Novelty Journals

ISSN 2394-9686

International Journal of Novel Research in Education and Learning
Vol. 8, Issue 3, pp: (32-39), Month: May - June 2021, Available at: www.noveltyjournals.com

Effect of Individual Active Learning Prior Problem Solving Versus Afterword Problem Solving on Student Achievement in College of Medicine, Riyadh

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Abstract: **Problem-Based Learning (PBL) is an approach to learning and instruction in medicine that confronts students with a problem, before they engage in self-directed learning to solve this problem. It is assumed that having to think about a problem first, facilitates understanding of new information about that problem. Some students need to have a direct instruction about a topic before they learn it, this is because of cognitive load of working memory will be lower if students first master principles and facts. While in PBL, presenting the problem first, is therefore, in their view is less efficient and not befit the student learning outcome. In PBL studies showed that students learn new information is less effective than having problems presented after that information is studied as happens in cognitive load studies. Therefore, this study aimed to compare two group of students either analysing problems before studying a relevant text, or analysing the problems after studying the text.**

Methods. An experimental study conducted at a King Saud bin Abdulaziz University for health sciences (KSAU-HS) in medical college. Third-year medical students were randomly allocated to three-task (diagnostic task; learning activity; test) by following a structured reflection procedure (prior solving problem group) or (after problem solving group). The participants received the same study material on the diagnosis of jaundice. This study focused on comparing between the two groups based on their learning achievements through a knowledge test.

Results: There was a significant effect of experimental condition on students' engagement in the learning activity and on learning outcomes. The study also included situational interest was significantly higher in PBL group than TBL group (mean = 3.8, standard deviation =0.64 versus (mean=3.4 standard deviation = 0.94). There was a significant differences emerged in age, t (33). p = 0.05. Other variable shows no significant differences on gender p = 0.78. there was no significant value on the studying year in medical school students p=0.60.

Conclusion. Problem solving using a clinical case for medical students increase students' interest may therefore concerned as a useful tool for teaching possibly both with simulated and real scenarios, to motivate their students and help them expand their knowledge.

Keywords: **Medical Students, PBL, Participations, Active learning.**

1. INTRODUCTION

Active learning is defined as any instructional methods that engages students in the learning process (1). In short, active learning requires students to do meaningful learning activities and think what they are doing. The core elements of active learning are often contrasted to the traditional lecture where students passively received information from instructor. According to (1), an active learning is a student centre instructional method in which students solve problems, answer questions, formulate questions of their own, debate, and discuss during class. There are many examples of active learning include: class discussion, short written exercise, polling the class, solving problems (1).

One of the most important innovation instructional method of active learning is PBL. PBL is a method of teaching by which complex world problems are used as a medium for promoting the students learning of principles and concepts rather than a direct presentation of concepts and facts (6).

PBL is an approach to learning and instruction in medicine that confronts students with a problem, before they engage in self-directed learning about this problem. It is assumed that having to think about a problem first, facilitates understanding of new information about that problem. (7).

The importance of the PBL is that it motivates the learners to look for a deeper understanding of the concepts. Besides the learners can make their decisions. Moreover, the students develop the skills of critical thinking (10). It also increases the students thinking and emphasizes on the memorization. The promotion of clinical thinking and problem solving among the students and the development of intellectual muscles to be able to solve problem is a key aim of the PBL model (3). Furthermore, studies have shown that PBL implementation can never be taken for granted: learners understanding of the logic behind the innovation of pedagogical can be varied and limited. In particular, developing medical students have awareness levels which are varied on contextual learning and clinical setting of problem-solving. Recent studies revealed that most students could not get the right answers but were grading regarding the thoughts of their questions and comments and the ability to find the effective resources for addressing the problem (2).

Loyens et al. (2014) argue that problems should only be presented to students after direct instruction about a topic because the cognitive load of working memory will be lower if students first master principles and facts. PBL, presenting the problem first, is therefore, in their view less efficient. Previous studies have demonstrated that in terms of short-term knowledge acquisition, PBL students often learn the same amount of new information though sometimes less than students in lecture-based curricula (4). The study shown that students who have experienced PBL achieve similar or less learning gains when it comes to short-term knowledge acquisition when compared to students in a lecture-based learning environment. (11), studied the effectiveness of PBL and found that PBL is more effective than traditional approaches when the measurement of learning outcomes focused on long-term knowledge retention, performance or skill-based assessment and mixed knowledge and skills. It was only when the focus was on short-term knowledge acquisition and retention that PBL appeared less effective. Some studies indicated that PBL was preferred for long term retention of the content, and short-term retention which involved elaborating new information and clinical skills application and reasoning (16). Tradition outlooks were suited for short-term course content retention which never required elaboration. Ways by which the learners face their studies in PBL in the health sciences are more related to the way they conceive PBL. To deal with this problem, a Cognitive Load Theory (CLT) is proposed. It focuses on the instructional methods for decreasing irrelevant CLT, so that the cognitive resources available may be devoted fully to learning (8).Proponents of PBL maintain that an activation/elaboration hypothesis predicts better learning when the problem comes first (Schmidt et. al 2007), while proponents of cognitive load theory suggest that load on working memory is too high under these conditions (15).

