of students and tutor interaction	56 (83.6)	3.328 \pm 0.786
Improvement of reasoning	55 (82.1)	3.209 \pm 0.729
Increasing curiosity and acquisition of attitude	62 (92.5)	3.254 \pm 0.586
Development independent of thinking	59 (88.1)	3.358 \pm 0.690
Preparation for clinical thinking	55 (82.1)	3.179 \pm 0.796
Learn different material resources	54 (80.6)	3.105 \pm 0.819
Overall value	60 (89.6)	3.254 \pm 0.786
Mean	58 (86.3)	3.253 \pm 0.682
Maximum	62 (92.5)	4.0

Table 1. Students' perception about PBL benefits at the College of Medicine, University of Bisha, Saudi Arabia

Statement	Students perception score 1-4 Likert scale (Means ± SD)			Mean differences	95% Confidence Interval of the Difference	P value
	Overall students in Phase I and II	Year 2 students (Phase I)	Year 3 students (Phase II)			
Knowledge and learning process						
Fulfill educational objectives of the subject	3.19 ± 0.58	3.179±0.670	3.205 ± 0.522	0.027	-0.264–0.317	0.175
Understanding content knowledge of the subject	3.25 ± 0.63	3.179±0.612	3.308 ± 0.655	0.129	-0.186–0.444	0.250
Encouraging to learn in context	3.20 ± 0.73	3.250±0.752	3.179 ± 0.720	-0.071	-0.433–0.292	0.366
Enhancing retention of knowledge	3.27 ± 0.69	3.250±0.799	3.282 ± 0.605	0.032	-0.310–0.374	0.177
Participation in learning process	3.44 ± 0.63	3.357±0.488	3.512 ± 0.683	0.156	-0.146–0.457	0.110
Making the topic more interesting and fun learning	3.25 ± 0.80	3.214±0.787	3.282 ± 0.825	0.068	-0.333–0.468	0.797
Overall mean score	3.27 ± 0.46	3.200 ± 0.400	3.300 ± 0.500	-	-	0.768
Development of soft skills						
Developing of higher thinking skill of the subject	3.46 ± 0.68	3.393±0.629	3.513 ± 0.721	0.120	-0.218–0.458	0.434
Promoting of reasoning skill of the subject	3.22 ± 0.62	3.286±0.600	3.190 ± 0.644	-0.106	-0.416–0.203	0.952
Simulating of self-directed learning on the subject	3.28 ± 0.75	3.250±0.701	3.308 ± 0.800	0.058	-0.318–0.434	0.385
Promoting of problem solving skills	3.46 ± 0.61	3.321±0.612	3.564 ± 0.598	0.243	-0.056–0.541	0.960
Developing of communication skill	3.48 ± 0.59	3.500±0.509	3.461 ± 0.643	-0.038	-0.331–0.254	0.110
Encouraging collaboration in small groups	3.15 ± 0.74	3.036±1.036	3.000 ± 0.688	-0.036	-0.630–0.132	0.047
Overall mean score	3.32 ± 0.45	3.300 ± 0.400	3.300 ± 0.500	-	-	0.297

Table 2. Effectiveness of PBL approach on acquisition of knowledge and soft skills during Phase I and Phase II from medical students' points of view

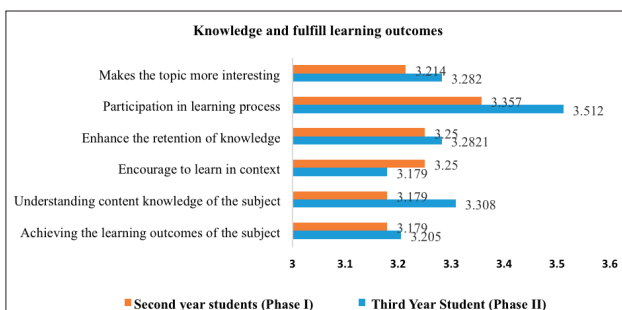


Figure 1. Comparison between second and third year students' responses (presented as mean scores) to the several items assessing the acquisition of knowledge and learning process during PBL sessions

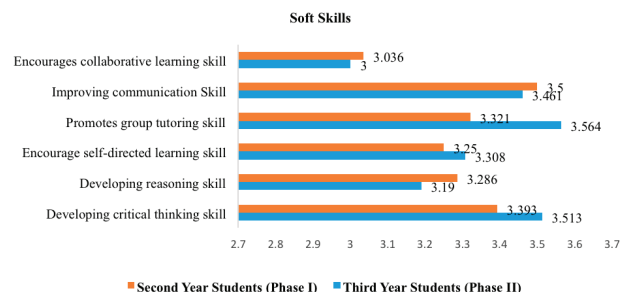


Figure 2. Comparison between second and third year students' responses (presented as mean scores) to the several items assessing development of soft skills during PBL sessions

parts of questionnaire response was; 0.880 for students' perception about PBL sessions benefits; 0.853 for acquisition of knowledge and soft skills and 0.830 for students' preferences in Phase I and II modules. Each item of the questionnaire was checked and found to have high scores.

