

Effectiveness of Problem-Based Learning on the Performance of Pre-Clinical Dentistry Students in their Removable Partial Denture Design and Wax Patterns

RESEARCH ARTICLE

Stephanie Charleine Saxton HernandezPh.d. Science Education, Virgen Milagrosa
University Foundation Inc., San Carlos
Pangasinan, Philippines
scsaxton@e.ubaguio.edu
ORCID: 0009-0004-1366-2844

Abstract

Teaching in the 21st century is both exciting and challenging. The changing roles of teachers and changing characteristics of learners in this age of globalization makes it imperative for teachers to respond to the challenges of the times especially with regards to instruction. This study determines the effectiveness of the constructivist problem-based learning approach on the performance of pre-clinical Dentistry students in the course, Removable Partial Denture. The study utilized the experimental research method using the two-group research design. A total of 17 participants, with eight assigned to a control group using traditional instruction, and nine to the experimental group receiving PBL intervention. Preliminary assessment revealed low mastery for both groups, with mean scores of 12.50 (fair) in the control group and 20.55 (good) in the experimental group. After intervention, the achievement assessment scores improved to 19.37 (good) for control and 29.00 (very good) for experimental participants. T-test analyses found no significant difference between groups at pre-assessment ($t = 1.03$, $p > .05$), but a statistically significant advantage for the experimental group following PBL ($t = 2.67$, $p < .05$). The assessment rubric used demonstrated very high reliability (Cronbach's $\alpha = 0.933$) Comparison of the preliminary assessment and achievement assessment scores of the two groups was done to determine the effectiveness of the problem-based learning approach. The level of performance of the RPD students in the preliminary assessment reflects that the students have not fully mastered the principles and skills needed in designing and wax pattern fabrication. The level of performance of the RPD students in the achievement assessment reflects that the RPD students, particularly the experimental group have attained mastery of the principles and skills needed in designing and wax pattern fabrication. The problem-based learning intervention worked well in improving the level of performance of the experimental group. This concludes that Problem-Based Learning (PBL) is an effective teaching-learning strategy in the Dentistry education. Key limitations of the study include small sample size, the single institution setting, and the focus exclusively on pre-clinical laboratory outcomes rather than clinical skills or long-term learning retention.

Corresponding Author: Dr. Stephanie S. Hernandez
School of Dentistry, University of Baguio,
Baguio City, Philippines
scsaxton@e.ubaguio.edu

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INTRODUCTION

Teaching in the 21st century is exciting yet, it is full of challenges. The globalization age brought many

changes. The varying roles of instructors together with the increase in demands and expectations of society and policy makers require a high-quality education for teachers and growth in the realms of

professional development. Since teaching is a practical activity, efficient problem-solving skill is one of the fundamental competencies that teachers need to possess.

This study discusses how Problem-Based Learning (PBL) can help improve the performance of pre-clinical students of dentistry, in designing and manufacturing removable partial dentures (RPD) and wax patterns. As technologies have been widely implemented in the education sector, as student needs become increasingly more varied, and demand an increased level of technological capability, the traditional means of teaching are becoming decreasingly effective in ensuring student engagement and mastery. In dentistry, especially, there are special problems, such as recurrent failures with ill-fitting denture frameworks commonly associated with lapses in practical laboratory competence. It is in this landscape that teachers are encouraged to embrace student-centered teaching and learning strategies that develop self-regulated, and independent learners who can solve real-world issues. The study also addresses PBL as a constructivist approach to learning that is student-centered and encourages group learning, critical thinking, and concept application. Comparing the performance of students that have been exposed to conventional teaching with the performance of students taking part in the PBL motivated laboratory sessions, the study will contribute to empirical research on what teaching methods are the most effective in developing the necessary professional skills of future dental practitioners. Finally, the results will inform the existing debate on best practices in dental education and reflect the possible value of incorporating PBL into pre-clinical programmes.

