USING PROBLEM BASED LEARNING MODEL TO IMPROVE PROBLEM SOLVING ABILITY OF MEDICAL STUDENTS

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ABSTRACT

The purposes of this research were 1) to use problem-based learning model to improve problem-solving ability of medical students and 2) to compare students' problem-solving ability, before and after the implementation base on the problem-based learning model. The simple group included 30 samples for this research were 2nd year university medical students from Weifang Nursing Vocational College. The research instruments involved 1) lesson plan and 2) problem-solving ability assessment. The data were analyzed by mean, standard deviation and t-test for dependent samples.

The results revealed the followings:

1. The instructional model for using problem-based learning model to improve the problem-solving ability of second year medical students which consists of 1) Create questions 2) Implementation Problems 3) Results showcase 4) Reflection evaluation 5) Expanded applications, it was able to improve the problem-solving ability of medical students, achieving the research objectives.

2. The comparing students' problem-solving ability before and after teaching in the problem-based learning model, second-year medical students the assessment scores prior the class had the average 17.28 (SD.=4.83) another, the assessment scores after the class had the average 20.41 (SD.=4.10). The assessment scores after the class were higher than prior the class by statistically significant at the .01 level.

Keywords: Problem-based learning model, Problem-solving ability, Medical students

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Jia Zhenzhen

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Introduction

Rationale

One of the higher-order abilities required of students in the twenty-first century is the ability to solve problems. Cultivating problem-solving ability is the demand of China's quality education reform and the cultivation of creative talents, and this ability is not the ability of students to simply solve problems, but the ability to consider them comprehensively and apply what they have learnt to solve some complex problems (Yang,2016). Problem-solving is a process in which every student should be trained. Ministry of Education of the People's Republic of China (2010) National Programme for Medium- and Long-Term Educational Reform and Development Plan clearly states: “Promote the diversification of cultivation modes, and endeavor to improve students' problem-solving abilities." Therefore, improving students' problem-solving ability has become the entry point for cultivating creative talents, and it is also the necessary way for China's education and teaching reform to go deeper.

Currently, the problem-solving ability of medical students in clinical practice is not satisfactory. For medical students, when they enter the university after experiencing primary education and secondary education, the content they learn for a long time is refined, filtered, and rich in logical knowledge system, and the exercises they practice are general exercises with just enough conditions. Such learning and connection can make students in a shorter period of time, master a large amount of knowledge, has the characteristics of high efficiency. However, this traditional education and teaching method will make students think rigidly and lack the ability to solve problems when facing clinical problems (Liu,2019). China attaches importance to rehabilitation medicine in line with international standards, China provides 5 years of clinical medical education for undergraduate medical students (Li, 2022).Exercise therapy is an important part of rehabilitation medicine, and the current clinical status of rehabilitation medicine in China shows that professional rehabilitation medicine in China started relatively late compared with the more than one hundred years of development history of rehabilitation medicine in developed countries such as the United States. From the perspective of the current development of the industry, China's sports rehabilitation talent system has not yet

matured, and the lack of professional talent resources has a great gap, and there is a long way to go in the cultivation of sports medicine talents.

The traditional teaching model has limitations in teaching exercise therapy courses. The problem-based learning model provides the necessary avenue for the pedagogical application of exercise therapy. Schmidt et al. showed that in a university course on nutrition, students in an experimental group who applied the problem-based learning model developed stronger thinking and problem-solving ability than those who were instructed in the traditional method. Alrahlah's study showed that the problem-based learning method significantly improved the teaching and learning outcomes of a professional dental course, and enhanced dental students' critical thinking, analytical and problem-solving ability, and prepared them well for their future careers (Hmelo-Silver, 2004). The problem-based learning model has more obvious advantages over traditional teaching models and it can be concluded that the scientific method using the problem-based learning model is a type of learning in which students are committed to solving scientifically authentic problems and assigning meaning to the information and events they experience. (Obinna, Chidume and Christian,2022)

In summary, educational institutions have a responsibility to promote and support the development of problem-solving ability in medical students, and there are limitations of the traditional teaching model in the teaching of kinesiotherapy courses. The traditional teaching mode is not student-centered, which seriously restricts the cultivation of students' problem-solving ability and makes it difficult to achieve the expected results. Compared with the traditional teaching mode, the advantages of the problem-oriented learning mode are more obvious. Reasonable use of the problem-based learning method can improve the quality and efficiency of classroom teaching and alleviate the limitations of traditional classroom teaching to a certain extent. The problem-based learning mode has been recognized by scholars at home and abroad, and its problem-solving advantages have been proved by many scholars and teachers through practice. Therefore, this study attempts to apply the problem-based learning model to the teaching of exercise therapy from the requirements of the new curriculum standards, in order to better investigate the cultivation and development of students' problem-solving ability in the teaching process.

Objectives

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Research Hypothesis

After the implementation based on problem-based learning model, the students' problem-solving ability has been improved obviously.

Scope of the Research

Population and the Sample Group

Population

There are 150 second-year medical students majoring in exercise therapy of Weifang Nursing Vocational College, 5 classes with 30 students in each class.

The Sample Group

Through cluster random sampling, 30 second-year class 3 medical students with mix abilities (strong, mediem, and weak) of Weifang Nursing Vocational College were sampled.

The Variable

Independent Variable

Problem-based learning model.

Dependent Variable

Problem-solving ability.

Content (s)

The purpose of this study is to use the problem-based learning model in the course of exercise therapy to improve students' problem-solving ability of exercise therapy. This course is divided into the following four chapters.

Chapter 1: joint mobility training	3 hours
Chapter 2: Balance and Coordination Training	3 hours
Chapter 3: strength training	3 hours
Chapter 4: breathing training	3 hours

Time

The study period is from March to October 2023 is divided into the following phases:

1. Develop proposal research in March 2023.

2. Modified and completed 1) the lesson plan based on the problem-based learning model and 2) the problem-solving ability assessment from June to August 2023.

3. Experimental studies will be conducted from August to September 2023.

4. The formal study will be conducted from August to September 2023.

5. Summarize the research and complete the research paper, which will be published in October 2023.

Advantages

1. For students. The use of problem-based learning model can mobilize the enthusiasm of medical students to learn kinesiotherapy courses and prepare them for the improvement of their professional course performance. In addition, the use of problem-based learning model to cultivate the problem-solving ability of medical students is an expansion of the scope of application of this mode in the teaching of exercise therapy in universities, and it is also a way to cultivate the problem-solving ability of medical students to improve their problem-solving ability.

2. For teachers. The introduction of problem-based learning model in the classroom can help teachers understand students better, improve their teaching and design skills, enrich teaching methods, increase students' interest in movement therapy, and provide theoretical references for improving students' problem-solving ability in the problem-based learning model.

Definition of Terms

Problem-Based Learning model: Problem-based learning model is a student-centered teaching model with a problem-solving focus and constructivist learning approach that uses real problems as experiences. It emphasizes students as the main organ of learning and increases their autonomy through self-directed learning. The problem-based learning model provides authentic experiences that promote active learning, support the construction of knowledge, and naturally integrate school learning with real life. The learning aspects of the problem-based learning model are hereby summarized into the following five steps.

Step 1 Create questions, Before the class set up learning tasks, students complete the assessment according to the task, the teacher preliminary assessment, to determine the group. Teachers according to the actual work tasks and the existing cognitive level of students, create problem situations; classroom, the teacher guides the students to ask questions, the formal start of new knowledge learning.

Step 2 Implementation Problems, After asking a question, students describe the problem and analyze its content. When encountering easy problems, students explore independently in small groups. When the problem is difficult, the teacher demonstrates the operation and guides the students to carry out co-operative learning and actively find solutions to the problem.