Characterization of the study subjects

A total of 70 medical students at Phases I and II (second and third years) in UBCOM recruited for the study. Among them, 67 (95.7%) were returned a completed questionnaire. Of these 67 students, 39 were from the second year and 28 from the third year. The age of the students in both groups ranges between 19 to 23 years old. All of the students are Saudi nationality.

Table 1 demonstrates students' responses about their perceptions on the benefits of PBL approach. Overall, the majority of the students had positive perceptions of all items; the mean value of all the elements was 86.3%, with the maximum of 92.5%. As shown in Table 1, 92.5% agreed and strongly agreed that PBL promoted their curiosity, acquisition of attitude and developed their interpersonal relationship. Moreover, 89.6% perceived that PBL stimulates them to learn basic sciences contents, and promote their teamwork skills, 88.1% felt that PBL developed their independent thinking.

Table 2 demonstrates the students mean scores and SD about the effectiveness of PBL in acquisition of knowledge and soft skills. The overall students' responses on PBL pro-

cess relating to the acquisition of knowledge (3.27 ± 0.46) and soft skill (3.32 ± 0.45) were positive. There were no significant differences determined in s mean scores of knowledge (p=0.768) and soft skills (p=0.297) between second and third year students (Table 2).

Students' responses to the items assessing knowledge and soft skills

The students mean scores of each item regarding knowledge and soft skill during PBL sessions are represented in Table 2, Figures 1 and 2. Students in each group rated high scores for all the items under investigation. There were no significant differences in students' responses to the most items when comparing the mean score of the second and third year's students. However, there is a significant difference of students' response to collaborative learning. Second year students perceived that PBL is encouraging collaborative learning comparable to the third-year students (3.036±1.036 vs. 3.000 ± 0.688; p=0.047).

Third year students' preferences	Means ± STD	95% Confidence Interval of the Difference		P value
		Lower	Upper	
Phase I modules	3.0256 ± 0.627	-0.54662	-0.14349	0.001
Phase II modules	3.370 ± 0.299			

Table 3. Comparisons of third year students' preferences of PBL approach during Phase I and II modules

Students preferences of PBL during Phase I and II modules

The total mean score of students (third-year students) preferences of PBL during Phase I modules was compared to their preference in subsequent Phase II (Table 3). PBL most likely to be preferred in Phase II modules comparable to Phase I modules (3.371 ± 0.299 vs. 3.026 ± 0.627 ; $p=0.001$).

4. DISCUSSIONS

The present study investigated the perception second and third-year students about the PBL approach for teaching basic science and preclinical phases at the UBCOM. In this study, the Cronbach's alphas for all the instruments items of students' perception about the PBL were all above 0.80; hence, the questionnaire proved to be a reliable tool for this study. However, the obtained values indicate strong reliability and the questions were measuring the same underlying concepts.

In the present study, the majority (86%) of our medical students were perceived PBL to be an acceptable learning strategy. This in agreement with recent studies published on the acceptance PBL in Saudi's medical schools (13, 14). Elsewhere a study indicated that medical students valued and expressed a more positive outlook and satisfaction toward the PBL approach (15, 16). These findings with our current results give a strong evidence of the interesting perception of PBL in medical schools from the students' points of view.

In the present study, 89.6% of students' felt that PBL stimulate the learning of basic sciences contents. This encouraging rates could be compared with another report from Saudi Arabia, where 84.8% of medical students indicated that the PBL sessions were helpful in understanding basic science concepts (11). Even though there is a consensus that PBL results in the better acquisition of core and preclinical concepts (11, 14), other authors argued that PBL did not impact knowledge acquisition, but impacts the application of knowledge (17). For instance, Nanda and Manjunatha, mentioned that the amount of basic science knowledge that is sufficient to equip an undergraduate to successfully and confidently function as a medical practitioner is difficult to determine (12). Likewise, in earlier a study carried out among medical graduates of McMaster University, found that basic medical sciences are requiring more attention in the curriculum (18).

