

PROPOSING A PROBLEM-BASED LEARNING ORGANIZATIONAL PROCEDURES TO FOSTER PROBLEM-SOLVING COMPETENCY ASSOCIATED WITH STUDENTS' MAJORS: AN ILLUSTRATIVE EXAMPLE FOR NURSING MAJORS

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Abstract: Nowadays, at universities, the learning outcomes in training programs require students to have the practical knowledge to solve complex problems related to the training field. In this article, based on literature reviews, we propose problem-based learning organizational procedures to foster problem-solving competency associated with students' majors and gives an illustrative example when teaching some knowledge of Nuclear Physics to Nursing students. The article's results help lecturer referral in teaching Physics – Biophysics, other subjects to meet the learning outcomes, contributing to improving the quality of higher education in Vietnam.

Keywords: problem-solving competency associated with majors, problem-based learning, Nuclear Physics, Nursing

INTRODUCTION

Along with the country's deeper international integration, the rapid development of science, technology, and fierce competition in many fields between countries require education to be innovative. In essence, the competition between countries today is competition for human resources and science and technology. Therefore, the general trend of the world when entering the 21st century is to conduct vital innovation in education.

Educational innovation in Vietnam is an essential job in which higher educational innovation is fundamental, based on retaining the characteristics of higher education in the country, and at the same time approaching the general outcomes of the world. Specific objectives of the fundamental and comprehensive reform of higher education focus on training highly qualified human resources, fostering talents, developing quality, capacity for self-study, self-enrichment of knowledge, creativity, and innovation created by learners.

Higher education needs to renovate the structure, requirements, and learning outcomes of training programs to integrates with the region, with the world, and is suitable to the conditions, circumstances of Vietnam. The contents must be closely related to the practical requirements of the chosen majors. Allowing the use of various teaching methods according to the principle of "taking the learner as the center," minimizing the teaching load in class so that learners have time to learn and research on their own. Some authors have researched higher education innovation in many different fields, published in prestigious domestic and foreign journals and conferences (Dang & Duong, 2019; Ngo, 2016; Dang & Tang, 2021) or doctoral theses (Dang, 2021; Nguyen, 2014; Nguyen, 2019).

To prepare and maintain a future workforce capable of dealing with these practical demands, students need to develop important competencies. One of them is problem-solving competency associated with majors. To foster this competency, higher educators need to innovate teaching methods and innovate in assessing the teaching process and innovating the examination and assessment of student's academic achievements tablets (Keengwe & (ed), 2020).

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Many different teaching methods have been researched and applied, such as problem-based learning (PBL).

PBL as a pedagogical strategy appeals to many educators because it offers an instructional framework that supports active and group learning—premised on the belief that effective learning occurs when students construct and co-construct ideas through social interactions and self-directed learning. (Yew & Goh, 2016). Its implementation can vary across institutions and programs. In general, it can be viewed as an iterative process made up of first, a problem analysis phase, a period of self-directed learning, and a reporting phase (Schmidt, 1993; Schmidt & Moust, 2000).

In Vietnam, there are also some studies on PBL for students (Nguyen, 2015; Le, 2021). However, researchers have not dealt with building PBL organizational procedures to foster problem-solving competency associated with students' majors so far. Therefore, this study aims to propose the PBL organizational procedures to foster the problem-solving competency associated with students' majors. The study addresses the following research questions:

- What is the basis for proposing the PBL organizational procedures to foster the problem-solving competency associated with students' majors?
- What are the steps in this procedure?
- How to apply the PBL procedures to foster problem-solving skills associated with Nursing majors?

CONTENT

1. Literature review

1.1. Problem-solving competency associated with majors

Problems associated with majors are understood as practical problems contain difficulties and challenges but not considered, researched, and resolved satisfactorily. Problem-solving competency is the synthesis of knowledge, skills, attitudes, emotions, and motivations of learners to solve real-life situations in specific contexts where solutions are not immediately available instantly." (OECD, 2013). "Problem solving competency is an individual's capacity to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious. It includes the willingness to engage with such situations in order to achieve one's potential as a constructive and reflective citizen" (OECD, 2010).

From the definitions of problem-solving competency and the definition of problems associated with majors, the article defined problem-solving competency associated with the major is the ability of an individual to rely on the effective mobilization and combination of internal and external resources to successfully resolve complex situations from professional life". Internal resources are students' knowledge, skills, attitudes, strategies, emotions, morals, and motivations. External resources can be friends, teachers, experts, or the support of the community. Structure of problem-solving competency associated with majors is shown in Table 1.