There are three cognitive load types that is extraneous cognitive load, intrinsic cognitive load and germane cognitive load. The intrinsic load is that idea that all instruction has difficulties associated with it. The difficulty might not be affected by an instructor. The extraneous cognitive load is generated in the way in which a certain information is presented to learners.

The possible explanations may include the construction of a situational interest as a response of motivation to a distinguished knowledge shortage. It is activated in circumstances where the knowledge shortfall becomes clear, such as in opposition to a problem. Situational interest is influences knowledge in a greater way (Schroeder, 2017). Cognitive load is high, and thus new methods are required in the management of the cognitive load. More so complex learning is so lengthy, and it requires motivation of the learners' levels and development expertise to be considered. The perspective needs more advanced methods of measuring expertise.

Reflection in practice is assumed to enhance interest in knowing more about a topic, increasing engagement in learning and learning outcomes (Ribeiro et al .2019). Reflection has been considered one of the best education strategies for the fact that it triggers engagement in learning and can, therefore, foster identification of knowledge gaps and interest in learning including medical education. For the case of reflection in medical education, the strategy has not been proven but only stands true from a theoretical perspective. In most cases, clinicians conclude that they have a deficiency of certain knowledge that they need to have to inform their choices. This deficiency would then be a driving force for the clinician

to want to seek more knowledge on the problem and therefore triggering learning activities that eventually lead to increased knowledge concerning the topic. It would be right to conclude that the deliberate reflection procedure fosters learning among the medical students. (Ribeiro et al .2019). Deliberate reflection creates an instance of situational interest where the medical student develops some kind of thirst for knowledge.

(16) in their research analyzed the effects of deliberate reflection on medical students when solving clinical cases. The study be based on a follow-up on the students' outcomes on their learning activity. They concluded that structured reflection increased medical students' interest and may therefore be a useful tool for teachers concerned with enhancing students' motivation for learning. A hypothesis was later conducted with the parameters being how deliberate reflection fostered learning engagements and how deliberate reflection fostered learning as compared to the option of differential diagnosis (2). Therefore, this paper studied the effectiveness of active learning when students asked individually to solve a clinical problem in the learning situation; before or after new information is learned.

Aim

The aim is to study the effectiveness of active learning when students asked to solve a clinical problem in the learning situation; before or after new information is learned.

Objective

To assess if problem/exercise before studying new information will lead more learning of a subsequent text than a problem/exercise after (direct instruction) among medical students using clinical cases.

2. METHODS

Design

Randomization was intensively used in the experiment with participants being placed in two experimental conditions either prior problem- solving condition or afterword problem solving condition. The experiment partitioned into three major parts that dealt with studying, recalling, and diagnosis. Diagnosis involved procedural reflection where the participants used these two approaches to analyze two clinical cases they had diagnosed. The participants from both approaches were presented with same study material concerning Jaundice's diagnosis. They then had to perform a free-recall task about their compiled information.

Analysis tasks assigned to the medical students in the study were identified as a diagnostic task, learning activity, and a knowledge test relating to the causes of jaundice through the application of the structured reflection procedure. However, the overall materials of the assignment tasks were assigned on an equal basis for establishing the difference between the knowledge level related to the jaundice of the group of medical students (prior-solving problem group and after the problem-solving group) after learning new information related to the diagnosis of the same.

Setting and participants

The experiment was run at King Saud Bin Abdul-Aziz University allowing sixty- six, third year medical students to be participants in the experiment. All third-year male and female students from COM at KSAU-HS, from the academic years 2019-2020. The students might have drawn the knowledge from lectures and tutorial groups from the university.