Step 3 Results showcase, At the end of the students' collaborative learning, two student representatives or representatives from each learning group present the training learning outcomes while other students listen carefully and add to them. The teacher summaries and evaluates the students' training learning outcomes and gives clear answers to the questions.

Step 4 Reflection evaluation, The teacher guides the students to summarize and reflect on the learning outcomes so that they can figure out what the experiences and shortcomings are, while the teacher comments on the effectiveness of each group member's cooperation and the overall performance of the operation, and suggests improvements.

Step 5 Expanded Applications, After the teacher's evaluation, the students are guided to expand their ideas in order to assessment whether they have mastered the new knowledge, exercised their knowledge application and transfer ability, and further improved their communication skills.

Problem-solving ability: Problem Solving is the ability of individual learners to apply cognitive processes to address and solve problems in authentic interdisciplinary contexts. This definition emphasizes that problem-solving ability are applied in authentic interdisciplinary situations that require individual learners to apply cognitive processes to solve problems. Such competencies include, but are not limited to, analyzing problems, solving problems, applying creative thinking, and teamwork. Problem Solving is as a process caused by a certain situation, according to a certain goal, applying various cognitive activity skills, after a series of operations, so that the problem can be solved. PISA (2003) analyses the six major competencies of problem-solving ability, which are more comprehensive and more relevant to the needs of problem-solving ability training in the new era. The author has sorted out the composition of PISA problem-solving ability and believes that the problem-solving ability of medical students should include six aspects: 1) Comprehension ability, 2) Discriminatory ability, 3) Presentation ability, 4) Problem-solving ability, 5) Reflective ability and 6) Communication ability. Therefore, the teaching programmer of the exercise therapy course will be designed to enhance students' problem-solving ability based on these 6 areas.

Medical students: Medical students are students who study various medical specialties in medical schools, including clinical medicine, rehabilitation medicine, preventive medicine, dentistry, Chinese medicine, psychology, forensic medicine, medical testing, anesthesiology, medical imaging and other specialties. The object of this study is the rehabilitation of medical students who, after graduation, will use physiotherapy, exercise therapy, life training, skills training, speech training and other means to maximize the recovery of the sick and disabled or elderly with limited activities, so that they can achieve the maximum possible self-care, labor and work abilities and lay the foundation for social reintegration. Rehabilitation medical students can work clinically in hospitals, as well as in the community, nursing homes, health centers and rehabilitation centers.

Research Framework

Using problem-based learning model to Improve problem-solving ability of medical students. The research concept framework is as follows:

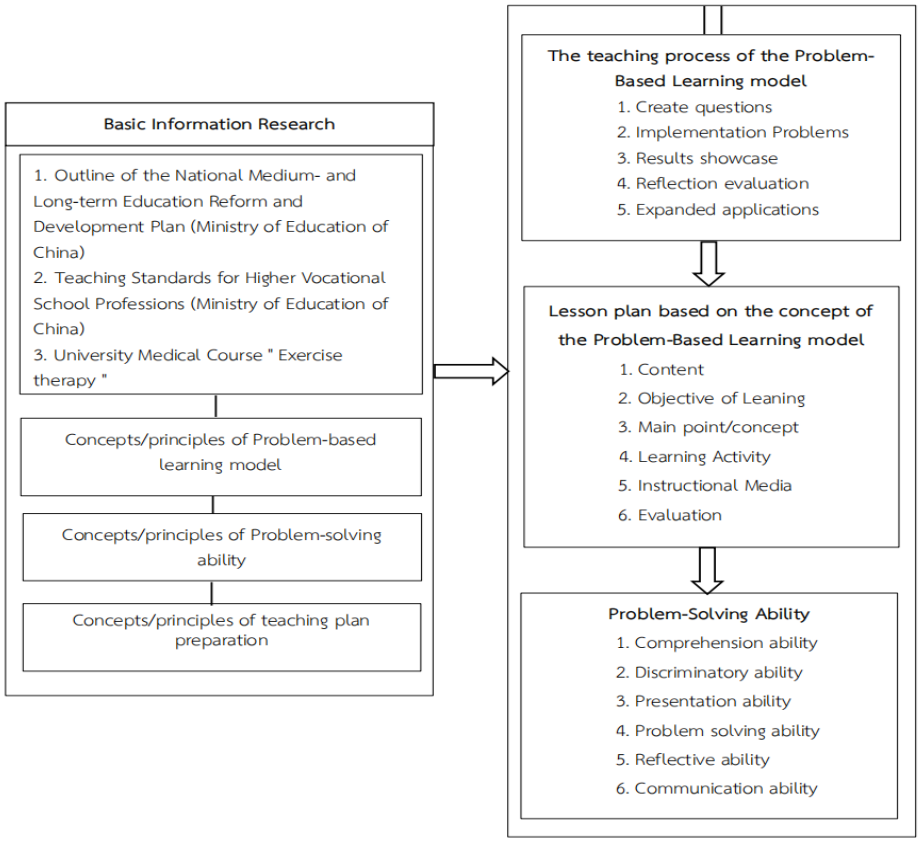

Figure 1.1 Research Framework

Chapter 2
Literature Review

Using problem-based learning model to Improve problem-solving ability of medical students. Therefore, with the theme of problem-based learning model, the implementation link of the problem-based learning model, sports medicine and exercise therapy, we use tools such as CNKI, Google Scholar and Baidu Library to retrieve and review relevant documents, and organize them, and study the following documents:

1. Problem-based learning model
2. Problem-solving ability
3. Medical course
4. Relevant research

The relevant details are as follows:

Problem-Based Learning model

The problem-based learning model is a constructivist learning approach, and its implementation can help students better understand the knowledge of exercise therapy. Therefore, teaching activities under the guidance of the problem-based learning model can improve students' problem solving, independent inquiry, and teamwork skills. Theoretically, combining the problem-based learning model with the exercise therapy classroom with a view to developing students' clinical practical problem-solving ability is not only an expansion of the scope of the problem-based learning model in teaching applications, but also an enrichment of the practical test of the theory and an enrichment and development of the methodological theory of developing students' problem-solving ability.

The meaning of Problem-Based Learning model

In general, the "P" in PBL can be "Project" or "Problem", but the "P" in this paper is the abbreviation of "Problem". In this paper, "P" is the abbreviation of "Problem", so the full English name of "PBL" is Problem-Based Learning.

The "P" is "problem", which refers to a poorly constructed problem, and it is a problem derived from a real-life situation, not a dry and life-disconnected rote knowledge. The essence of problem-based learning model is to take a real problem situation as the starting point for students to investigate and analyze, and the

problem usually has more than a single solution or answer. Students can use different methods to solve the problem or get different answers through their efforts.

The "L" here refers to the abbreviation of "learning", which means learning, reflecting that the main object of learning activities is not the teacher but the students, and that the students are no longer passive recipients of knowledge instilling, but can actively learn from their hearts. It means learning. Teachers do not provide knowledge, but design real problem situations in the problem-based learning classroom to guide and stimulate, give appropriate guidance to students in Problem-Based Learning activities, and act as the "scaffolding" for students' learning.

Barrows, H. S. and Tamblyn, R. M. (1980, p.28) states that problem-based learning model is a model of education. The curriculum is problem-focused, with problems carefully selected and designed, while the problems need to be challenging. Problems are solved in a systematic way, the relationship between teachers and students is transformed, and students are expected to plan and handle problems on their own, with some guidance and assistance from the instructor.