Problem-based learning (PBL) has gained more and more prominence in medical and dental education. It is mainly aimed at developing critical problem-solving, collaborative learning, self-direction, communication and the work competency needed by the twenty first century learners (Jaganathan et al., 2024). Unlike conventional lecture-based approaches to the curriculum, PBL places students in real-life case situations and encourages the construction of knowledge in groups, which has now become quite a common practice in dental faculties around the globe (Barrows & Tamblyn, 1980; Trullàs et al., 2022). Recent studies have shown that students who are exposed to PBL perform better than others in clinical reasoning, teamwork, and the retention of core concepts. Most studies also indicate that PBL not only excels in knowledge retention, but also lifelong learning and reflective practice than conventional

didactic teaching (Strobel & van Barneveld, 2009; Trullàs et al., 2022).

In the field of dentistry, specifically in the area of prosthodontics and teaching removable partial denture (RPD) design, PBL and other forms of interactive pedagogy including computer-assisted instruction and near-peer teaching have shown statistically significant improvements in the learning outcomes of students (Trullàs et al., 2022; Jaganathan et al., 2020). These strategies will allow the learners to set personal learning goals, use the knowledge in the context of complex situations and develop psychomotor and cognitive skills needed in the work of a dentist (Neufeld & Barrows, 1974; Mayer et al., 1972). In addition, recent meta-analyses endorse that student-focused learning interventions, including PBL and team-based learning, are also highly linked to high performance in terms of academic outcome, clinical skills development, and self-efficacy (Strobel & van Barneveld, 2009; Trullàs et al., 2022).

Students are also unanimously satisfied with PBL, which is due to their increased involvement, inspiration, and the development of practical skills. This preference is recorded in various study of questionnaires in a variety of cultural and institutional conditions (Jaganathan et al., 2020). Although tutors and administrators continue to face challenges especially related to adaptation of roles and infrastructural requirements, the empirical support of PBL is not only strong and growing.

Overall, the published literature after 2022 indicates the general agreement about the advantages of PBL and similar student-centered methods in dental learning. These approaches boost the retention of knowledge, RPD design expertise, and readiness to practice autonomously. As a result, they are becoming widely accepted as best practice towards academic excellence and professional flexibility in dental students (Trullàs et al., 2022; Strobel & van Barneveld, 2009; Jaganathan et al., 2024).

Dentistry now faces immense challenges, among which the most reviewed problem faced is related to ill-fitting metallic frameworks which are generally caused by the poor and unacceptable laboratory works, improper impression registration, or ridge changes following denture installation (Abdelfattah, 2019). By practicing students to be at the center of their learning, they become more responsible for their gains in knowledge and are often encouraged to use their individual curiosity to help resolve everyday problems. By adapting student-centered learning, students are pushed to become more independent and

form a style of learning they can use throughout their practice.

In view of the transition of the education system, there is a need to take a closer look at teacher-learner relationships, curriculum, instruction, learner grouping, and evaluation. Relationships between the clinical instructor and learners are more collaborative. The curriculum focuses more on themes, provides hands-on experiences, and incorporates diverse viewpoints. Instruction allows for a broad range of learning preferences that are built from learners' strengths, interests, and experiences, and is participatory. Grouping is not tracked by perceptions of ability but rather promotes cooperation, a shared responsibility, and a sense of belonging. Evaluation considers multiple intelligence, uses authentic assessments, and fosters self-reflection (Arends, 2012). With the students being exposed to new technologies and other learning portals, their attention and patience for traditional way of teaching tends to be shorter and they lack interest in learning in the classrooms.

In Dentistry, the subject Prosthodontics 2 or Removable Partial Denture, is an outcome-based subject wherein students are expected to produce wax patterns and RPD designs appropriate for cases that are given to them. For the past semesters traditional teaching methods were utilized to teach this subject. Lectures were conducted followed by laboratory activities, where students would accomplish the objectives on their activity paper individually. To further facilitate and enhance the student's learning with regards to RPD designing and wax pattern fabrication, problem-based approach may be applied in their classes. Problem-based learning (PBL) is a term used to describe a constructivist approach to learning in which students are assigned into small groups and would schedule several meetings and discussions to work on a specific task or problem. It is believed that adults learn more effectively when joined into small groups and are focused on solving a problem or accomplishing a task (Arends, 2012). As a developing instructional approach, PBL is somewhat changing the dental education landscape by offering students a more valuable learning experience, allowing them to apply their individual professional knowledge and skills to a specific clinical issue while collaborating with their classmates and outlining a framework of information that can serve as a foundation for acquiring new knowledge and insights (Feroz et al., 2019). The studies conducted using Problem-based learning in the field of Dentistry focus mainly on the clinical aspect of the course where they apply the approach