Table 1. Structure of problem-solving competency associated with majors

Elements of competency	Behavioral indicator
1. Learn about problem associated with majors	1.1. Learn about the context and problem situations associated with majors
	1.2. Find out the problems associated with majors
2. Propose the solutions to problem-solving associated with majors	2.1. Building a problem tree associated with majors
	2.2. Identify the cause can solve
	2.3. Build an objective tree to problem-solving associated with majors
	2.4. Identify priority objectives

Elements of competency	Behavioral indicator
3. Implement the solutions to problem-solving associated with majors	3.1. Clarify the way to achieve the objectives
	3.2. Implement the solutions to problem-solving associated with majors
	3.3. Evaluate and adjust the steps to implement solutions to problem-solving associated with majors
4. Evaluate problem-solving activities associated with majors, detecting new problems that need to solve	4.1. Evaluate and adjust problem-solving activities associated with majors
	4.2. Find out new problems that need to solve

(Author's compilation)

It can see that problem-solving competency associated with the students' major will develop if choosing the correct method of fostering. And PBL is one of the optimal measures that can help foster problem-solving competency related to their major.

1.2. Problem-based learning (PBL)

In the world, PBL has been studied and applied effectively in practice by famous educators from countries with advanced education (Hmelo-Silver & Barrows, 2006; Hussain, Mamat, Salleh, Saat, & Harland, 2007; Savery, 2006). Several authors identified the origins of PBL in the medical schools at Case Western Reserve University and McMaster University in the 1960s and 1970s, intending to develop students' problem-solving abilities in the field of diagnostics. Clinical diagnosis. There, problems are formulated differently based on disease situations, and then students will search and discover content in each specific context. PBL has spread to other Universities in the USA, Canada, Netherlands, Denmark, Germany, Sweden, Australia, Spain, Mexico, and others. It has been successful and replicated not only for the medical profession but also for many other fields and fields such as architecture, psychology, business, biology, chemistry, science, law, physics, and engineering.

Some other authors emphasized the more simultaneous development of PBL in Europe, Australia, and North America and tailored it to the needs of each school, country, and sector, so it is more different definitions. PBL continues to replicate and popularize worldwide, reflected in the regular programs of international PBL seminars and conferences, including events in Lima, Peru (2006), in Singapore (2007), Sao Paulo, Brazil (2010), and many other events such as fostering, training, training, or establishing projects, groups to support, practice PBL (Harasym, Tsai, & Munshi, 2013).

Some prestigious universities globally have also established research centers to implement PBL for their training disciplines and share them directly on the university's websites, such as Maastricht University, Ha Lan, McMaster University, Canada; Delaware University, Newark, USA; Creighton McMaster, USA; Sydney McMaster, Australia. Currently, there is also an online publishing journal specializing in PBL operating at the Halla/Newcastle PBL Center, Cheju Halla University in Korea, with many valuable articles in science.

In Vietnam, in the early 80s and 90s, PBL first appeared at Can Tho University when cooperating with a Dutch project. However, when designing, it mainly focused on creating PBL in the form of tasks discovery service. In 2004, PBL was officially put into teaching by the Faculty of Public Health (Hanoi Medical University) to catch up with the general trend of medical schools in the world. After that, the University of Public Health implemented a pilot application for six subjects in the master's program of Public Health and one subject for the bachelor's program in the 2007 – 2008 academic year. Up to now, there are quite a few authors who researched and applied PBL to teaching at different levels and different fields as Mathematics, Physics, Chemistry, Biology (Nguyen, 2015; Phuong et al., 2016), and through some initial evaluations, many positive results obtained.

PBL has different definitions: PBL is a process of using identified problems in a scenario to improve knowledge and understanding (Wood, 2003); PBL is a process in which individuals are proactive in identifying their learning needs, setting goals, determining human and material resources, selecting and implementing appropriate learning strategies and assessment of learning outcomes (Loyens, Magda, & Rikers, 2008); PBL is an active way of learning that helps learners better retain knowledge, increases motivation and encourages learners to develop skills needed for the 21st-century job market (Maastricht University). It can seem that, although there are different definitions, PBL all have the same goal of forging skills and promoting self-directed learning of learners. In PBL, the teacher only plays the role of a facilitator, students self-direct, deciding how to approach the problem and what activities need to carry out to solve real problems in the field of training.