Schmidt, H. G. and Moust, J. H. (2000, p.18) proposed that the definition of problem-based learning model can be divided into a narrow uppercase "PBL" and a broad lowercase "pbl". The former is a teaching method based on the systematic standard structure and process established by Barrows in medical teaching, while the latter It refers to an educational method characterized by problem orientation and without firm definition.

Liu, R. D. (2001, p.54) believes that problem-based learning is student-center instruction, through problem-based learning, 2 knowledge related to problems. Through a series of problem-based learning, students' understanding of their own professional knowledge can be promoted, so that students' ability to diverge thinking and solve practical problems can be improved. This model is problem-centered, allowing students to engage in a process of knowledge construction around the problem, which promotes the acquisition of a flexible knowledge base and the development of high-level thinking skills, problem-solving ability and independent learning. The learning process includes the organization of the group, the start of the problem, the cycle of repeated problem solving, the results of the presentation and the final reflection and evaluation. This teaching mode is more consistent with the current trend of education reform in China, and is very inspiring to the domestic teaching reform.

Torp, L. and Sage, S. (2002, p.20) pointed out that: The problem-based learning model is an approach to learning that uses real problems as experiences. It

emphasizes students as the main organ of learning and increases their autonomy through self-directed learning. The problem-based learning model provides authentic experiences that promote active learning, support the construction of knowledge, and naturally integrate school learning with real life; this curricular approach also meets national and state standards for the integration of disciplines. Problem situations are at the heart of the organization of the curriculum, engaging and keeping students interested in the problems they are solving, while highlighting different perspectives. Students are committed problem solvers who identify the root causes of problems and the circumstances necessary for a good solution, seek meaning and understanding, and become self-directed learners. Teachers are problem-solving colleagues who lead by example, stimulate interest and enthusiasm for learning, and are cognitive coaches who create environments that support open-ended inquiry.

Zhao Haitao (2004, p.20) believed that the problem-based learning model is equally important in developing students' ability to understand knowledge and their ability to apply knowledge, and pointed out that the teaching goal of the problem-based learning model is not for students to acquire professional knowledge, but to learn to learn to transfer." Problem-based learning has had a broad and positive impact on teaching and learning at all levels and in all types of schools in the United States and has developed into a unique model of teaching and learning. The underlying philosophy, characteristics and theoretical underpinnings of this model are well developed. In other words, through the problem-based learning model, students can learn how to apply their knowledge to real-world problems and be able to transfer this ability to other areas.

Yang, L. Y. (2005, p.3) pointed out that the problem-based learning model is a collaborative group effort in which learners work together to solve real problems in complex, meaningful situations, and in the process acquire scientific knowledge and develop problem-solving, independent learning and lifelong learning skills. The main feature of problem-based learning model is problem-centered, group-based and individual independent learning. This teaching method can enhance students' motivation, promote high-level thinking, improve their ability to acquire and apply knowledge, and develop certain interpersonal skills.

Zhang Jingjing (2010, p.13) believed that Problem-based learning (PBL) is a kind of teaching mode "focusing on constructivist thinking", which originated in foreign higher medical education and has gradually attracted the attention of domestic researchers. Under the situation of the new round of curriculum reform in China, the

problem-based learning model is based on the real world, and students work together in problem situations to acquire theoretical knowledge and develop independent learning, cooperative learning, inductive judgement and problem-solving ability, and critical thinking.

Savery, J. R. (2015, pp.5-6) pointed out that the problem-based learning model is a practical solution that enables students to solve problems based on concrete problems and theories, when theory is combined with practice. The problem-based learning model is an approach to teaching and learning that has been used successfully for over 30 years and continues to be widely accepted in many disciplines. It is a learner-centered pedagogical (and curricular) approach that allows learners to re-investigate, integrate theory with practice and apply knowledge and competences to develop a workable solution to a defensible problem. Although problem-based learning has many advantages, there are some challenges and limitations in its practical application. Therefore, the use of problem-based learning needs to be evaluated and adapted to the specific situation to ensure that it can achieve good results.

Although experts and scholars at home and abroad do not have a unified discussion on the definition of problem-based learning model, their basic ideas are the same: (1) Problem-based learning model is understood as teaching mode, teaching method, learning mode, and teaching strategy, but they all advocate treating problems as the main line of teaching and learning advocates that students are the main body of problem solving. (2) Problem-based learning model emphasizes that the questions should have a practical background and fit with the students' actual life situations, so as to arouse students' interest in learning. (3) Problem-based learning model should not only emphasize the basic knowledge of students, but also develop students' creative thinking and problem-solving ability.

In summary, problem-based learning model is a student-centered teaching model with a problem-solving focus and constructivist learning approach that uses real problems as experiences. It emphasizes students as the main organ of learning and increases their autonomy through self-directed learning. The problem-based learning model provides authentic experiences that promote active learning, support the construction of knowledge, and naturally integrate school learning with real life.

Characteristics of Problem-Based Learning model

There are multiple variants of the characteristics of the problem-based learning instructional model, and different scholars may devise different characteristics of the problem-based learning instructional model depending on their research areas

and research questions. These variants may differ in terms of specific instructional design, implementation methods, and application areas.

Barrows, H. S. and Tamblyn, R. M. (1980, p.18) believed that the characteristics of Problem Based Learning: students are responsible for their own learning; problems must be ill-structured; learning is a combination of interdisciplinary; cooperation is necessary; independent learning results to get feedback; discuss and summarize learned knowledge, concepts , principles; self-evaluation and student peer evaluation; activities must be meaningful and valuable activities in the real world; students conduct progressive evaluation; Problem-based learning is the teaching basis of the course, not part of it. Most medical students, especially those studying basic science programmes, have to memorize a large number of 'facts' that may or may not be relevant to medical practice. Problem-based learning has two key assumptions - that learning through problem-solving is more effective in creating a body of knowledge that is usable in the future, and that the most important skill for a doctor to have for a patient is the ability to solve problems, not memorize skills.

Bridges, E. M. and Hallinger, P. (1999, p.4) considered the characteristics of Problem Based Learning: starting from real-world problems, problems are the center of learning, student groups or individuals are responsible for teaching and learning, and learning occurs in group situations. In the problem-based learning model, the stimulus for new learning is usually a problem, but not always presented as a case. Students work in small groups (six to eight); they learn how to apply their newly acquired knowledge to problems they may encounter in the future. Depending on the teacher's teaching objectives, one student may be designated as the group leader responsible for allocating the time needed to solve the problems in the case, while other students may take turns as moderators or note-takers.

Newman, M. J. (2005, p.10) pointed out five key features: first, in problem-based learning, the role of the teacher is to facilitate student learning, not to impart and instill knowledge; second, in the problem-based learning classroom, there must be a clear set of third, the questions must be ill-structured and from real-life situations, so as to help students integrate learning into the environment; fourth, poorly-structured questions require students to learn cooperatively; finally, the assessment must Goals and learning goal-driven in ill-structured real-world problems. These features embody the core ideas and operational methods of problem-based learning, which are important guides for both teaching and learning in practice. Through problem-based learning, students are able to better understand and apply what they

have learnt, improve their problem-solving and creative abilities, and also promote the development of their cooperative and independent learning abilities.

Qiao Lianquan (2007, p.5) pointed out that the problem design in problem-based learning model should be jointly participated by teachers and students. After the problem is designed, the teacher guides the students to conduct inquiry and analysis, and finally the students use the knowledge they have learned to solve the problem. Problem design in problem-based learning model is a very important bad section. Good problems can stimulate students' interest and motivation in learning and develop their practical ability and creativity. Therefore, the design of problems needs to be challenging, open, practical and interdisciplinary. Only in this way can students get the maximum learning value in problem-based learning model.