on their clinical rotations. This study aimed to focus on improving the skills of pre-clinical Dentistry students specifically on their RPD designing and wax pattern fabrication before they reach clinical years.

A study on the effect of problem-solving methods on science teacher trainees for the solution of environmental problems was conducted by Dođru (2011). The findings revealed that problem solving methods improve the scientific operation skills of the science teacher trainees. The impact of Problem-Based Learning on a pre-university geography class was the focus of a study conducted by Yeung (2010). It was found that students could analyze problem statements and present their understanding systematically.

Theoretical Framework of the Study

Constructivism

One of the student-centered learning theories that gained prominence in the twenty first century is constructivism. This theory encourages students to learn in an active and constructive process, and they would construct their subjective representation of their objective reality.

Student-centered models of teaching and learning hinge on the Theory of Constructivism. As educators begin to seek a more student-centered instructional model, they tend to be drawn towards the "social constructivist" camp (Pelech & Pieper, 2010).

The constructivist perspective holds that learning is a social and cultural activity, that knowledge is somewhat personal, and that learners construct meaning through interaction with others (Arends, 2012).

The tenets of constructivism are as follows (Orlich et al., 2010); Learning is dependent on the prior conceptions the learner brings to the experience; He must construct his own meaning and his learning is contextual; Learning is dependent on the shared understandings learners gain by working with one another and effective teaching involves understanding students' existing knowledge and providing appropriate activities to assist them. The teachers can also utilize one or more key strategies to facilitate gaining new knowledge, depending on the compatibility with student's understanding and conceptualization.

Greater emphasis should be placed on "learning how to learn" than on accumulating facts. In the constructivist model, learners and teachers learn from

each other. The teacher is not perceived as the sole authority; rather the teacher facilitates learning, guiding and supporting learners' own construction of knowledge.

Significance of the Study

The research provides multiple valuable contributions to students, educators, institutions, policy makers, and the researcher, which helps to develop dental education and pedagogical methods.

The benefits taken through this research study on the applicability of Problem-Based Learning (PBL) to the performance of pre-clinical dentistry students are myriad and useful to various parties. The research makes it clear to the community of interest in this instance: dental students and educators, that the PBL method leads to a significantly greater mastery level and ability in Removable Partial Denture (RPD) design and wax pattern creation, in comparison to the traditional teaching method. PBL helps students to develop critical thinking and practical skills that are vital to clinical success by promoting more active, collaborative and self-directed learning. This will not only be beneficial to the students in their academic life but also make them more worthy of professional practice in future.

The findings of this study would also benefit decision makers and policy makers in dental education. The strong evidence on the effectiveness of PBL warrants a shift to more student-centered, outcome-oriented curricula in response to the worldwide demands of quality, accountability, and innovation in postsecondary education. Those schools that embrace PBL as an additional or alternative instructional modality can position themselves as pioneers of academic excellence, better equipped to send their graduates into the realities of contemporary dental practice, and they can also facilitate lifelong learning among faculty members.

At the organizational level, this study can highlight that incorporating PBL into the laboratory and pre-clinical courses is worthwhile. This enhances student involvement and achievement and institutional work to promote dynamic and productive learning conditions in line with best practices in pedagogy. To researchers and organizational members, a study like this would offer them a chance to grow professionally through making relevant and evidence-based

recommendations to curriculum development and teaching, by promoting further collaboration in the academic community, and by creating a culture of research and innovation in the institution. All of these are definite approvals of the attentional relevance of the research-based educational modification that will respond to the evolving requirements of the learners, trainers, and the profession of dentistry.