Materials and Procedure

Qualtrics software played a vital role of aiding the participants in going through the tasks given to them. The computer-based task was made up of two clinical cases to be diagnosed, cued recall tasks, and jaundice material that needed to be studied. To address the exercise on Jaundice, there were pre-written symptoms, descriptions about the disease, laboratory findings, and physical examination results. The previous studies conducted on Jaundice provided at least one validated diagnosis for the two diagnoses of choledocholithiasis and viral hepatitis. The study material comprised of a brief review of physiopathology and bilirubin physiology (Ribeiro et al. 2019). In order to explain the study, there were some common steps completed by all groups in order to achieve an understanding of the experiment, they were: first verbal instruction was given to the students prior to the experiment, a prior exercise in deliberate reflection that student have to practice, two clinical diagnosis that participants were read and fill in during the experiment. There were eight open ended questions they answered about the text they read.

First group before problem solving students were assigned to the following tasks: Practiced with the instructor a deliberate reflection exercise, then an example of a case study shown to the group for their understanding. Then the cohort given a sample case study to practice upon.

Next the group given a book text and instructed to use their personal code to label themselves and they to use the same code when applied the knowledge test exercise. The cohort then be given one Jaundice related problem to deliberate and solve. Situational interest and cognitive load measured and recorded during this stage. The final stage for this group was the Knowledge test which measured through time and score factors.

The second group after problem solving group were assigned to same materials as before Problem solving group but in a different order: the students practiced with the instructor a deliberate reflection exercise, next the group given a book text and instructed to use their personal code to label themselves and used the same code when applied the knowledge test exercise. Then the cohort given a sample case study to then practice upon, the cohort given one Jaundice related problem to deliberate and solve. Situational interest and cognitive load measured and recorded during this stage. The final stage for this group would then the Knowledge test.

The students' understanding of the study material was measured using a cued-recall task that was based on open-ended questions. The questions were eight in number and addressed the differential diagnosis of Jaundice based on topics such as physical examination, laboratory tests, and clinical history (Kapur, 2016). The participants then had to write what they could recall from the variety of texts they had interacted with.

Upon reading and understanding the materials provided, participants using deliberate reflection conditions typed the immediate diagnosis, made a reflection of the case, and typed the findings that tallied with the initial diagnosis hypothesis. The participants were also, required to type the contradictory hypothesis. Besides, they were also expected to give other alternative diagnoses that were lacking in the first diagnosis. All this was to form a platform for the participants to conclude. (Ribeiro et al. 2019). Finally, the students were also supposed to make their conclusion on the diagnosis for the case.

An instructor present during the experiment in order to offer support to the participants and prevent any distractions during the reflection. The participants were assigned to different groups randomly because it was difficult to determine which student would volunteer to either of the two main conditions.

Since time is a factor in any experiment, the experiment questionnaire and exercise were linked to the computer in order to control the time for every step. Participants working under the reflection conditions had two minutes to type the most probable diagnosis for the case. Making reflections and answered the questionnaire, the cued-recall task and study materials was be completed within an hour. The Qualtrics software counted the time spent and the participants' responses (Kapur, 2016). The software only provided the participants with the freedom to carry out recall tasks and material analysis without going back or skipping the task.

Student perception questionnaire

To examine students' perceptions toward learning by using clinical cases were invited to anonymously fill a questionnaire distributed during the sessions. The questionnaire consisted of four-item instrument developed by Rotgans & Schmidt in order to measure the students' situational interest (SI) an example of items such as "I enjoyed working on this topic" the questionnaire used a five-point Likert scale from entire agree to entire disagree.

Measurements

Proposition analysis. All utterances of the students were transcribed and subsequently parsed into propositions. A proposition is usually a subject-verb combination that express a single idea. They can be identified in texts by conjunctions (as 'and', 'or' and 'for'), adverbs (as 'when' and 'whereby'), relative pronouns, periods, and semicolons. Sometimes commas or parentheses also separate propositions from each other.

3. RESULTS

Characteristics of Participants

In the experimental study, the study included 66 students from the King Saud Bin Abdulaziz University in Medical School have been selected as the participants upon whom the assignment task related to the diagnosis of jaundice was

allocated randomly. The study included 33 students in each group condition of whom 24 (73%) were male in PBL group and 25 (76%) were male in TBL group.

The results on the knowledge-level

There was a significant effect of experimental condition on students' engagement in the learning activity and on learning outcomes. The results on the knowledge-level within the group of medical students after learning new information portrayed that knowledge-level regarding causes of jaundice of prior-solving groups of medical students were identified to be significantly higher than the problem-solving group after acquiring new information. There were significant results obtained for the prior-solving problem group portrayed a mean value of 1.26 $\pm$ 0.44. On the other hand, problem-solving group after learning new information displayed a mean value of 2.80 $\pm$ 0.98. (p value= 0.002).