Du Xiangyun, Comos, A. and Zhong Binglin. (2013, pp.5-6) pointed out that problem-based learning is a learning method that starts from the problem situation and can help students find evidence and explore knowledge independently. Problem-based learning links learning to a larger task or problem and engages students in the problem; it designs authenticity tasks that emphasize setting learning into complex, meaningful problem scenarios and solving problems through student-directed inquiry and collaboration, thereby learning the science implicitly behind the problem and developing problem-solving abilities and self-directed learning.

Zhang Xumei and Xu Zuoying (2018, pp.2-3) sorted out the classroom teaching operation process of problem-based learning based on Barrows' model, which is carried out in the following links: (1) Creating a problem situation: the teacher creates a real and meaningful problem situation to stimulate students' interest and motivation to investigate. (2) Putting forward a general question: Teachers put forward a general question to guide students to think and explore. (3) Presenting materials and refining the problem: Teachers provide some relevant materials to help students understand the problem better and refine it. (4) Problem solving: students solve the problem and find the solution through independent enquiry and cooperative learning. (5) Presentation and exchange of results: Students exchange their solutions with their peers through reports, presentations and discussions, and accept the evaluation and suggestions of others. (6) Summarizing and evaluating: Teachers summarize and evaluate students' performances and solutions to help them better understand and apply what they have learnt, as well as to improve their problem-solving and creative abilities. These sessions can help students better understand and solve problems, and improve their independent

learning ability and creativity. At the same time, the problem-based learning model can also promote interaction and communication between teachers and students so that students can better understand what they have learnt and apply it to real life.

Chen Hui (2017, p.12) pointed that the process in problem-based learning model begins with creating a problem situation, focusing on problem identification and analysis, collecting information, and finally solving the problem and extending it. These links can help students better understand and solve problems, and improve their independent learning ability and creativity. At the same time, the problem-based learning model can also promote interaction and communication between teachers and students, so that students can better understand what they have learnt and apply it to real life. The problem-based learning model strategy permeates the whole teaching process, thus enriching the teaching methods of secondary school biology teachers and developing the comprehensive quality of students, and laying the foundation for students' lifelong development.

Liu, H. et al. (2019, p.8) pointed that under the perspective of core literacy, high school biology teaching based on the problem-based learning model is carried out in the following ways:(1) Dividing groups and assigning tasks: the teacher divides students into groups and assigns tasks to ensure that each group has a clear task and role. (2) Creating a situation to elicit a problem: the teacher creates a problematic situation, guides students to ask specific questions, and identifies problems that need to be solved. (3) Analyzing what is known and dissecting the theme: students analyze and define the problem, identify key elements and relevant relationships, and sort out existing knowledge and experience. (4) Collecting materials and exploring: Students collect information and knowledge related to the problem through independent searching for materials, and carry out discussion and exploration to find a solution. (5) Multi-evaluation and summary: Teachers conduct multi-evaluation and summary of students' performance and solutions to help students better understand and apply what they have learnt, as well as to improve their problem-solving and creative abilities. These sessions can help students better understand and solve problems, and improve their independent learning ability and creativity. At the same time, the problem-based learning model can also promote interaction and communication between teachers and students so that students can better understand what they have learnt and apply it to real life.

In summary, the problem-based learning model is characterized by the following aspects:

1. Problem-oriented teaching organization

In order to stimulate students' interest in learning, problem-based learning sets up a lot of oriented questions, some of which are found and explained by students, and some are unknown to students and need to be studied. The perceived quality of questions by students (defined in terms of how clearly the questions are in front of students, their ability to spark interest and spark group discussion, etc.) is a major source of problem-based learning influence. The quality of the questions affects not only the quality of the group discussion, but also the time for self-study and interest in the topic. Problem-based learning promotes students' active learning. Students actively construct new knowledge that is closely related to the previous ones under the stimulation of questions. Questions are the focus of cultivating thinking.

2. The educational concept of taking students as the main body and teachers as the leading

In the problem-based learning model, in order to better solve problems, students actively choose to search for more efficient and beneficial relevant materials, independently formulate and arrange their own study plans, and students have sufficient autonomy in the whole process. Pupils who adopt a problem-based learning model are more independent learners and take greater personal responsibility for their learning. In a problem-based learning model, students are the main learners, discovering and solving problems independently. Teachers should facilitate or activate student learning and promote effective team functioning by encouraging active participation of all members, monitoring the quality of learning and intervening where necessary. Teachers should also actively support student learning by providing a framework for students to generate knowledge independently, encouraging students to think deeply and providing examples of the kinds of questions students should ask when solving problems.

As a facilitator of learning, teachers need to keep the process going, monitor and ensure that all students are involved. Teachers can ask questions and issue tasks to know students' expression, knowledge integration, communication and interaction process. Students gain more independent learning ability in this process, and have the ability to solve problems independently in future work and study.

3. Take the small group as the unit and be collaborative

Problem-based learning model divides the students who need to complete the task into several groups, and they divide and cooperate around the common central problem that needs to be solved. In a group setting, students communicate and collaborate, for example, explaining material to others, asking their own questions and answering those of others. In this process, students should discuss and vote on role distribution, establish the specific content of the division of labor, collect, organize and analyze data, and conduct evaluation and reflection within the group. Heterogeneous groups cooperate around a common goal, which can not only enhance the interaction in the emotional field, but also meet the needs of the individual's internal psychological sense of belonging through communication and mutual help within the group, and improve interpersonal communication and cooperation ability and cooperation levels. The main functions of the group are as follows: 1) Motivation. A team motivates its members to give their best efforts, because members can only achieve their individual goals if the team succeeds. 2) Stimulate cohesion. Team members work together for their own interests, which promotes the development of team spirit. 3) Developmental concepts. There is a lot of interaction in student learning, including discussing, arguing, presenting and listening to each other's points of view, and these activities can promote students' mutual learning. 4) Improve cognitive elaboration ability. Students can improve by combining acquired information with prior knowledge for self-expression. A group's success is inseparable from these motivations and cognitive processes, and interaction is most important in terms of success.

The process of Problem-Based Learning model

A study of the existing literature reveals that there are multiple variations of the problem-based learning model, and different scholars have designed different basic processes of the problem-based learning model according to their own research areas and research questions.

Barrows, H. S. (1980, pp.10-12) systematized the structure and flow of problem-based learning activities, the display is as follows:

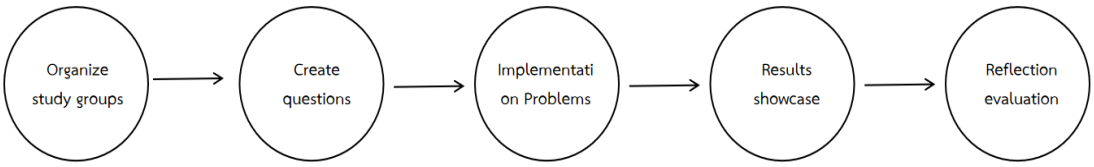

Figure 2.1 The teaching process proposed by Barrows

From the above chart, we can see that "problem-based learning" is divided into five stages. The five-step model is "organizing group work, creating a situation to ask questions, cooperatively learning to explore problems, solving problems, sharing, and summarizing and reflecting to evaluate feedback.

Step 1 Organize study groups

First, after a brief introduction, the teacher and the students divide the learning groups to prepare for the subsequent cooperative group learning and to clarify their respective division of responsibilities.