Objectives of the Study

This research aimed to assess the usefulness of problem-based learning as a way of improving the academic performance of pre-clinical Dentistry students undertaking the Removable Partial Denture course. In particular, the study will tend to compare the degree of performance in the field of RPD designing and wax pattern fabrication between the group of students, who are subjected to the problem-based learning (experimental group) and the one which is instructed in accordance with the traditional approaches (control group). The research analyses the student outcomes based on both preliminary assessment and the achievement assessment and gives insight into any deviation in student outcomes that can be attributed to the instructional method. The investigation also aims to find the answer to the question whether there is a significant statistical difference between the experimental and the control groups in both stages of the experiment and therefore the possible effect of problem-based learning on the abilities and knowledge acquisition during dental education.

METHODOLOGY

The research design used was experimental one with two separate groups taking part in the study: a control group and experimental group. The respondents were preclinical dentistry students taking Prosthodontics 2 in the University of Baguio, in the 2019-2020 academic year. A total enumeration method of sampling was used, totaling to 17 students enrolled in the course. The students who had already taken the subject were excluded.

The students were first exposed to traditional learning that was based on lectures and covered the basics of Removable Partial Denture (RPD) design and the wax pattern creation. In the laboratory part, students

were grouped according to their academic performance determined as very good, good, fair, poor. Then they were randomly selected to the control and experimental group to achieve balanced representation and minimize the possibility of bias.

The control group consisted of eight students. These participants were subjected to the normal laboratory methodology of teaching, where they were provided with instructor-led explanations, handouts and demonstrations. They did the activity alone in a separate room without consulting their peers, and they handed in their work after two hours of time were over to be graded. There were nine students in the experimental group. The approach used by this group was problem-based learning (PBL) and based on the IDEAL model (Identify, Define, Explore, Act, Look). The experimental group worked in groups of three to design and make their RPD structures and wax patterns. They were allowed to talk over case scenarios together and presented their products after two hours.

Validated rubrics were used to assess their completed products and the reliability was established as 0.933 Cronbach. The approach focused on equal distribution of academic potential, systematic comparison between the two teaching procedures and high rates of ethical principles, such as informed consent and anonymity of findings.

Study Design

This study utilized experimental research design to compare the pre-assessment and achievement assessment performance of the control group and the experimental group and to determine the effectiveness of the problem-based learning intervention applied during their laboratory activity to the experimental group.

Sample/Population of the Study

A total enumeration of the Pre-clinical Dentistry students at University of Baguio, enrolled in the subject Prosthodontics 2 during the A.Y. 2019-2020 were the respondents of the study. This population was chosen in order to prepare the students to properly accomplish the activity before their clinical level, in which RPD is one of their major requirements for their clinics. Students who took the subject before the said academic year were excluded.

A total of 17 preclinical dentistry students participated in the study, and who were then exposed to traditional teaching for the lecture on the basic principles of designing and wax pattern fabrication.

They were divided into experimental and control groups for their laboratory activity. The students were categorized to very good, good, fair, and poor depending on their previous grades. A random selection was made later to distribute them between the experimental and control groups to ensure the distribution was equal and without bias.

Data Gathering Tools

Dentulous casts and a specific RPD case were given to the participants. The participants were required to fabricate a design for that specific case and use assembly/pattern waxes for their wax pattern.

After the design and wax pattern were fabricated, the finished product was checked and graded using the rubrics provided. The rubric underwent tool validation and calibration to establish its validity. The research tool has obtained a reliability-coefficient of 0.933 interpreted as very highly reliable.

Data Gathering Procedures

The researcher sought permission from the Dean and Program Chair before the conduct of the study. The consent from the participants was obtained before the experiment.

The data were gathered during the laboratory period of the subject during their wax pattern activity. All the principles and rationale of RPD designing and wax pattern fabrication were discussed during the lecture to ensure that the students understood their expected output for the laboratory activity.