1.3. Problem-based learning organizational procedures

The procedures of organizing activities in PBL is interested in building and applying by many researchers and educational institutions, depending on the characteristics of the subject or majors (IOWA University; Maastricht University). According to Maastricht University, PBL can be carried out in seven steps, as illustrated in Figure 1.

The process of organizing activities in PBL is also divided into specific stages by some educational institutions and researchers (Nguyen, 2015; IOWA University; Do, 2012). According to IOWA University, organizing PBL is divided into three main stages, including: understand the problem, explore the curriculum, and resolve the problem, as shown in Figure 2.

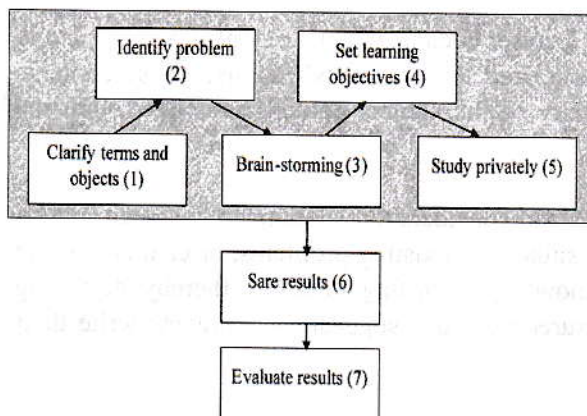


Figure 1. Seven basic steps in PBL (Maastricht University)

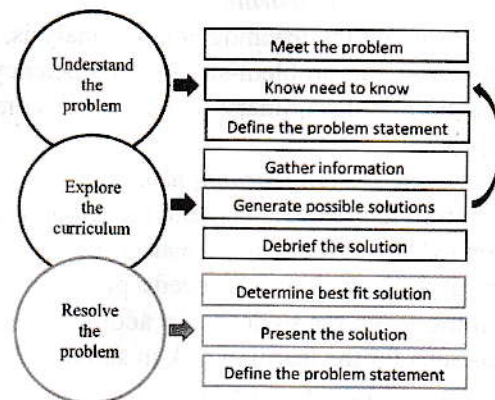


Figure 2. Stages in the PBL procedures (IOWA University)

From the above studies, we find that to build a complete PBL organizational procedures, and it is necessary to have adequate preparation, from analyzing learning outcomes, determining teaching objectives, and selecting teaching content to match the goals relevant to the major. Then lecturer designs learning tasks for students and identifies the resources known and unknown to assist students in the task performance. Next, the lecturer organizes research and performs functions with students' participation through individual and group activities. These activities are associated with component competencies in problem-solving competency related to the study, and the lecturer organizes the report and evaluation after the students have completed the task.

2. Method

The article uses the literature review about PBL, problem-solving competency associated with majors, and students' learning outcomes to propose the PBL organizational procedures to foster the problem-solving competency associated with students' majors. At the same time, the article illustrates some of the steps in this procedure when teaching some knowledge of Nuclear Physics to Nursing students.

3. Result

3.1. Problem-based learning organizational process to foster the problem-solving competency associated with students' majors

Based on the above analysis, the article proposes the PBL organizational process into stages and activities of lecturers and students, as described in Figure 3.

Stage 1. Preparation

Step 1. Learning outcome analysis

Based on the general requirements of the learning outcome that students need to achieve after graduation, the majors' learning outcome, and the subjects' learning outcome to choose and determine the essential competencies that need fostering for students.

Step 2. Identify teaching objectives

From the learning outcome analysis, the lecturer will determine the teaching objectives to foster the problem-solving competency associated with students' majors through PBL.

Step 3. Select learning contents

Based on the teaching content analysis, the lecturer decides which content is appropriate to help foster the problem-solving competency associated with students' majors. These contents must be interdisciplinary to match the complexity of the subject content associated with the majors.

Step 4. Design learning tasks

From the selected content, the lecturer learns and considers the relationship between subject knowledge and the majors, learns about current situations, existing problems, or challenges that the major is facing, and needs professional knowledge learning to solve, thereby designing learning tasks for students. In addition, the lecturer may also suggest that students write their situations for the learning task in some contexts.

Step 5. Identify resources

Based on the learning task, the lecturer identifies some available support resources for students (such as tools, learning equipment, some books, textbooks, reference materials, links to related websites, design of observation sheets, interviews, rubrics, or learning techniques) to help students better problem-solving. Some unknown resources include learning plans, modeling tools, collaboration, support from friends, experts, or the community. In this step, students can also participate in identifying some resources with the lecturer.

