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Effectiveness of PBL in delivering image processing method to undergraduate radiography students in Puducherry, India

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ABSTRACT

Purpose: Problem Based Learning is an approach to learning and instruction in which students tackle problems in small groups under the supervision of a tutor. This method is very useful in imparting medical education. In this study I am going to apply PBL in the teaching of undergraduate radiography students and study the effectiveness of PBL, particularly in teaching image processing methods in radiography.

Materials and Methods: A randomized controlled design was used for the study to test the addition of Problem Based Learning (PBL) to theory lectures and clinical experience versus theory and clinical experience alone on student's knowledge in performing Image processing in radiography. The students were randomly selected and then randomly distributed either to experimental or control group. The knowledge is accessed by valid questionnaire through the pretest and post test for both the experimental and control group. The data are then analyzed by excel work sheet to get the result.

Results and Conclusion: Sixty radiography students from fourth semester were randomly assigned either to the experimental or control group, so that there were 30 students in each. The mean score for the pretest and posttest score are at 21.67 and 34.04 for experimental group with a standard deviation 4.44 and 3.44 respectively while it was 21.80 and 29.07 for the control group with a standard deviation of 3.88 and 3.85 respectively. This study shows that students' knowledge in performing image processing in radiography significantly enhanced after the application the PBL module.

1. Introduction

Problem based learning is an approach to learning and instruction in which students handle problems in small groups under the supervision of a faculty. Most problem consist of a descriptive set of idea that can be perceived in reality. These phenomena have to be explained by the tutorial group in terms of their underlying principles, mechanism and processes. This is known as a systemic approach, or an attempt to apply cognitive psychology results to educational practice. This suggested that competence is created by promoting an inquisitive learning attitude rather than by teaching or imparting knowledge. This style of learning is assumed to foster of knowledge increase, improve students general problem solving skills, enhance integration of basic science concepts into clinical problems, foster the development of self directed learning skills, and strengthen students intrinsic motivation.

2. Background

With advancements in medicine, the healthcare industry's skills and expertise are likely to grow. Rapid advances in research, ineffective cramming, and fact knowledge becoming obsolete after ten years are all key difficulties in medical education. As a result, modern training courses for

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medical practitioners have concentrated on more effective teaching approaches for the knowledge development and abilities.[1] Similarly, healthcare worker training courses must depart from traditional learning approaches. In radiology, screen film systems are giving way to Photo stimulable Phosphor(PSP) plates for viewing plain radiographs, and digital panel detectors are becoming more common in hospitals and clinics. Single-slice CT scans have been superseded with multi-slice CT scans. Radiographers and imaging technologists must have skills and expertise that evolve over time, such as clinical picture interpretation and novel imaging techniques, information sharing, and healthcare safety as a result of technological advances.[2] As a result, imparting all of this knowledge in a short amount of time will become increasingly difficult in the future, and training courses for healthcare professionals, including radiological technologists, will need to incorporate more efficient learning methods. Problem-based learning (PBL) is one method for reaching this goal.[1] Educational approaches with the problem-based learning leads to a successful teaching learning model.[3] Prior researches has suggested that PBL can enhance student attitudes. For example, Koponen et al. used a communication skill attitude measure previous and after each learning method to compare student attitudes in 3 experiential learning approaches.[4] In their research Takayoshi Terashita et al. found that the attitude of self-efficacy was improved after practical training, which incorporated PBL in radiography students.[5] In another article Takayoshi Terashita et al. suggested the re-orientation of education to radiography students is essential to meet the intellectual appetite regarding X-ray radiography.[6] However, because testing across all curricula is difficult in this study, we must reduce our focus. I discussed radiographic image processing techniques in this work.

3. Objective

To study the effectiveness of PBL, particularly in teaching image processing methods in radiography for the Undergraduate Radiography students of Puducherry, India.