The wax patterns were done by the students for two hours to adapt with the board examination practice. Then the activity output was graded based on the rubric provided.

In the **control group**, the participants were exposed to the traditional teaching method practiced for laboratory activities such as the instructor provided the activity sheets and handouts, discussed the procedure, and demonstrated the activity. Then, they were assigned to a different room to ensure separation from the experimental group. Also, the participants individually performed their own activity, decided on their own design for the given case, and fabricated a wax pattern. They were encouraged to work independently and to ask only from the instructor for any clarifications. They were only given for two hours to complete their output for grading and evaluation.

For the **experimental group**, the participants were exposed to problem-based learning approach for their

laboratory activity as a supplement from the traditional teaching method used in their lecture class. They were grouped to comprise three members in each group. The steps based on IDEAL model was discussed to them before they were assigned to a case, to design a framework, and to fabricate a wax pattern together. They were allowed to brainstorm and collaborate can discuss as a group and confer with each other while doing their outputs. After two hours, their outputs were collected for evaluation and grading.

The Bransford and Stein’s IDEAL model was adopted for this study because the steps were applicable for the RPD designing and wax pattern fabrication.

Treatment of Data

The rubric used in the study covers both the designing and wax pattern activity. Checkers under prosthodontic department indicated the total scores of both the designing and wax pattern activities to be categorized as follows:

Score Scale	Level	Description
29-39	Very Good / Very High	Has extensive mastery of the principles and skills of designing and wax pattern fabrication
19-28	Good / High	Has moderate mastery of the principles and skills of designing and wax pattern fabrication.
9-18	Fair / Low	Has minimal mastery of the principles and skills of designing and wax pattern fabrication.
1-8	Poor / Very Low	Has no mastery of the principles and skills of designing and wax pattern fabrication.

To determine the effectiveness of PBL approach in the fabrication of wax patterns of pre-clinical dentistry students, assessment scores of each activity/wax pattern were compared with the achievement assessment scores. The t-test for dependent samples was used to determine the significant difference between the preliminary assessment and achievement assessment scores.

Ethical Considerations

Before the conduct of the study, a permission was obtained from the dean, the program chair, and the other faculty members concerned for the calibration of the rubrics, utilization of the rooms, rubrics and laboratory classes.

Consent forms were obtained from the students informing them about the purpose of the study, and the benefits they may gain from their participation. Only the students who agreed to participate were

included in the study, and they may withdraw at any time should they be uncomfortable during the duration of the experiment. Numbers were assigned to the students to provide confidentiality, and their scores were utilized as part of the study have no bearing on their grades. The overall result of the study will be disseminated to the class to inform them about the effectiveness of the problem-based learning on their performance. Furthermore, the researcher, as a faculty of the School of Dentistry and also the instructor of the participants did not manipulate the results, participants and any aspect of this study for her own benefit.

RESULTS AND DISCUSSION

Problem-based learning maximizes learning efficiency through in-depth strategies on how to approach a given problem and promotes collaboration among peers. The results of the research determined the effectiveness of problem-based learning on the performance of dentistry students in RPD designing and fabrication of wax pattern.

Level of Performance of Control Group in the Pre-test

Table 1 presents the level of performance of the control group in the preliminary assessment. The control group performed as follows: Very good, 00.00 percent; good, 25.00 percent; fair, 37.50 percent; and poor, 37.50 percent. As seen in the data, a greater percentage of the control group performed fairly and poorly in the preliminary assessment. The group mean is 12.50, interpreted as fair. This means that the students had minimal mastery of the skills needed in Removable Partial Denture designing and wax pattern fabrication.

Removable Partial Denture designing and wax pattern fabrication involves dexterity and skill. Skill development is achieved through mastery learning. In traditional classrooms where teachers focus more on what they, as teachers do rather than on what students can do, students tend to be passive and work in a trial-and-error method. They do not take responsibility for their own learning which is discussed in the study of Darsih (2018). The control group performed fairly in the preliminary assessment. This is an indication that mastery learning on the preparation of removable partial denture was not attained.