In addition, the prior-solving problem group also projected a difference (*d*) value of 0.1 as compared to the *d* value of 0.64 for after problem group. This denotes that the knowledge related to the causes of jaundice was significantly higher mean=2.91sd= 1.019 (p value = 0.038) in terms of the prior-solving group.

Moreover, the situational interest is also depicted to be higher in terms of a prior-solving group with the mean=3.8 sd= 0.64 (p = 0.01). however, when comparing to the after problem-solving group's there was no significant difference mean=3.4 sd= 0.94 (p = 0.383). Furthermore, the mental effort used by both the groups of medical students on understanding the topic-based texts was observed to portray a p-value of 0.004, whereas the mental effort put on understanding the process of diagnosing used on the two cases of jaundice portrayed a mean=6.52 sd=1.84 p-value of 0.04). Thus, it can be stated that there was a significant difference in terms of knowledge-level about the process of diagnosing the two cases of jaundice between the two groups before and after acquiring new information related to it.

Table 1: presents age, gender, which year in medical school students studying, previous experience with patients with jaundice and the rang of students sleeping hours. There was a significant differences emerged in age, t (33). (p = 0.05).

Other variable shows no significant differences or gender p = 0.78. Previous experience with patients with jaundice, 0, p=.38 and also did not differ on which year in medical school students studying mean= (p=0.60).

Table 1.

	PBL (n= 33)	TBL (n=33)	p-value
Age?	Mean=22.15 SD= 2.59	Mean=22 SD= 1.21	.005
In which year in medical school are you?	Mean=2.97 SD= .71	Mean=3.06 SD= .73	0.60
Sex?	Male=24(73%) Female=9(27%)	25(76%) 8(24%)	0.78
How much do you think you know about the causes of Jaundice?	Mean=2.91 SD= 1.01	Mean=2.70 SD= .95	.38

Table 2.

	PBL (n= 33)	TBL (n=33)	p-value
Before How much do you think you know about the causes of Jaundice?	Mean=2.91 SD= 1.01	Mean=2.70 SD= .95	.38
SI measured before text	Mean=3.8 SD= .64	Mean=3.4 SD= .94	.10
After1 How much do you know about this topic?	Mean=2.52 SD=.87	Mean=2.67 SD=1.16	.55

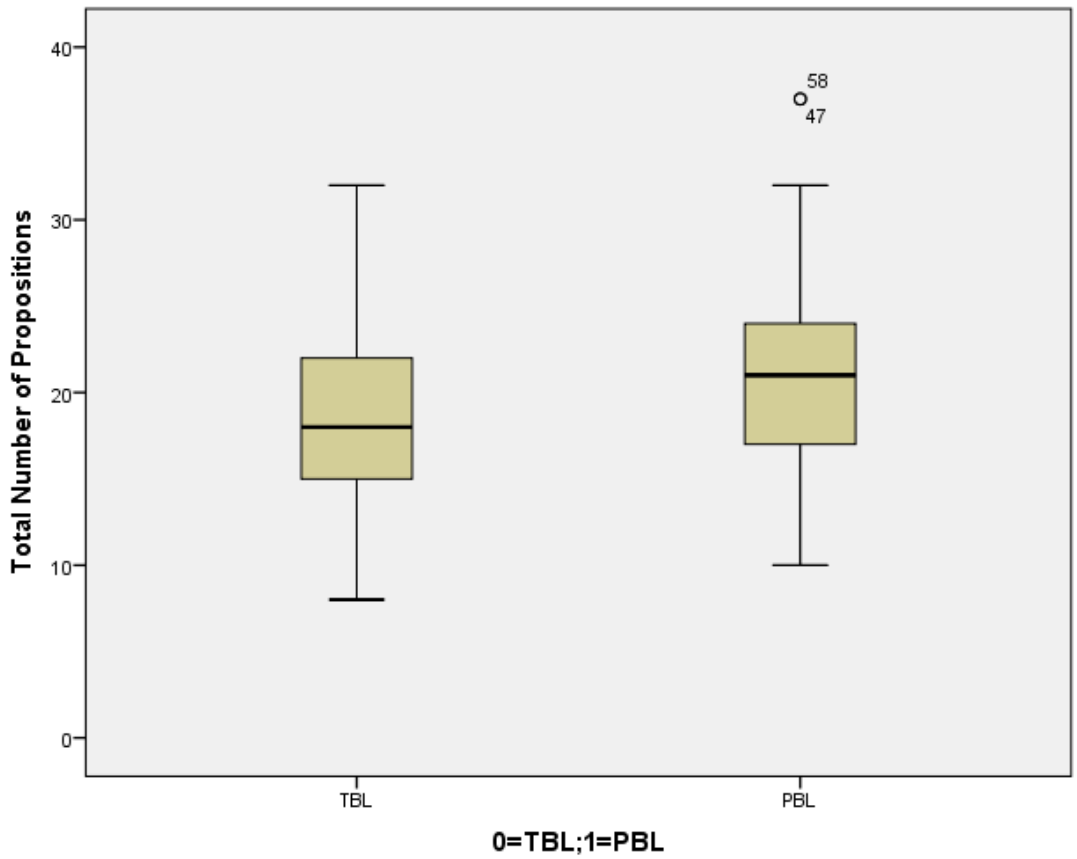
SI measured after text	Mean=6.21 SD=1.62	Mean=5.03 SD=1.59	.27
After2 How much do you know about this topic?	Mean=3.27 SD= .91	Mean=3.00 SD= .90	.23
After1 How much mental effort did you invest in studying the text?	Mean=6.21 SD=1.62	Mean=5.03 SD= 1.59	.004
After2 How much mental effort did you invest in diagnosing case?	Mean=6.52 SD=1.84	Mean=5.64 SD=1.48	.04