Stage 2. Organizing the tasks research

Step 1. Assign learning tasks to students

From designed learning tasks, lecturer assigns learning tasks to students, guides individual-group organization and activities, provides available resources to students, exposes students to relevant learning techniques, and plans real-time.

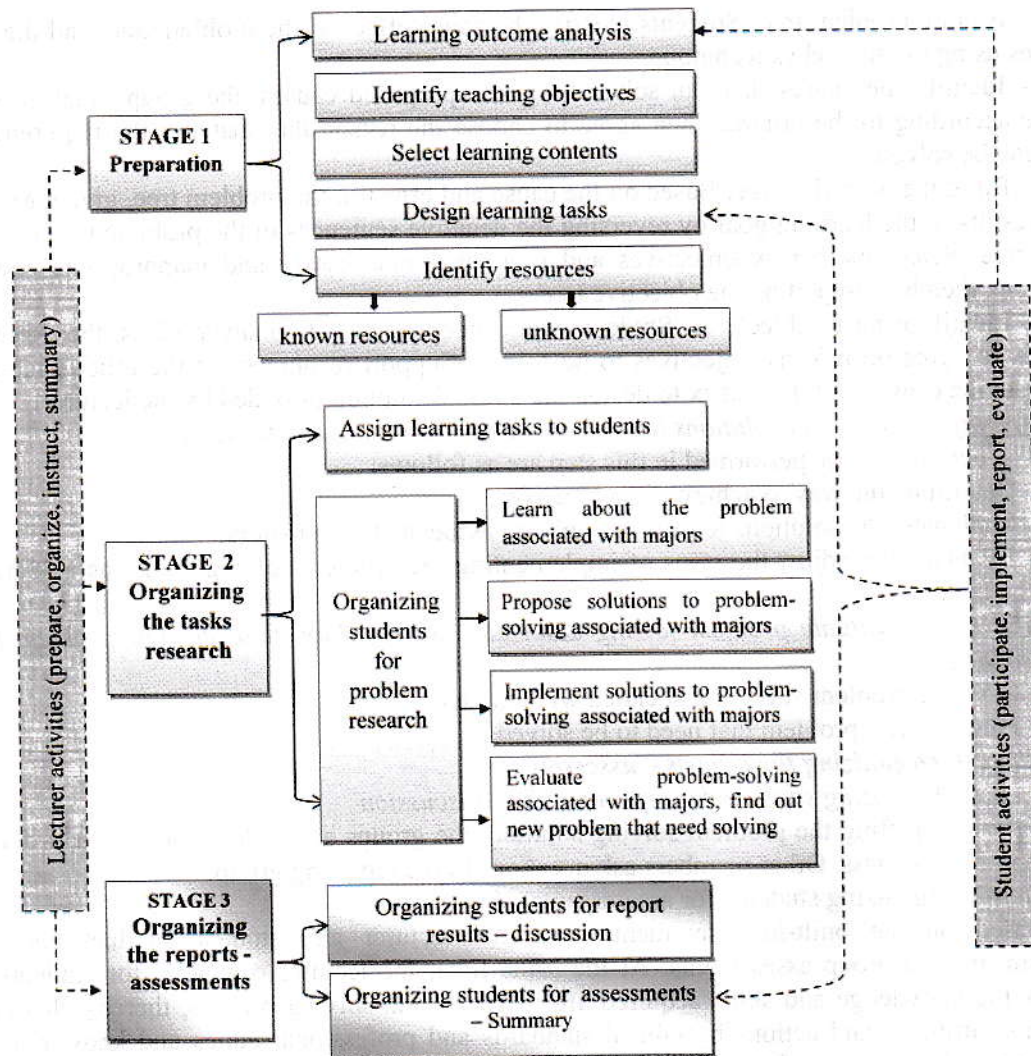


Figure 3. Problem-based learning organizational procedures to foster problem-solving competency associated with students' majors

(Author's compilation)

Step 2. Organize students for problem research

Activity 1. Learn about the problem associated with majors

From the designed task, the teacher assigns the students to perform. The task content can be a context or a practical situation of the majors, or it can also be informative from pictures, photos, videos, websites, thereby giving rise to a need for problem-solving associated with the majors through some of the following activities:

- Explain and clarify concepts and terms in the situation;
- Ask questions around the situation;
- Give the signs of problems, thereby find out problems that need to solve;
- Analyze the discovered problems through criteria or use the criteria matrix table to identify the main problem to be solved.