Table 1. *Level of Performance in RPD of the Control Group in the Preliminary Assessment*

Score scale	Number of Students	Level of Performance
29-39	0	Very Good

19-28	2	Good
9-18	3	Fair
1-8	3	Poor
Total	8	
Mean	12.50	Fair

Level of Performance of the Experimental Group in the Pre-test

The experimental group performed as follows: Very good, 44.45 percent; good, 11.11 percent; fair, 22.22 percent; and poor, 22.22 percent. As noted, a greater percentage of the experimental group performed at the level of good to very good during the preliminary assessment. The group mean is 20.55, interpreted as good. This means that the students had moderate mastery of the skills needed in designing and wax pattern fabrication. The moderate (good) level of performance of the experimental group signifies that they have signs of being self-directed learners and have self-confidence in doing their tasks. When the learner is self-directed, they exude power in their learning according to the study by Weimer (2012).

Level of Performance of Control Group in the Post-test

The control group performed as follows: Very Good, 25.00 percent; good, 37.50 percent; fair, 12.50 percent; poor, 25.00 percent. A greater percentage of the control group performed at the level of good in the achievement assessment. The group mean is 19.37, interpreted as good. This means that the performance of the control group improved from fair level to good level in the achievement assessment. The result of the achievement assessment signifies that the control group had achieved moderate mastery of the skills needed in designing and wax pattern fabrication. The slight improvement in their level of performance from fair to good shows that they profited from the lectures on RPD designing to a certain extent but not very much. This was shown in the study of Moreno-Lopez et al. (2009) who compared problem-based learning versus the lecture method on a course in Dentistry.

Level of Performance of Experimental Group in the Post-test

The experimental group performed as follows: Very good, 44.44 percent; good, 55.56 percent; fair, 00.00; and poor, 00.00. The group mean is 29.00, interpreted as very good, as noted in the data, the experimental group registered very remarkable improvement in mean scores; from good in the preliminary assessment to very good in the achievement assessment. This increase in level of performance is

attributed to the problem-based learning (PBL) as intervention, to which the experimental group was exposed. A critical review was conducted by Alrahlah (2016) show that students in PBL courses exhibit superior professional skills and effective learning compared with those using traditional approaches.

Comparison of Level of Performance of Control Group and Experimental Group in the Pre-test

The control group had fair level of performance while the experimental group had good level of performance. The computed t-ratio of 1.03 is less than the tabled T-value of 1.740 at .05 level of significance.

This means that there is no significant difference in the performance of the control group and experimental group even if the control group registered fair level and the experimental group is at level of good. The difference in mean score is slight and not significant. This further implies that the performance of students in both groups on the preliminary assessment is almost the same, basing it from the mean score. Both groups have the same grasp and knowledge of the basic principles about RPD designing and wax pattern fabrication.

Table 2. *Comparison of Level of Performance of Control Group and Experimental Group in the Pre-test*

Group	M	SD
Control Group	18.20	10.77
Experimental Group	20.55	12.29
Difference	2.35	
t _{.05} =1.740	t-ratio=1.03	
Decision: Accept Ho		

Comparison of Level of Performance of Control Group and Experimental Group in the Post-test

The control group registered good level of performance while the experimental group had very good level of performance. Evidently, the experimental group performed better than the control group. The computed t-ratio of 2.67 is greater than the tabled t-value of 1.753 at .05 level of significance. This means that there is a significant difference in the performance of the control group and the experimental group in the achievement assessment, obviously, the experimented group, which was exposed to the problem-based learning approach, registered higher gains in the achievement assessment than the control group.

Table 3. *Comparison of Level of Performance of Control Group and Experimental Group in the Post-test*

Group	M	SD
Control Group	19.37	11.10

Experimental Group	29.00	12.59
Difference	9.63	
t.05=1.753	t-ratio= 2.67	
Decision: Reject Ho		

Comparison of the Pre-test and Post-test Performance of the Control Group

The computed t-ratio of 0.60 is less than the tabled T-value of 1.74 at .05 level of significance. This means that there is no significant difference in the performance of the control group between the preliminary assessment and the achievement assessment.