4. Materials and Methods

4.1. Design

The study employed a randomized controlled design to compare the effects of adding Problem Based Learning (PBL) to theoretical lectures and hospital experience vs just theoretical lectures and hospital experience on students' knowledge of image processing in radiography. The students were chosen at random and then assigned to either the experimental or control groups. The experimental group got classroom lectures, a clinical course at the hospital, and PBL scenarios for manual processing, automatic processing, CR image processing, and digital radiography image processing. The control group, on the other hand, attended hospital lectures and clinical training on manual processing, automatic processing, CR image processing, and Digital Radiography image processing without PBL scenarios.

4.2. Sample and sampling technique

Using simple random sampling technique, randomization was achieved to recruit the radiography students who were willing to participate in the current study. A record including all radiography students in the college of radiography who are coming for clinical training at Indira Gandhi Government General Hospital and Post Graduate Institute (IGGGH&PGI) was obtained from the radiology department. After that, a random sample of radiography students (N = 60) was selected using a computer generating record. Then, the participating students were distributed to either the experimental (n = 30) or control group (n = 30) randomly. Radiography students who were in the fourth semester of Bsc., Radiography course of the Pondicherry University were included in the study.

The inclusion criteria in the current study were Bsc Radiography student who were in the fourth semester at the Pondicherry University who are willing to participate in the study.

The total number of students enrolled for Bsc Radiography fourth semester in Puducherry were 72. Out of 72 students 60 students are willing to participate in this study. They were equally distributed to have 30 students in the experimental and the control group by randomization.

4.3. Setting

This study was conducted in IGGGH&PGI. The baccalaureate radiography degree is a 4-year program consist of 6 semester and one year compulsory internship. English is the language of teaching and examination, and text books are the same to those recommended by the International universities. The clinical training for the radiography students were given in various modalities of radiography including conventional radiography, special procedures, CT scan, MRI, Mammography, CR and DR. This institute has equipped classrooms computers for power point presentations. The PBL scenario is implemented in IGGH&PGI very easily since the institute is provided with clinical setup and theory classrooms.

4.4. DATA collection procedure

The project proposal was presented to the Institution Ethics committee and Institution Scientific Advisory committee of IGGGH&PGI and got the approval to conduct the study.

By applying random selection to have 60 radiography students whom were randomly assigned to either experimental or control group. A written examination measuring knowledge in image processing methods was

conducted for the control and the experimental group. A code number was provided for each student in the whole sample to cover their participation and keep their data confidential.

The assigned lectures were given to the experimental group in the classroom of IGGGH&PGI and the clinical training over the whole semester that lasted over three months. However, the experimental group received the PBL scenarios regarding the manual processing, automatic processing, CR image processing and Digital Radiography image processing. Power point presentation and classroom discussion are used in the lectures to provide the students with the information. The reason for providing the total sample with theoretical and clinical training in hospital was to standardize the students' knowledge about Image Processing In Radiography. The educational lecture was carried out by the same educator two times each week and lasted approximately 1.5 hours for each. The clinical training was conducted for the experimental and the control group over two days per week over three months in hospital setup with all imaging modalities.

After that, the 30 students involved in the PBL experience were divided into 3 groups, 10 students per group for the purpose of demonstration. The researcher used the same scenarios for each group. The scenarios were about management of over exposure and under exposure in conventional radiography, quality assurance test in conventional radiography, CR plate maintenance, CR artifacts and how to reduce or eliminate then, various image processing techniques in CR, Digital radiography processing methods, Digital radiography artifacts and their remedies, how to use the portable Digital panel in the infectious conditions like COVID-19.

There were three scenarios for each system including conventional radiography, Computed Radiography and Digital radiography systems. Each scenario lasted two hours for each group. After each scenario fifteen minutes session for discussion was conducted. This session included problems usually consist of a description of as set of real life phenomena sharing experience from the students. A total of 18 hours Problem Based Learning was provided for each group of the students in the experimental group. Each scenario was explained by the researcher for the group with actual demonstration for the required image processing skills. After that, each student was asked to practice and demonstrate the required scenario and skills and was closely monitored by the researcher. The scenarios assessed both critical thinking and hands-on skills for the students. These scenarios were implemented in the first two weeks before student's clinical training in the hospital. The experimental and the control group completed the posttest which consists of a written examination measuring knowledge in image processing methods. The data collection duration lasted for three months from September to December 2021.