Activity 2. Propose solutions to problem-solving associated with majors

Each student works according to the group's common progress assignment, works independently to find solutions, then meets in groups to share and unify views. Group and individual activities are intertwined until the task is completed. The specific activities are:

- Build a problem tree: Students identify the cause-effect of the problem and find the root causes using the five whys technique.
- Identify the causes that can solve: From the proposed causes, the groups analyze each cause according to the criteria, then agree to choose the reason that matches the requirements and can be solved.
- Build the objective tree: Based on the cause and effect in the problem tree, give measures and results of the learning goal by reversing the negative sentences in the problem tree into the goal tree. Select more new objectives and removing unnecessary and inappropriate ones is possible, thereby completing the objective tree.
- Identify priority objectives: Students work independently to analyze plans, then meet in groups to agree on priority objectives to be solved. Support resources are the criteria table to evaluate the causes and the matrix to decide the optimal solution provided by the lecturer.

Activity 3. Implement solutions to problem-solving associated with majors

The activities to be performed in this step are as follows:

- Determine the way to achieve the objective;
- Implement the solutions to problem-solving associated with majors;
- Evaluate and adjust the steps of implementing the problem-solving solutions associated with the major.

Activity 4. Evaluate problem-solving associated with majors, find out new problem that need solving

- Evaluate problem-solving associated with majors;
- Find out new problem that need to be solved.

Stage 3. Organizing the reports – assessments

Step 1. Organizing students for report results – discussion

After completing the problem-solving solution, the groups assign to present their products and report to the class. Other members ask questions to the reporting group.

Step 2. Organizing students for assessments – Summary

Based on the built-in assessment tools, the lecturer and student conduct personal assessments and group assessments. At the same time, the lecturer organizes for students to review the knowledge and skills acquired after the problem-solving process, thereby changing students' attitudes and actions by ethical standards and professional ethics and know how to condemn violations of professional ethics.

3.2. Sample

In the scope of the article, we only illustrate some of the activities in stage 2 of this procedure when teaching some knowledge of Nuclear Physics to Nursing students.

Step 1. Assign learning tasks to students

Task: Nowadays, radiation therapy is a commonly mentioned method in cancer treatment, but many patients are still afraid of having radiation therapy. As a future nursing bachelor, what will you do to make patients feel secure and cooperate in care, treatment?

Step 2. Organize students for problem research

Activity 1. Learn about the problem associated with majors

Learn about the context and problem situations associated with majors

The task led to the need to find out why patients are afraid to have radiation therapy. After going to practical experience in hospitals with radiation treatment, the groups collected information from observation sheets, questionnaires, shared data and agreed to list the telltale signs problem:

- Patients are afraid of complications during and after radiation therapy.
- Patients are worried that if they can stand the pain after radiation therapy.

– Patients are worried that they and their family members will be radioactive contamination after radiation therapy.

Find out the problems associated with majors

From the listed signs, students found out the problems:

- The patient is psychologically affected after learning that he has the disease.
- Patients are worried about side effects after radiation therapy.

From the found out the problems, the groups discuss, analyzes and agrees on which problem are the most important, the most significant impact, and can solve. Students work independently, give evaluation results and score points according to the criteria, then summarize the group results and decide to choose the main problem to be solved based on the total score of the whole group. Students identify the main issue to be solved: Patients worry about side effects after radiation therapy.

The student stated the main problem in a question: What causes patients to worry about side effects after radiation therapy? What are the consequences of those causes?

Activity 2. Propose the solutions to problem-solving associated with majors

Build a problem tree associated with majors

Students use the “5 whys” technique to find the exact root causes of problems.

From the identified causes and effects, the groups discuss, arrange the primary and secondary causes and effects, then represent the contents on the problem tree diagram (Figure 4).

Identify the cause can solve

From the identified causes, the group discusses, analyzes, and agrees on which reasons are essential and have a significant influence, then fills in the criteria table for evaluating the causes and the decision matrix for the optimal plan.

