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Introducing the concepts of inquiry based learning in a problem based learning (PBL) workshop using a game based learning strategy

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ABSTRACT

Background and Aim: Critical thinking and application are imperative skills for medical students as they learn to look for clinical features, interpret investigation, diagnose, and treat patients. Many educational strategies exist to foster this process, one of which is problem based learning (PBL). Though the concept of PBL looks lucid and uncomplicated, it requires understanding of the principles by faculties and students to make it more student oriented. We used a "Magnetic Building Set" as a mind opener to orient the teaching faculty at RAK Medical and Health Sciences University to the core concepts of PBL. The main aim of the workshop was to familiarize the faculty on various aspects of PBL, especially, the importance of identification of learning objectives, designing a problem on predesigned objectives, and the relation of PBL to inquiry based learning. This study also depicts how a simple game can make the participants correlate with the principles behind PBL.
Methods: A total of 17 new faculty members, some of them having previous exposure of teaching in a PBL curriculum were included in the medical education orientation workshop on PBL. The faculty members were divided into three groups and each group was given a magnetic building set, which consisted of metallic spheres and magnetic rods. Initially, there were asked to make design of their choice using all the materials and later a second task was given asking them to make a specific structure. The game is then correlated to the key principles of PBL using a pre- and post-game questionnaire.
Results: After the game, the knowledge of the faculty regarding the concepts and efficient use of PBL increased dramatically. The post-game questionnaire showed all the faculty understood well about the concepts of PBL.
Conclusion: Various instructional strategies are employed in adult learning. Further, game-based learning is one amongst them and the current study highlights how a simple game can be used as an innovative and effective approach to introduce the concepts of PBL.

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Teachers of the current generation are often faced with a problem on how to make their students to "learn." In the traditional curriculum, students are often asked to define, state, describe, explain rather than to analyze, synthesize, correlate, or evaluate [1]. Abraham Flexner's in his report on modernizing medical education in the early 20th century points toward the importance of core knowledge and scientific basis [2]. The Canadian eminent medical educationist, Sir William Osler, toward the end of the 20th century gave a paradigm view on medical education indicating the importance of application and problem solving there by gaining the knowledge as an offshoot [3]. Introducing only the knowledge component without any application can lead to short term, exam oriented learning rather than applying the concept in problem solving especially in medical profession as they need to be life-long learners [4]. While it is been widely accepted that critical thinking and application is

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required for medical students in diagnosis, appropriate investigation, and management, there has been a constant conflict of how to achieve it. Many educational and learning strategies exist to foster this process, one of which is problem based learning (PBL).

Originating from Mc Master University in the early 1960s, PBL has been widely accepted in many medical universities, as it helps in internalizing the concepts and its application. The metacognition and team building activities significantly increase not only the knowledge component, but also improve the skills and professional attitudes of the students.

Though the concept of PBL looks lucid and uncomplicated, it requires teamwork involving university administrative staffs, curriculum committee, faculty, and students. Many workshops and orientations are conducted worldwide to introduce the concepts of PBL. In our model, we used a "Magnetic Building Set" as a mind opener when we first introduced the concept of PBL to orient the teaching faculty at RAK Medical and Health Sciences University (RAKMHSU).

The main aim of the workshop was to familiarize the participants to the following aspects of PBL:

1. Outcomes for a single problem.
2. Importance of identification of learning objectives.
3. PBL and its relation to inquiry based learning.
4. Designing a problem on predesigned objectives.

We adapted the concept from "JUNKYARD" which is one of the project oriented learning sessions given to engineering students for creating a windmill turbine using scrap products. In the above project, students were asked to build a windmill turbine from a set of scrap provided to each groups [5]. We made use of the above technique, however, instead of scrap materials we introduced "Magnetic building game set." Using the above material, we introduced the teams to a game with two tasks to reinforce the core concepts of PBL followed at RAKMHSU and to promote imagination, problem designing, problem solving skills, confidence, and team working spirit.