4.5. The educational program content

The educational lecture and PBL scenarios covered different topics regarding conventional radiography, Computed Radiography and Digital radiography systems. The educational lecture focused on the process of decision making in image quality maintenance in the case of conventional radiography, CR and DR systems. The course aims to integrate specific theoretical knowledge of image processing to produce good diagnostic image to provide radiographic intervention for patients experiencing health disturbances, with ALARA principle. This course covered different topics that are included management of over exposure and under exposure in conventional radiography, quality assurance test in conventional radiography, CR plate maintenance, CR artifacts and how to reduce or eliminate then, various image processing techniques in CR, Digital radiography processing methods, Digital radiography artifacts and their remedies, how to use the portable Digital panel in the infectious conditions like COVID-19.

4.6. Instrument

The required data was gathered using a standardised questionnaire based on the study's objectives. The questionnaire starts with a brief statement about the study's objectives and informed consent. The tool's first section contains demographic information such as roll number, age, and gender. The image processing in radiography exam, which consisted of 40 multiple-choice questions, assessed knowledge of traditional radiography, computed radiography, and digital radiography systems. This exam was created expressly for the current research project. The correct response received one mark, while the erroneous answer received zero. The total score ranged from 0 to 40, with a higher score indicating greater knowledge. The questions were compiled from a variety of sources, including pertinent literature, textbooks, and online sites. Face validity was tested by three specialists from the institution's radiography faculty, and the tool was found to be valid. Other two external radiology specialists assessed the content validity. The entire questionnaire was pilot tested with ten radiography students who matched the inclusion criteria but were not included in the final sample size. The results revealed that there were no issues with the questionnaire's delivery, coding, or scoring. The time allotted to complete the questionnaire was around 60 minutes.

4.7. Ethical issues

The Institutional Ethics Committee and Institution Scientific Advisory Committee of IGGGH&PGI, Puducherry, India, gave their approval to the current work. Before the data collection began, all participants who accepted to participate in the study gave their informed consent. The pupils were

promised that their participation was entirely optional and that their responses would be kept fully private. Each participant was given a code number in order to maintain their anonymity. To keep the obtained data private and confidential, all completed surveys were kept in a locked cabinet. Participants were free to leave the study at any time without incurring any penalties. The subjects suffered no physical, psychological, social, or economic harm or danger.

5. Data analysis

Microsoft Excel spreadsheet software was used to evaluate the data. Descriptive statistics such as mean (M) and standard deviation (SD) were used to describe the sample's characteristics as well as the level of competence (SD). An independent t-test was employed to assess if there was any statistically significant difference in knowledge and confidence between the experimental and control groups at the pre-test and post-test levels. The difference between the experimental and control groups' mean pre-test and post-test knowledge and confidence ratings was examined using a paired t-test.

6. Results

6.1. Sample characteristics

Sixty radiography students from fourth semester were randomly assigned either to the experimental or control group, so that there were 30 students in each group at pretest. The mean age for the students was 20.43 (standard deviation, SD=0.70).

29 male students and 31 female students participated in the study. Chi-square showed that there was no significant difference statistically between the control group and experimental group the in terms of gender. In addition, independent t test revealed that there was no statistically significant difference between the groups in terms of age and pretest knowledge. Table 1 indicated that no significant difference between the two groups at baseline in terms of demographics and other all related variables.

The mean score for the pretest and posttest score are at 21.67 and 34.04 for experimental group with a standard deviation 4.44 and 3.44 respectively while it was 21.80 and 29.07 for the control group with a standard deviation of 3.88 and 3.85 respectively. In addition, a paired t test revealed that mean knowledge (M=34.04, SD=3.44) regarding image processing skills at the post-test was significantly higher than that at the post-test for knowledge (M=29.07, SD=3.85)and for control group.