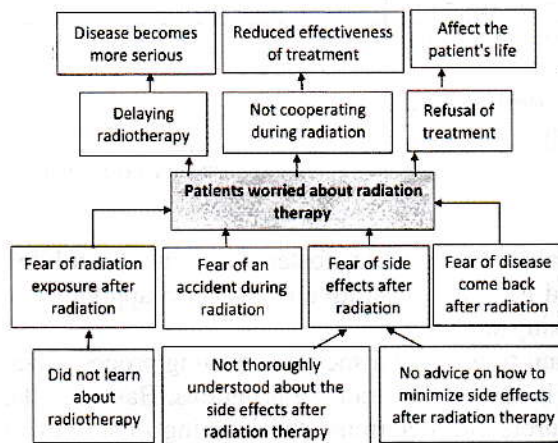


Figure 4. Problem tree

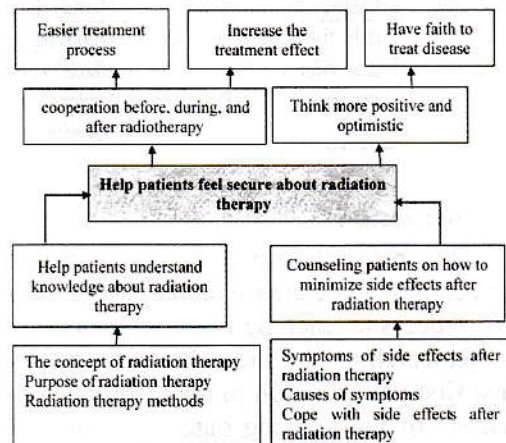


Figure 5. Objective tree

Source: Author's compilation

Build an objective tree to problem-solving associated with majors

Students determine the corresponding result and solutions from the causes – consequences mentioned in the problem tree. They can choose to add new goals, and remove unsuitable ones, thereby completing the objective tree (Figure 5).

Identify priority objectives

Students work independently to analyze the objectives, then agree on priority goals to be solved. Support resources are the criteria table to evaluate the causes and the matrix to decide the optimal solution. From there, students identify priority objectives:

- Objective 1: Help patients understand knowledge about radiation therapy
- Objective 2: Counsel patients on how to minimize side effects after radiation therapy

Activity 3. Implement the solutions to problem-solving associated with majors

Clarify the way to achieve the objectives

Students make a logical framework to determine how to achieve the objectives. The content includes: general objectives, specific objectives, outputs, activities, means of verification (support force, indicators, implementation time) (Table 2).

Implement the solutions to problem-solving associated with majors

From the logical framework matrix, team members based on the assigned tasks to perform. The group discussed and agreed on the implemented content and presented reports and products.

Table 2: Illustrated table for the logical framework

General objectives	Specific objectives	Activities	Resources	Performance time	Indicators
1. Help patients understand knowledge about radiation therapy	Help the patient understand the concept of radiation therapy	State the concept of radiation therapy Explain when to use radiation therapy			
	Help the patient understand the purposes of radiation therapy	Describe the purpose of radiotherapy Explain the choice for each purpose			
	Help the patient understand the methods of radiation therapy	Identify radiotherapy methods Describe the procedure for performing radiotherapy			
2. Counseling patients on how to minimize side effects after radiation therapy	Help the patient understand the symptoms of side effects after radiation therapy	Indicate the symptoms appearing in patients after radiation therapy in some diseases			
	Help the patient understand the causes of symptoms	Identify the causes of symptoms Identify the consequences of symptoms			
	Help the patient cope with side effects after radiation therapy	Proposing solutions to deal with side effects in patients Guidance on steps to take to deal with side effects in patients			

(Author's compilation)

4. Discussion

This research proposed PBL organizational procedures to foster the problem-solving competency associated with students' majors and gave an illustrative example in applying the PBL process to teaching Physics Nuclear for Nursing students.

Research results show that when lecturers want to propose a specific teaching process, they must first pay attention to the learning outcomes in the current training programs. Based on the analysis of the learning outcomes, the new lecturers can determine the learning outcomes in subjects, teaching objectives, learning content, methods, resources to support learning. They have organized an organization for students to research issues related to their majors. However, when the training program changes to suit the general trend of higher education, lecturers must also redefine teaching objectives in this procedure.

This study only stops at the proposal, so the reliability and validity of the procedure have not been verified. Therefore, the following research direction of the topic is to check the procedure's reliability by consulting experts and check the validity by pedagogical experiment.

CONCLUSION

To bring Vietnamese higher education deeper into the international environment, then necessary to make a complete change, both in methods, teaching means, forms of examination, and assessment, towards the development of competency for students. The article had proposed

a PBL organizational process to foster students' problem-solving competency associated with students' majors consisting of 3 stages and 9 steps and gave an illustrative example when teaching some knowledge of Nuclear Physics to Nursing students. The results are documents for teachers to refer to in organizing learning activities to foster problem-solving competency associated with students' majors in different training fields. At the same time, it creates favorable conditions for students to have the opportunity to practice competency according to the requirements of the learning outcome.

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