Table 2. displays the mean scores for SI reported by students from the two experimental conditions. There was a significant main effect of experimental condition with students who reflected upon the cases (PBL) reporting higher SI than those who made differential diagnoses (TBL), in both before reading the text p=.10 and compared with after reading the text group p=.27. There was also a significant main effect of experimental condition on mental effort, mean=6.52, p = 0.04, d = 1.84.

There was also a significant main effect of experimental condition on learning out come within the two groups p-value=.02. Students who deliberately reflected upon the cases on PBl showing higher scores on the cued-recall task than those who deliberated upon cases on TBL p=21.70.

Total Number of Propositions shows in the ficure1.

P=0.02



4. DISCUSSION

The purpose of this study was to investigate whether learning activity effect the student learning out come when reflection to clinical cases, and would influence medical student`s SI.

Vogel & Harendza (2016) portrayed those medical students undergo effective learning by implementing unique learning methods such as self-learning or self-teaching methods. The application of such voluntary learning methods and engaging them on a daily-based individual curriculum to provide self-feedback has been identified to be the key factor for ensuring effective learning on different topic-related information. Based on the findings of Dunlosky et al. (2013), it has been observed that the efficacy of student's learning techniques further indicated that among different forms of learning techniques, self-explanation learning technique was the most effective for understanding and learning about new information related with problem-solving practices.

Thus, this evidence further highlights that the study of newer information on their own problem by the student themselves are highly effective on dealing with their individual problem rather than identifying the problem before studying or acquiring any information related to their own problems.

In this study, we also investigated the effect of engage medical students in deliberate reflection while solving problems using clinical cases in a learning activity and learning outcomes. To that end, we compared study time and test scores of students who worked with two clinical cases through deliberate reflection with those who made differential diagnoses. Students who worked with deliberate reflection (PBL) engaged longer in the learning activity and attained higher score on the cued-recall test.

The deliberate reflection, however, requires students to compare and contrast the alternative diagnoses, searching for evidence supporting and refuting each one in a systematic way. This process might raise uncertainty and facilitate recognition of knowledge gaps, which has already been shown to foster interest and engagement in learning within students outside medical education (Ribeiro et al.2019). Therefore, that deliberate reflection led to longer engagement in the learning activity and showing that deliberate reflection fostered medical students' interest in knowing more about the cases.

As deliberate reflection increased both study time and test scores. Engagement in learning, after all, has been shown to be a consistent and important mediator of learning, even if the time engagement is short.

5. CONCLUSION

In summary, we studied the influence of active learning using clinical cases of Jaundice disease on medical students. Also investigated the effect of the active learning between the two groups on students learning achievement and on SI among third year medical student. We found that using clinical cases activities improve SI, which is indication for educators to use this important activity to engage their students during their courses. We found also that active learning using this actively as individual increase students' interest and identify their own knowledge gap such PBL group when they learn new information because of cognitive load as found in previous studies.

we studied the influence of deliberate reflection while working with to-be-diagnosed clinical cases on engagement in learning and learning outcomes among third-year medical students. We found positive effects of deliberate reflection on both, which adds evidence to sustain it as an important competence for medical students. It also expands the evidence on the potential benefits of a deliberate reflection procedure that can be easily used by clinical teachers to motivate their students, possibly in both real and simulated clinical environments.

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