"Game based learning," as it is called, is an instructional methodology in which the learner participates in a competitive game with preset rules [6,7]. It has been proven to have better attitude, team spirit, and retention rates than the traditional didactic methods. Various games strategies have been successfully used from charades, board games to "who wants to be a surgeon?" to improve the learner's interests.

Materials and Methods

A faculty orientation workshop on PBL was planned at RAKMHSU. 17 faculties from the colleges of Medicine, Dental, Pharmacy and Nursing enrolled for the workshop and they were divided into three diverse groups. It was made sure that the group had atleast one member from each college. After a short introduction, a pre-questionnaire (Appendix A) was administered before the program began.

After collecting back the responses from the pre-game questionnaire, a "Magnetic building play set box" each consisting of 30 metallic balls and 45 magnetic rods was distributed to each team. The metallic balls in the set, can be linked with one another using the magnetic rods and many patterns could be created using it.

The groups were then given a task (Task 1), wherein they were instructed to utilize all the materials available in the magnetic set and to create a pattern and rationalize the reason behind making up of such a pattern within a span of 5 minutes. The main objective behind Task 1 was to assess:

1. The creativity skill of the members of the group.
2. Provide justification behind their design.
3. The teamwork involved in planning and execution.
4. The time management skills.

All the three groups were enthusiastically involved and requested an extra 5 minutes to complete their task. At the end of 10 minutes, the groups were assessed. Each group gave justification for their design. Each group was assessed based on the objectives set by them in the formation of design.

After assessing each groups, for Task 1, all the groups were then given Task 2. All the groups were asked to make a "cartwheel" pattern using all the metallic balls and magnetic rods available in the box within a span of 6 minutes. In Task 2, all the groups were given a specific task (objective) (that applies the same for problem designing). At the end of 6 minutes, all the groups were assessed. Though all the groups had tried, none of them could meet the learning objective (making of cartwheel) set by the author and they quoted various reasons for their inability.

The faculty member then underwent the orientation program regarding the learning systems and at

the end a post—questionnaire (same as Appendix A) was administered.

Results

Pre- and post-game questionnaires were analyzed. The pre-game questionnaire analysis (Fig. 1) showed that only half the faculty members knew that PBL is an inquiry based and that pre-determined learning objectives are identified in open inquiry. Also none of the members were aware of the number of inquiry based learning systems and many thought guided inquiry learning system fosters creativity. Since most of them were unaware about the principles of PBL they were not happy with the PBL learning system. However, most of the faculty were aware that open inquiry learning strategy is the highest level and agreed that we don't follow that in our university. In short, the faculty perceptions varied differently on aspects of PBL even though some faculty had prior experience in problem based learning environment.

However, after the game and signifying the implications of the statements in PBL, all the faculty understood the concept and gave the right answers (Fig. 1). They indeed understood about the different learning strategies, and that open inquiry is highest level of learning strategy which could be achieved by students in an inquiry based learning system. They also understood that in our university we follow a guided inquiry based learning system. Since they were now clear about the principles in PBL, all the faculty member were happy about the outcomes of the PBL and were ready to implement in our university. Though the method of instruction was found to be successful, appropriate statistical analysis could not be carried out owing to small sample size.

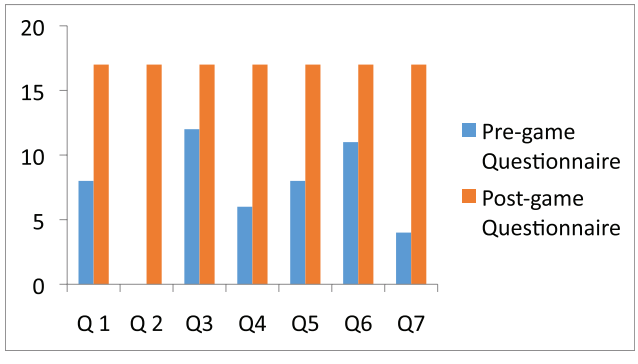

Figure 1. Responses from the pre- and post-game questionnaires.

Discussion

Modern day education is changing from factual based to inquiry based. Most teachers agree that students potential of learning from a didactic lecture is less when compared to students who are engaged in a learning process where they critically analyze the problem, acquire the knowledge and able to apply it in a meaningful and applicable way [7].