Step 2 Create questions

The teacher presents the students with a small number of clues of a complex problem, and the student groups fully mobilize the relevant information already in their minds to Cognitive information, systematically analyze and define the problem, find the terminology and main concepts contained in the problem, and try to analyze whether the main concepts contained therein can be further refined into several sub-concepts or sub-problems. The main concepts contained in the problem can be further subdivided into several sub-concepts or sub-problems, and the sub-concepts can be solved in a teacher and students finally form a unified learning goal.

Step 3 Implementation Problems

Each member of the group shares the information they have collected within the group, tries to combine a variety of newly acquired knowledge to solve the problem, formulates a hypothesis and verifies whether the hypothesis is valid. In this session, each member is actively involved in the discussion and exchange, and in the process of evaluating others' opinions and insights, they complete the integration of knowledge points to form a systematic solution to the problem.

Step 4 Results showcase

After the discussion, each group will compile the learning results of the group and try to share and report their conclusions and the process of solving the problem in various forms, such as oral narration, deduction of flow chart, role play, simulation experiment, etc.

Step 5 Reflection evaluation

Finally, the teacher needs to comment on the results of the group reports, help students identify problems in the problem-solving process, as well as problems that may be common to all groups, and help students deduce a more complete problem-solving process and summarize the problem situations for which the approach is suitable for subsequent knowledge transfer and application.

The organization of the learning process should pay attention to the ability and quality of each member of the group, create a harmonious group atmosphere, and help students quickly enter the state of problem study; creating problems includes decomposing the problem, making assumptions and understanding the problem in depth; the process of implementing the problem requires the integration of learning results through intra-group sharing and repeated revisions, and students solve the problem through group cooperation with appropriate guidance from the teacher; displaying the results refers to the summative report of the group members and reflection on the activity process; reflective evaluation is mainly in two ways: self-evaluation and mutual evaluation.

Barrows' five-step model provides a complete set of teaching methods for the problem-based learning model, including: organizing a learning group, starting a new problem, solving the new problem (follow-up), presenting the learning results (activity debriefing), and reflecting after solving the problem. The five modules constitute a complete teaching process, and in each of them there is a specific operation step, and each link is closely related to each other, forming a complete model. In the whole process of problem solving, students not only solve the problems proposed by the teacher and learn the theoretical knowledge, but also improve their abilities in analysis, solution and cooperative inquiry.

Barrows distinguishes the problem-based learning model from the "Developing Instructional Modules" of the Systematic Design for Teaching model by Walter Dick, Lou Carey, and James O. Carey, both of which include specific instructional processes. Dick, Lou Carey, and James O. Carey, in Systematic Design for Teaching and Learning, suggest how to organize instruction (learning), ask questions, solve problems, organize reporting of results, and assess instruction (learning).

Edens, K. M. (2000 p.58) argues that problem-oriented learning can be divided into three stages:(1) Problem development stage: This stage involves two main issues. One is the source of the problem, which can be developed independently by the instructor, jointly by the instructor and the learners, or by the learners themselves. The second is the nature of the problem, which should be complex, inquisitive, challenging and with sufficient clues. (2) Problem inquiry phase: This is the process of scientific inquiry. This process is important and includes the following steps: defining the problem, building a hypothesis, combining old and new experiences, proposing steps to solve the problem, collecting data, analyzing and communicating data, and proposing possible solutions. (3) Problem validation phase:

This phase includes, validating the learners' solutions, and submitting task reports to assess the learners' performance.

Hmelo-Silver, C. E. (2004, pp.240-241) proposed a five-stage model for applying the problem-based learning model. The first stage involves exploring the situation and characterizing the problem; the second stage involves forming various hypotheses about problem solving; the third stage involves identifying missing information and clarifying the topic of learning; the fourth stage involves integrating new and old knowledge to solve the problem and testing previous hypotheses; and the final stage involves summarizing the knowledge and skills gained. This five-stage model contains two clues, one is the explicit cognitive clue aimed at discovering and solving problems, and the other is the implicit socio-cognitive clue that focuses on group cooperation and joint problem solving. The two cues advance in parallel. This five-stage model places high demands on students' cognitive and social skills.

Zhao Haitao (2004, p.56) pointed out that the problem-based learning model consists of the following links: (1) Creating a problem situation: teachers need to create a real and meaningful problem situation to stimulate students' interest and motivation to investigate. (2) Interpreting the problem in relation to what is known: students need to use their prior knowledge to understand the problem and to analyze and define it. (3) Formulating hypotheses: Students need to formulate hypotheses to solve problems and verify them through experiments or investigations. (4) Consulting information: Students need to collect information and knowledge related to the problem by searching for information independently. (5) Independent research: Students need to think and investigate independently to find the best way to solve the problem. (6) Reporting findings in a group: Students need to report their findings in a group to communicate and share with their peers. (7) Constructive reflection: Students need to reflect on their own learning process, summarize their experiences, improve their methods and enhance their learning. These sessions can help students better understand and solve problems, and improve their independent learning ability and innovation. At the same time, the problem-based learning model can also promote interaction and communication between teachers and students, so that students can better understand what they have learnt and apply it to real life.

Wang Wei (2005, pp.108-110) believed that the problem-based learning model consists of creating a situation to pose a problem, organizing group learning, independent study, cooperation and communication, and presenting the results of the summary and evaluation of the four major links. Care needs to be taken that the

problems set in problem-based learning have a degree of authenticity. Due to the complexity and authenticity of the problems, which require division of labor among learners, students are usually organized into groups. Each group, according to the problem to be solved, determines the learning objectives under the guidance of the teacher and understands the knowledge necessary to achieve the objectives. After discussing and solving the problem, the groups present the results to the teacher and other groups using different forms, tools and skills. Finally, the teacher summarizes and evaluates the problem-solving process, and group members reflect on and evaluate their own learning process under the guidance of the teacher, summarizing the knowledge and thinking skills they have acquired.

Schmidt, H. G., Rotgans, J. I. and Yew, E. H. (2011, pp.792-806) summarize Loyens M.M. Sofie's division of the problem-based learning process into three phases: in the first phase, Implementation Problems; in the second phase, students review relevant literature; and in the third phase, Reflection evaluation. Sofie's empirical study of problem-based learning in a real classroom environment demonstrated that problem-based learning significantly promotes deep learning. Typically characterized by a focus on critical understanding, integration of information and transfer of application, Problem-based learning is an attempt to provide solutions to complex problems that involve the development of higher-order thinking and problem-solving abilities.

Wu Gang (2012, pp.3-7) concluded that problem-based learning instructional design is mainly aimed at solving teaching problems and promoting learners' learning, based on the principles of "teaching" and "learning", using a systematic approach to the teaching objectives, teaching content, teaching methods and teaching evaluation. Specific planning, design effective teaching system "process" or "procedure". As a highly practical teaching and learning model, problem-based learning requires careful planning of its objectives, content, strategies and processes if it is to achieve significant results in practice, such as Benjamin's eight-step model for proposing a problem-based learning model, "Create questions, Implement Problems, generate hypotheses, confirm what is known, establish required information, Results showcase, Gather new information, Expanded Applications".