Students' opinion about PBL benefits

In this study, students were more attractive in PBL approach, felt motivated and stimulated their attention in the learning of the subject matter. It's well known that PBL creates a different teaching environment by making learning fun, motivated, enjoyable, and getting students out of the boring routine in the classroom (19). Researchers reported that the PBL sessions promote and enhance students' knowledge, enthusiasm, and motivation and enjoyable learning medicine (3, 11, 20). According to Khoshnevisas et al. students preferred PBL because of motivation boost, quality learning, knowledge retention, class attractiveness, and practical usefulness of contents (10).

Interactions and collaboration within the small group provide students with opportunities to ask questions, receive clarifications that lead to a deeper understanding of the subject matter (21). A significant number of students in this a study agreed that PBL has beneficial in the development of

teamwork skills and interpersonal relationships. This goes with numerous studies reported that the PBL was improving teamwork interpersonal skills, interaction and collaboration in small-group tutorials (11, 20, 22). In the present study, the students perceived PBL encourages them in developing curiosity, reasoning, and independent thinking. This character is significant for efficient patient care in daily practice (19). Our finding in agreement with several studies found that PBL has the potential to enhance the effectiveness of teaching and learning, particularly in developing independent thinking, curiosity and improves student interactions among each other as well as the tutor (12, 22, 23). Studies assumed that the ability of tutors to communicate informally and examining students thinking is crucial in PBL and keeping process moving (12, 24). Therefore, the training of our PBL tutors for mastering essentials PBL process, skills and attitudes may be required to deal with the PBL method.

Effectiveness of PBL in acquisition of knowledge and soft skills

Our medical students found to have positive perceptions toward implementing of PBL in the acquisition of knowledge and in the learning process (3.27 ± 0.46). Recent studies in Saudi Arabia students felt the PBL was improving the learning outcome domains, enhancing of learning abilities (8, 11). Consistent with these findings, elsewhere a study found that most of the students felt that PBL sessions were beneficial in achieving their learning objectives and allowed an in-depth understanding of the topic of learning (25). In contrary, Hartling et al. suggested that PBL does not impact knowledge acquisition; evidence for other outcomes does not provide unequivocal support for enhanced learning. Work is needed to determine the most appropriate outcome measures to capture and quantify the effects of PBL (17).

Obviously, PBL shown to develop different kinds of soft skills needed for their future clinical practice (Table 2). These findings supported by other studies. For example, Ibrahim et al. suggested that PBL provides students with better critical thinking, reasoning, team building, communication, self-directed learning, and summarization skills than do traditional lectures (8). According to Surif et al. PBL could enhance soft skills particularly, on students' motivation, communication skills, collaboration and independent learning (23). Hmelo-Silver et al. also emphasized the importance of communication skills in aiding group members "negotiate shared meaning" of information, related to the problem at hand (24).

Our finding is consistent with different studies that suggested PBL is effective in fostering students' development of higher-order thinking, appropriate problem-solving processes and skills (26, 11, 23, 27-39). Furthermore, previous a study indicated that PBL graduates rated themselves better prepared professionally than other non-PBL graduates regarding interpersonal abilities, problem-solving skills and the ability to work and plan efficiently and autonomously (2). In contrary, studies found that PBL requires much time that must be provided to solve complex problems, which lead to a lack of time available for the material/content (16, 28).

In this study significant increase in PBL students' perception concerning simulating of self-directed learning on the subject. In a previous survey, Tsou et al. stated that students in their study claimed that they were more active in learning

and had better learning skills and confidence in self-directed learning as compared with students from the lecture-based curriculum (29).

Comparison of students' mean scores regarding knowledge and soft skills

PBL found to be effective in acquisition of knowledge and soft skills among second and third-year students. However, almost most of the third-year students rated relatively higher scores for the majority of the investigated items. The possible explanation for that could be due to the third-year students have become more experienced with PBL process and long experience of a student-centered educational context. In a study conducted in interdisciplinary biotechnology courses Steck et al. (2012) found that the students' mean report of their content knowledge improved after taking this series of courses, but problem-solving strategies and critical-thinking skills did not statistically improve. These are in disagreement with a recent a study found that PBL did not show the expected increase depth in learning approaches over the program years (31).

5. CONCLUSION

PBL was a useful educational methodology and had several learning benefits from students' points of view. Effectiveness of PBL found to be increased according to students' experience and after taking a series of modules. Although PBL methodology has impact in acquisition of knowledge and soft skills, intended program should be determined to capture and evaluate the effects of PBL. PBL being active in soft skills improvement, therefore, the training of tutors for mastering essentials process, skills and attitudes may be required to deal with this method effectively.

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