In PBL, ill structured problems are given and students are encouraged to use the problem as a tool and ask themselves, "what knowledge should I gain to understand, analyze, and finally to solve this problem?" Hence the students should first seek to understand the problem, learn the concepts behind them, able to hypothesize, and finally apply them. In PBL, the role of the teacher/facilitator is changed drastically from providing information to coach students thinking, and guide them on inquiry based learning, thereby facilitating deeper level of understanding. Teachers have a huge responsibility because they are the first point of contact with their students and have a tremendous influence over the way they learn [7].

It is great challenge for the teachers who are the experts in that particular field to give up control and change their role as facilitator. The teacher should understand the core concepts of PBL and help in inquiry based learning of students. Students too need to look at the teacher as a facilitator, and not as a person who provides answers. Hence for a good PBL session equal understanding and cooperation is needed from both the teachers as well as the students. It is agreed that teachers do take a considerable time to get acquainted to the new form of inquiry based learning. However once they implement it they agree it is as a rewarding and an exciting experience.

A problem can be viewed in a multidimensional aspect, especially from students of various professions, to develop an understanding of each other's strengths and skills to develop a team based approach. Hence there are many important and relevant areas that could be studied in a single problem [8]. Here in our magnetic game set, we could observe that even in a simple, single problem we can have various outcomes (Task 1).

However, in PBL, the critical factor is for the students to make effective use of the problem and have a clear understanding of the educational objectives program. For both the faculty and the student this approach (PBL) requires considerable attention to learning objectives, identification of appropriate

educational issues, and knowledge of the physician's cognitive processes and how that should be learned and evaluated [8]. The faculty understood this concept after the game.

Inquiry is commonly cited as an effective means of achieving learning objectives. However, inquiry based activities encompass a broad spectrum ranging from guided inquiry to open inquiry. It is highly important to link the type of inquiry to the desired learning outcome [9].

Inquiry based learning generally can be divided into three types:

1. Structured inquiry
2. Guided inquiry
3. Open inquiry

In a "structured inquiry based learning system," the students analyze the case through a well-structured procedure, using a step by step approach to achieve the predetermined learning objectives. Students here develop the art of developing the basic inquiry skills. One of the main disadvantages of this approach is that students do not think autonomously and the results are "known in advance."

In a "guided inquiry based learning," students brainstorm about the problem presented to them, and they work collaboratively, hypothesize the problem and frame the learning objectives. Here the faculty guides them with appropriate questions and therefore this decreases the level of uncertainty when compared to the open inquiry based system. The students function as a team, lead the inquiry process and may come up with unforeseen yet good learning objectives.

"Open inquiry" is the most complex level of inquiry based learning. Here the faculties allow the students to select their objectives and approaches. Open inquiry system is ideal to work on research and experimental projects and demands higher order thinking capabilities [10]. In an open inquiry, the teacher's role is to facilitate student generated investigation and learning. Hence hypothesizing and achieving the learning objectives is considered crucial. This type of system also depends on the students' cognitive ability. Teachers familiar with the students' cognitive ability will be able to facilitate them appropriately [11]. Table 1 shows the difference between the three types of inquiry based systems.

In our current study:

Task 1—can be compared to "open inquiry."

Task 2—can be compared to "guided inquiry."

Table 1. Highlighting the differences between Structured, Guided and Open inquiry based learning systems.

Structured inquiry	Guided inquiry	Open inquiry
Students will be given objectives and also given steps of construction	Students are guided to identify the objectives and then to process the task	Students are expected to ask questions to generate the possible objectives about a task and create their own objectives

Structured, guided and open inquiry approaches: Advantages and disadvantages

Many schools follow different types of inquiry and it has always been an agenda of controversy. Educators put forward that structured and guided inquiry based learning systems helped the students understand the concept and master the skills [12,13]. Studies done by Trautmann also show that students often get lost in the open inquiry based system. Students also agree that sometimes the open inquiry is waste of time and most of the time they land up frustrated in not achieving the learning objectives [14]. Institutions following open inquiry methods claim that students achieve higher skills and practices and engage in higher order thinking [15,16]. The student's functioning corresponds closely to the teacher's efforts to facilitate the student's scientific literacy, creativity, initiative, responsibility, and motivation [17].