In summary, many scholars have different views on the implementation process of problem-based learning model, and the development of a good "problem" is the key to the successful implementation of problem-based learning model. During the implementation of the problem-based learning model, the general learning process of problem-based learning model involves the following steps:

"grouping, guiding, analyzing, solving and evaluating". In the process of analyzing a problem, students can use both inherent, on-hand information and collect materials and information from other sources that can be used by students. In this process, students are able to apply important knowledge or skills, build a series of concepts from detail to outline, develop new concepts, new thinking, and new perspectives, take the initiative to analyze, synthesize, and judge problems, and effectively complete problem-solving tasks. Although the designed sessions are different, they basically start from group division to a process of problem formulation, analysis, solution, verification, modification, and reflection. The process is similar, and the goal is to develop students' independent learning ability and practical analysis and problem-solving ability. Therefore, the author summarized the problem-based learning model process of many scholars and finally formed the problem-based learning model process of this study as shown in the table below:

Table 2.1 The process of the Problem-Based Learning model

Auther	Barrows 1980	Hmelo-Silver 2004	Zhao Haitao 2004	Schmidt 2011	Wu Gang 2012	This research Detail 2023
Step 1	Organize study groups	Exploring the situation and characterizing the problem	Creating a problem situation	Impleme ntation Problems	Create questions	Create questions
Step 2	Create questio ns	Forming various hypotheses about problem solving	Interpreting the problem in relation to what is known	Students review relevant literature	Implement Problems	Impleme ntation Problems
Step 3	Implem entation Problems	Identifying missing information and clarifying the topic of learning	Formulati ng hypotheses	Reflection evaluation	Generate hypotheses	

Table 2.1 The process of the Problem-Based Learning model (continue)

Auther	Barrows 1980	Hmelo-Silver 2004	Zhao Haitao 2004	Schmidt 2011	Wu Gang 2012	This research Detail 2023
Step 4	Results showcase	Integrating new and old knowledge to solve the problem and testing previous hypotheses	Consulting information		Confirm what is known	Results showcase
Step 5	Reflection evaluation	Summarizing the knowledge and skills gained	Independent research		Establish required information	Reflection evaluation
Step 6			Reporting findings in a group		Results showcase	
Step 7			Constructive reflection		Gather new information	Expanded applications
Step 8					Expanded Applications	

The teaching tasks and teaching strategy contents of this teaching mode are listed in the table below:

Table 2.2 Detailed Interpretation of Problem-Based Learning model

Teaching link	Teaching task	Teaching strategy
Create questions	Organize study groups Set up problems; students understand the problem; describe the operation; assign tasks	Create problem situations to ask questions and enhance students' interest in learning.
Implementation Problems	Reasoning to solve problems; formulating possible outcomes; refining learning points; identifying resources.	Organize cooperative group learning to explore problems together and promote in-depth problem analysis.
Results showcase	Discuss resources used; reassess questions; debrief learning outcomes.	The group works together to solve problems and communicate and share together, prompting students to solve multiple problems of exercise therapy in depth and further understanding of exercise therapy knowledge.
Reflection evaluation	Summarize knowledge and self-evaluate.	The group summarizes, gives evaluation feedback, and students find deficiencies to promote problem-solving ability.
Expanded Applications	Give examples of further application of the operations learned in class.	Extend and apply new and old knowledge further to enhance students' problem-solving ability.

The application effect of Problem-Based Learning model

At present, problem-based learning has been widely used in various fields abroad, including medicine, education, engineering and economics, mainly in the field of medical education, followed by university education. Most studies have shown that problem-based learning model can positively impact students' academic performance.

Huang Yaling et al. (2006, pp.3-7) took seven-year and five-year clinical medical students as the research objects and organized problem-based learning

model group study in batches. The research showed that Chinese students at different levels can gradually adapt to the problem-based learning model, which has a good student foundation in China, with the feasibility of promotion. Although the problem-based learning model is produced in the West, it is consistent with the ancient teaching concept of "teaching people to fish is better than teaching people to fish" in China. In modern society, information resources are very developed, and problem-based learning model advocates the full and reasonable use of various resources to improve learning efficiency, which is the development trend of modern teaching or learning. The problem-based learning model can improve the interest in learning, and at the same time, it is a self-revolution in learning and a new learning experience, which can enable medical students to successfully complete the transformation to the role of doctors and be able to face the complex and changing medical life in the future. The problem-based learning model is scientific and advanced compared with the traditional education mode, which makes up for the shortage of the single large lecture system in traditional medical education.

Cui Bingquan et al. (2009, p.105) studied the advantages of the problem-based learning model compared with the traditional teaching mode and the problems in teaching. He pointed out that problem-based learning model has outstanding advantages and is in line with the student-oriented concept, but it still needs teachers and students to work together to solve it. Unreasonable curriculum design, insufficient research ability of students, low enthusiasm of students in classroom activities and time-consuming problems of problem-based learning model. In order to solve these problems, teachers and students need to make joint efforts to do a good job of course design and students' research ability, and also actively carry out classroom activities to improve students' learning motivation and effect. In addition, for the problem that problem-based learning model is time-consuming, teachers can arrange the teaching time and tasks in a reasonable way so that students can get a better learning experience and effect in a limited time.

Silver, E. A. (2013, p.13) believes that Pupils are taught to discover mathematical problems independently in mathematical contexts or to discover new problems through problem-solving, thus fostering their creativity. New problem-solving activities seem to stimulate students' curiosity and enthusiasm for learning more than textbook problems. The objectives of the Problem-Based Learning (PBL) model include helping students to develop flexible knowledge, effective problem-solving ability, sustainable learning skills, effective collaboration skills and intrinsic motivation to learn. During the learning process, teachers should encourage students to ask

questions themselves and provide them with appropriate guidance and support to help them think independently and solve problems. At the same time, teachers should design problems of varying levels and difficulties, according to the different characteristics and needs of pupils, in order to meet the learning needs of different pupils and better stimulate their creativity and curiosity.

Finkelstein, N. et al. (2010, p.6) examined the effectiveness of problem-based learning on students' content knowledge and problem-solving ability compared with traditional teaching, and measured students' problem-solving ability with closed tests and open tasks. The results found that problem-based learning model are improving Students' content knowledge and problem-solving ability are generally more effective than traditional methods. The problem-based learning approach can provide better support for students' learning and development and is an effective teaching method. However, it should be noted that the problem-based learning approach requires careful design and organization by the teacher, as well as active cooperation and participation by the students, so attention needs to be paid to good interaction and co-operation between teachers and students in its practical application.

Anyafulude, J. C. (2013, p.105) through a quasi-experimental study with prescribed student group assignments but random selection of experimental and control groups, pointed out that achievement tests based on pre- and post-test content significantly improved the former compared with discovery-based strategies problem-based learning instruction and traditional instructional strategies students' academic performance .The results of the problem-based learning rating scale showed that students' positive beliefs increased after each activity. Based on these results, it can be concluded that the problem-based learning model is effective in conceptual learning in chemistry. This result is significant because both pre- and post-test content-based achievement testing and discovery-based strategy problem-based learning instruction are student-centered learning approaches. Compared with traditional teacher-centered teaching methods, these methods focus more on active learning and independent thinking of students, which can better stimulate students' interest and motivation in learning and thus improve their academic performance.

Tarhan, L. and Acar-Sesen, B. (2013, p.565) carried out a study on the impact of problem-based learning activities on students' understanding of chemical concepts through a random stratified quasi-experimental design of students' prior knowledge. The results showed that the problem-based learning model groups had 25 multiple-choice questions after the test and focused on the average score of the

open questions of students' reasoning was significantly higher than that of the control group. It should be noted that although the results of this study present the advantages of the problem-based learning method, it is still necessary to consider other factors in the experiment, such as the curriculum, teaching environment, and teacher quality of the experimental and control groups. Therefore, in the actual teaching application, various factors need to be considered comprehensively in order to achieve the best teaching effect.