In conclusion, students' knowledge in performing image processing in radiography significantly enhanced after the application of either theoretical or clinical training in the control group, or PBL scenario in the experimental group. However, as indicated in Table 2, results showed that student knowledge and skill in performing radiography image processing was significantly greater in the PBL module group compared to theoretical and clinical experiences alone.

7. Discussion

The purpose of this study was to see how PBL affected radiography students' understanding and confidence in image processing skills in traditional radiography, computed radiography, and digital radiography. The results showed that the experimental group's knowledge was much higher than the control group's. This conclusion is in line with the findings of other studies. The following are some of the significant effects of PBL on knowledge. The availability of a team of learners who work together as they had in genuine scenarios in an environment akin to a real clinical setting was the key distinction in the experimental group's instruction, which included the PBL approach.

While discussing the problems in real time situation the students are in a position to react according to the situation. This will create more practical knowledge in handling the images and finding the pitfalls in the processing methods. The radiography students are having opportunity to study in the real time situation with the supervision of the trained staff. This is supported by the idea that learners like radiography students need to feel safe and secure in order to express themselves.

The Pondicherry university undergraduate radiographic programme is divided into four years: general courses in the first year, specialized basic courses in the second year, exclusive applied courses in the third year, and practical clinical training in the fourth year. Prior to the introduction of practical training with PBL, no lecture had used PBL, and there were very few lectures addressing clinical problems before the fourth year. When we asked students about their thoughts on the practical training, many indicated they had never experienced anything like it, that they were thrilled to put what they had learned to use, and that the process had been useful. By applying their own knowledge and building workflows in groups, students might receive specialized information via practical instruction, covering important components and cognitive processes in clinical practice. Students could also put their skills to use as radiological technicians by doing image processing in radiography using a workflow they built. As a result, since student self-efficacy developed as a result of the self-directed learning of PBL practical training, the PBL technique was utilized to observe a self-efficacy attitude. We demonstrated that incorporating PBL into radiographic image processing can be beneficial.

8. Limitations, Recommendations and Implications

The selection of a convenience sample of radiography students has an impact on the results' external validity, as the findings have limited generalizability. The author

Table 1: Sample characteristics at base line and the pre-test of knowledge for the experimental and the control group (n=60)

Variable	Total sample n=60	Experimental group n=30	Control group n=30
Age(in years)M (SD)	20.43 (0.70)	20.37 (0.72)	20.50 (0.68)
Male (nos)	29	14	15
Female (nos)	31	16	15
Pretest score M (SD)		21.67 (4.44)	21.80 (3.88)

Table 2: Mean and SD of experimental and control group in both pretest and post test

Variable	Experimental group				Control group			
	Pretest		Post test		Pretest		Posttest	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Knowledge (Score)	21.67	4.44	34.03	3.44	21.80	3.88	29.07	3.85
p-value paired t-test			1.32851E-19					

suggested that the study be replicated with a bigger, more diverse sample of radiography students from across India. Furthermore, more research is needed to establish the impact of PBL on image processing in radiography departments across the country. On a national and worldwide basis, several research findings indicated the considerable impact of PBL in radiography practice. Furthermore, this research adds to the body of knowledge showing PBL is an effective strategy for improving expertise in radiographic image processing. The findings of this study can be adopted in the curriculum of Undergraduate Radiography course since PBL is an effective technique that help enhance knowledge and should be used as main education strategy in all Indian universities.

9. Conclusion

The findings of the present asserted that Problem Based Learning has a significant and positive impact on radiography students' knowledge in implementing image processing skills in radiography. This finding adds to the current body of knowledge that adding PBL method is an effective and important teaching strategy to improve performing image processing in radiography. In addition, it is important that the attitude of self-efficacy appeared after PBL practical training. Despite the fact that the influence of other lectures and types of training that occurred concurrently with PBL practice training could not be totally eliminated, and despite the small number of study participants, we were able to confirm the effects of PBL.

10. Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal ties that may have influenced the work presented in this publication.

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