Research studies clearly indicate that the critical and scientific thinking is minimally achieved by the structured inquiry alone. Berg compared the student outcomes in open and structured inquiry and indicated the positive outcomes and perceptions of open inquiry over structured inquiry. In addition, the open inquiry system helps develop the skill for self-directed learning, the proper attitude, and the advantage of working together as a team. Cumulative evidence supports the effectiveness of open inquiry learning in developing cognitive and procedural skills for inquiry and autonomous learning, as well as more positive attitudes towards science and science learning [15].

Guided inquiry is considered to be at an intermediate level that helps in transition from structured to open inquiry system. In this stage based system students develop the critical thinking and are able to analyze the problem [14].

In our university, we receive students from different cultural background and who have undergone their school in different boards. Hence students, especially the first year students of different

programs, feel it is difficult for them to handle the PBL if the problem is an open inquiry based. Often student gets frustrated and try to adopt an easy method for acquisition of knowledge. Hence, we make the case scenario and train the facilitators to follow a guided approach. We observed that the students are then able to understand the concept and hypothesize the problem.

Though many changes have occurred in the teaching and learning methodologies, inquiry based learning remained focused on the concepts of evidence; began with an objective and ended on achieving it [18]. Sadeh and Zion in their study on influence of open versus guided inquiry system showed no significant changes with regard to "learning process" and "affective points of view." However, with regard to "procedural understanding" and higher skills, significant changes were shown. Though the open inquiry based system showed higher sense of cooperation and is ideal; using a guided approach and taking students gradually into the system of learning improved the understanding of concepts and lessen their "frustration," especially for the first year students [19–21].

Hence, student centered, self-directed learning requires a change in the approach by faculty and students. The faculty instead of giving explanations and corrections, should focus on guiding the students learning process [22,23]. It is mandatory that faculty in a medical school, that follows PBL as a teaching methodology, should learn to guide, focus, challenge, and encourage students in achieving their learning objectives [24–26].

Furthermore, game-based learning has been shown to be effective in reducing anxiety, helping the learners to focus on the important aspects and give an insight about the topic the learners are about to learn. The use of pre- and post-questionnaire helps in analysis of how well the learners have learnt about the concepts [27,28]. In our current study, the analysis showed the effectiveness of delivering the principles following a simple game and the impact on the learners (faculties) at the end of the workshop. However, the sample size was quiet small to adapt an appropriate statistics. Similarly, the level of experience of certain faculties who had previous experience in PBL was not measured. Nevertheless, this game for such faculties augmented their knowledge and concepts on PBL.

Conclusion

Faculties must learn to function as a facilitator and guide. Crawford in his studies inferred that faculty, when using inquiry based learning, need to assume many roles as a "motivator, guide, motivator, researcher, diagnostician, innovator, and collaborator" [23]. After understanding the core concepts of PBL, almost all faculties changed their attitude on PBL toward teaching and agree that it is indeed rewarding in many ways. They agreed that students become more motivated and enthusiastic and even agree that they gain new professional skills, which make them to collaborate with other disciplines to view the problem as a whole. Though all the faculty members understood about the PBL by the end of session, the game before the workshop made the team to work together, correlating the game activity to the objectives of the workshop and its outcomes [25]. Creativity is defined as "Mastery of simple things." This article shows how a simple game can be used as an innovative and effective approach to introduce the medical faculty to PBL workshop on problem designing.

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Appendix A

Pre/Post Game Questions

(Mark True, False, or Don't Know for the statements shown below)

1. PBL is inquiry based.
2. There are three types of inquiry based learning systems.
3. Open inquiry based is the highest level.
4. Guided inquiry based linked to creativity.
5. Predetermined learning objectives are identified by students in open inquiry.
6. We follow open inquiry based in RAKMHSU.
7. We are happy with the outcomes of PBL.