Zhao, G. J. and Wang, Q. (2020, pp.226-228) summarized and evaluated the practice of combining the "flipped classroom" and problem-based learning model in the teaching of physics laboratory classes, and concluded that such a combination optimizes traditional teaching methods, improves students' learning efficiency, and can be said to have fundamentally changed teaching practice. The popularity of the Internet and the promotion of computer technology have made the "flipped classroom" combined with the problem-based learning model feasible and realistic. Especially in the special period of global epidemic prevention and control in 2020, the flipped classroom teaching mode plays a decisive role and receives good teaching results.

Yennita, Y. and Zukmadini, A. Y. (2021, p.20) showed that students' motivation was effectively increased and students' participation in learning was enhanced under the guidance of problem-based learning. In this type of learning, lecturers use student-centered learning that emphasizes problems that arise in the real world. From the student-oriented problems, students are guided to find the knowledge concepts of these problems so that what they learn becomes the source needed to solve the problems. In conclusion, problem-based learning is a meaningful approach to learning that can be effective in increasing students' motivation and engagement so that they can better understand and apply what they have learnt. For lecturers, problem-based learning is also an effective teaching strategy that can help them better guide students' learning and improve the quality and effectiveness of teaching.

Lonergan, R., Cumming, T. M. and O'Neill, S. C. (2022, p.112) examined the effectiveness of problem-based learning in developing students' key competencies by administering pre-tests and post-tests on indicators related to students' key competencies-namely, subject matter knowledge, understanding of the problem-solving process, and self-regulation skills, which are essential to achieving the goals of problem-based learning, before and after the implementation of problem-based learning instruction The study demonstrated that the problem-based learning instructional model has a significant impact on the development of key

competencies. The study showed that the problem-based learning instructional model had a significant effect on developing students' key competencies.

In summary, the problem-based learning model allows students to participate, explore and communicate freely and boldly, truly stimulates students' learning initiative and enthusiasm, and helps to cultivate students' exploration consciousness and innovation ability. In addition, the problem-based learning model can strengthen students' perceptual understanding of the courses they have learned. Through comprehensive analysis and mastery of problems, they can get in touch with knowledge early. The ability of information resources and the ability of solidarity and cooperation will also be significantly improved.

Problem-Solving Ability

In order to grasp the current status of research on the cultivation of medical students' problem-solving ability, this study combed the research results in related fields and mainly reviewed the literature of the teaching researches related to the cultivation of students' problem-solving ability, elements of students' problem-solving ability as follows.

The meaning of "problem solving"

"Problems" can literally be understood as the results of discrepancies between ideals and realities that require answers or solutions through the present and the future.

This paper deals with the concept of "problem-solving", which was taken from the English word "problem-solving", also known as problem-solving, and is mainly concerned with the fields of psychological and educational research, with more emphasis on the educational aspect. In the field of psychology, some scholars believe that problem solving is an advanced form of learning activity. The opposing view was that all forms of learning can be regarded as problem-solving processes. "Problem solving" was defined in psychological scholarship as a continuous sequence of cognitive operations based on a goal. The concept of problem-solving ability can be developed in different interpretations from psychology and pedagogy.

Gowen (2001, p.69) summarized that E.L. Thorndike proposed the "trial-and-error" theory of problem solving, which essentially consists of trial-and-error to form a link between a stimulus situation and an appropriate response. Newell and Simon believe that human cognition involves three basic types of information processing including recollection, problem solving, and learning. Meyer suggests that problem

solving is cognitive, a process of acquiring and applying knowledge, and could be directed according to the goals to be achieved.

Han Rensheng and Li Chuanyin (2008, p.23) summarized definition of problem-solving ability as any goal-directed sequence of cognitive operations. An activity that had the following three conditions at the same time can be called a problem-solving activity: (1) goal-directed, problem solving is guided by the ultimate goal, and the problem solving must reach the goal state that was set at the beginning; (2) sequential, problem solving was the result of a series of sequential operations. Purposeful operations along the established goals, rather than through primary recall of the same time to repeat the operation; (3) with cognitive operability, problem solving activities cannot be mechanical completion of the task, there must be cognitive activities involved.

Song Shichun and Tian Huisheng (2015, pp.23-28) proposed that the programmed for International Student Assessment (PISA) definition of problem-solving competence is the ability of individual learners to apply cognitive processes to address and solve problems in authentic interdisciplinary contexts. This definition emphasizes that problem solving abilities are applied in authentic interdisciplinary situations that require individual learners to apply cognitive processes to solve problems. Such competencies include, but are not limited to, analyzing problems, solving problems, applying creative thinking, and teamwork. PISA's assessment of problem-solving ability provides insight into students' ability to solve problems in authentic contexts and their ability to apply them in interdisciplinary areas. This ability is of great significance for the future development of students and the needs of society.

Lee, D. Y. and Chung, J. I. (2019, pp.336-344) argue that problem solving was as a process and a competency. As a process, problem solving involves a series of steps, including identifying the problem, analyzing the problem, developing a solution, implementing the solution and evaluating the results. As a competency, on the other hand, problem solving competency is the ability of an individual to use available information to find solutions and approaches to problems. This ability includes, but is not limited to, analyzing problems, problem solving, creative thinking, teamwork, etc.

Ummah, I. K. and Yuliati, N. (2020, pp.387-406) argued that problem solving is the most complex part of human cognitive activity, which involves multiple facets of abilities. These include cognitive abilities such as memory, perception, reasoning, and conceptualization, as well as non-cognitive abilities such as language, emotion,

motivation, assertiveness, and control. Memory refers to an individual's ability to store and extract information in the brain, perception refers to an individual's ability to perceive and understand the external environment, reasoning refers to an individual's ability to infer and solve problems by applying logic and reasoning skills, and conceptualization refers to an individual's ability to understand and abstract things and problems. Also, problem solving involves non-cognitive abilities such as language, emotion, motivation, assertiveness and control. Linguistic ability refers to an individual's ability to use language to express and communicate, affective ability refers to an individual's ability to understand and respond to his or her own and other people's emotions, motivational ability refers to an individual's motivation and willingness to solve problems, self-confidence refers to an individual's evaluation of his or her own problem-solving ability and confidence, and control refers to an individual's ability to grasp the process of problem solving and control.

Yang Z.Z. and Shi C.G. (2020, pp.265-270) summarized that problem solving is not only about finding a solution plan for problem solving, but also includes classification, explanation and so on. The ability of problem solving is a comprehensive ability, which requires students to have a variety of skills and knowledge, such as the ability of analyzing and solving problems, the ability of innovative thinking, and the ability of teamwork. Problem-solving abilities are considered very important in the field of education. By developing students' problem-solving ability, it can help them better understand and apply what they have learnt, enhance their creativity and innovation, and also help them better adapt to the future social and working environment.

Shi C.G. and Yang Z.Z. (2020, pp.58-65) summarized that problem solving is defined as a process, i.e., the process of transforming from an initial state to a goal state using an operator. This viewpoint considers problem solving as a dynamic process that requires starting from an initial state and through a series of thinking operations and actions to finally reach the target state. In this process, operators can be viewed as methods and strategies needed to solve problems, including reasoning, induction, hypothesis, experimentation, etc. The significance of this view is that it emphasizes the fact that problem solving is a dynamic process that requires constant thought operations and actions rather than relying solely on inspiration and creativity. At the same time, this view also emphasizes the need for problem solving to make use of arithmetic, i.e. it is the need to use appropriate methods and strategies to solve problems, which helps us to better understand and apply the process of problem solving.