This implies that traditional method of teaching is somewhat less effective to the students today. As Aud et al. (2013) pointed out that higher education is in a state of change, and as such it is imperative for higher education institutions to strive to meet current demands for quality and sustainability.

Table 4. *Comparison of the Pre-test and Post-test Performance of the Control Group*

Assessment	M	SD
Preliminary Assessment	18.20	10.77
Achievement Assessment	19.37	11.10
Difference	1.17	
t.05= 1.74	t-ratio= 0.60	
Decision: Accept Ho		

Comparison of the Preliminary and Achievement Performance of the Experimental Group.

The computed t-ratio of 7.10 is greater than the tabled t-value of 1.74 at .05 level of significance. In this case, the null hypothesis is rejected. Significant gains are noted in the students' scores in the achievement assessment as compared to the preliminary assessment. This means that there is a significant difference in the preliminary and achievement assessment performance of the students. This corroborates with the study conducted by Alrahlah (2016) regarding the use of PBL in dental education. Results show that students in PBL courses exhibit superior professional skills and effective learning compared with those using traditional approaches. The study by Nerali et al. (2020) confirms that PBL is one of the most comprehensive and student-centered tools for teaching and learning health education. This tool helps students "define the problem, establish learning objectives, self-directed learning, and also facilitate understanding of the problems." In Kumar and Natrajan (2007), problem-based learning developed higher order thinking skills among the students. Likewise, Moreno-Lopez et al. (2009) compared problem-based learning versus lectures on a course on Dentistry. They concluded that PBL is a teaching learning strategy that improves

students' academic performance. Other researchers that confirmed the effectiveness of the PBL teaching strategy are Tsai et al. (2013); Yeung (2010); Dogru (2011); Sungur et al. (2006), and Neo and Neo (2001). Dental schools in Saudi Arabia also employ PBL as a central focus to provide relevance to topics covered in lectures, seminars, and laboratory course (Rahman, 2011).

Table 5. *Comparison of the Preliminary and Achievement Performance of the Experimental Group.*

GROUP	M	SD
Preliminary Assessment	20.55	12.29
Achievement Assessment	29.00	12.59
Difference	8.45	
t.05=1.74	t-ratio= 7.10	
Decision: Reject Ho		

The level of performance of the RPD students in the preliminary assessment reflects that the students have not fully mastered the principles and skills needed in designing and wax pattern fabrication and that traditional lecture teaching needs to be supplemented. The level of performance of the RPD students in the achievement assessment reflects that the RPD students, particularly the experimental group have attained mastery of the principles and skills needed in designing and wax pattern fabrication.

CONCLUSION AND RECOMMENDATION

This research concludes that Problem-based learning (PBL) is very effective in enhancing the performance and mastery of skills to dentistry students in laboratory training topics like design and wax pattern fabrication. The results indicate that there is a large gap between the results of students who were subjected to PBL and those whose results were taught through the traditional lecture approach, as the PBL group achieved scores of very good performances, and the lecture-only group made only moderate improvements. This shows that PBL does not only improve higher-order thinking and self-directed learning in students, but also their professional growth and involvement in the profession of dentistry.

Based on these results, the recommendations include integrating PBL as an additional tool to be applied to traditional lectures in dentistry laboratory classes and integrated into the curriculum of pre-clinical subjects. To further increase the benefits, faculty should be trained in PBL methods and the methodology should be encouraged and popularized into clinical specialties to train future clinicians. Further, it is recommended that future studies need to explore the relationship between PBL and other learning outcomes in different fields of dentistry, and how to perfect teaching methods of lab-based subjects. The

recommendations facilitate the development of dental education and offer a good basis of journal publication.

Declaration of Generative AI use in the Writing Process

During the preparation of this work, the author(s) utilized ChatGPT to assist with generating initial drafts, refining structure, checking grammar, or enhancing clarity. The content generated by the tool was carefully reviewed, edited, and validated by the author. The author accepts full responsibility for the accuracy, originality, and integrity of the final manuscript.

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