To sum up, Problem Solving is the ability of individual learners to apply cognitive processes to address and solve problems in authentic interdisciplinary contexts. This definition emphasizes that problem solving abilities are applied in authentic interdisciplinary situations that require individual learners to apply cognitive processes to solve problems. Such competencies include, but are not limited to, analyzing problems, solving problems, applying creative thinking, and teamwork. Problem Solving is as a process caused by a certain situation, according to a certain goal, applying various cognitive activity skills, after a series of operations, so that the problem can be solved.

Elements affecting Problem-Solving Ability

There are many variants of the elements of impact problem solving, and different scholars may devise different elements of impact problem solving according to their own research fields and research questions. These variants may differ in terms of specific influencing factors, modes of action and application scenarios.

R.E. Mayer. (1994, p.36) suggested three elements of student problem solving:(1) Internal representation of the problem: Internal representation of the problem refers to the way the problem is presented in the mind and how the individual understands and perceives the problem. The internal representation of the problem affects how and how well the individual solves the problem. (2) Students' analyses of the problem-solving process: students' analyses of the problem-solving process refer to the individual's thinking process and strategies in solving the problem. Different students may use different thinking processes and strategies, which can affect their problem-solving effectiveness. (3) Problem analysis skills: Problem analysis skills refer to the specific methods and techniques that individuals use when solving problems. For example, individuals may use techniques such as classification, induction, reasoning, and hypothesis to solve problems.

Lawson, M. J. and Chinnappan, M. (2000, pp.26-43) suggested six elements that influence problem solving and they are (1) Student motivation: when students are strongly motivated to solve problems, they are more likely to be actively involved and work towards finding solutions. (2) Student attitudes: Students' attitudes influence how they view problems and solutions. Positive attitudes can encourage students to find solutions to problems, while negative attitudes may limit their efforts. (3) Intellectual load: Students need sufficient intellectual resources to deal with problems. Problem solving may become more difficult if the difficulty of the problem exceeds the students' intellectual load capacity. (4) Intellectual organization: the way students organize their knowledge can also affect problem solving. If

students have a good, organized knowledge structure, they are more likely to understand the problem and find a solution. (5) Ability to understand problem structure: Understanding the structure of a problem is an important step in problem solving. If students are able to clearly understand all aspects of a problem, they are more likely to find a solution. (6) Problem-solving abilities: Students need to have appropriate problem-solving abilities, such as analyzing problems, finding solutions, and verifying solutions.

Liu, R. D. (2002, p.54) believed that in his doctoral thesis he attributed the factors affecting problem solving to six areas: functional fixation, problem representation, reflective stereotypes, knowledge background, intelligence level, motivational intensity and cognitive style. Functional fixation refers to an individual's over-reliance on a certain function or attribute when solving a problem, to the exclusion of other possible solutions. Problem representation refers to the individual's understanding and presentation of the problem, reflective stereotyping refers to the individual's over-reliance on certain conventional thinking patterns or fixed responses when solving problems, knowledge background refers to the knowledge and experience that the individual possesses, intelligence level refers to the individual's intellectual level and thinking ability, motivation strength refers to the individual's motivation and willingness to solve the problem, and cognitive style refers to the individual's information processing mode and thinking Cognitive style refers to the individual's information processing and thinking style.

Lin Chongde et al. (2003, p.37) believed that all levels of intelligence, from simple to complex, reflect the role of non-intellectual factors, and that the student's age, intelligence, academic performance, teaching style, and socio-cultural environment influence the level of problem solving. Age is an important factor that affects the level of problem solving, and as an individual grows older, his or her cognitive and problem-solving abilities gradually increase. Intelligence is the level of intelligence of an individual, which also affects problem-solving ability. Academic performance is the student's ability to master and apply what he or she has learnt, and the teaching style will also affect the student's problem-solving ability. The socio-cultural environment also has an impact on an individual's cognitive style and problem-solving ability.

Psycharis S. and Kallia M. (2017, pp.583-602) in his study pointed out that the richness of students' professional knowledge base has a positive impact on the improvement of problem-solving ability. In the study, students were asked to solve a series of problems related to their field of study. The study found that students with

a richer pool of expertise were more able to quickly understand the problems and find effective solutions. This is because a rich pool of expertise gives students a deeper understanding of the knowledge and skills in the relevant field, which makes it easier for them to identify problems, formulate hypotheses, analyze information and apply appropriate solutions.

Xia Peng (2022, p.10) summarized the influencing factors of problem-solving ability of our scholars, including the following aspects: (1) the level of basic knowledge: the level of individual's basic knowledge affects their problem-solving ability, and having solid basic knowledge is conducive to the individual's better understanding and analysis of the problem, so that they can better find solutions. (2) Inherent experience in problem solving: Individuals' experience in problem solving also affects their problem-solving ability. Individuals with rich experience in problem handling are more likely to find solutions to problems. (3) Thinking strategies: Individuals' thinking strategies in problem solving also affect their problem-solving ability. Adopting effective thinking strategies can help individuals better analyze and solve problems. (4) Problem-solving motivation: Individuals' motivation to solve problems also affects their problem-solving ability. Individuals with strong problem-solving motivation are more likely to actively seek solutions to problems. (5) Conviviality effect: Conviviality effect refers to the fact that when an individual temporarily abandons a problem in the process of solving it and carries out some other activities, he or she may get new ideas or inspiration after a period of time, thus solving the problem better. (6) Functional fixation: Functional fixation refers to an individual's over-reliance on a certain function or attribute when solving a problem, while ignoring other possible solutions.

In summary, the elements of problem-solving ability can be summarized in the following six areas:

1. Basic knowledge. Having a certain knowledge base is a prerequisite for problem solving, so before solving the problem, learners must supplement and improve their basic knowledge around the problem topic, and they should cultivate the ability of students to flexibly apply their knowledge.

2. Mental skills. Problem solving thinking is characterized by mental skills, and the level of students' mental skills reflects the level of thinking ability from one side. For this reason, it is important to focus on the development of students' mental skills.

3. Motivation and emotion. Motivation and emotion are double-edged swords in problem solving, with both positive and negative aspects. Not all motives

and emotions are conducive to problem solving, and only moderately strong motives and stable emotional states may contribute to the solution of the corresponding problem. Insufficient motivation and emotion will lack motivation; too strong will interfere with thinking and affect problem solving. Therefore, we need to guide our students to learn with a pleasant and calm state of mind and emotion on a regular basis.

4. The pattern of stimulus presentation. Everything related to problem solving provides a stimulus for problem solving and becomes a specific stimulus pattern. If a particular stimulus pattern provides clues to the solution of a problem, it is convenient to find out the solution; but there are also stimulus patterns that interfere with problem solving and thus increase the difficulty. Therefore, the organization of stimuli (e.g., arrangement of teaching aids, etc.) is crucial in teaching.

5. Thinking Stereotypes. Thinking stereotypes can either accelerate the completion of work and increase efficiency, or they can hinder work because of stereotypes.

6. Personality traits. Different students have different personality traits, which have an impact on their efficiency in problem solving, and teachers should correct unfavorable personality traits in order to facilitate problem solving.

Therefore, the knowledge elements are a necessary condition for the formation of mental skills, and mental skills are the guarantee for the development of knowledge, these two factors are the basis of other factors, the knowledge factor in the knowledge has been mastered knowledge is crucial, many foreign information processing experiments show that experts in a certain field are more successful in solving problems than novices, and it is the role of professional knowledge in the knowledge element of the expertise and the internal illustration of the role of the knowledge factor, which is a favorable attack on the opposition to the students' This is a favorable attack on the view that knowledge transfer in the development of problem-solving abilities of students. Mental skills can be subdivided into general and specific skills, and mental skills need to be developed gradually during the problem-solving process. The six elements of problem solving necessitate a moderately strong motivational mood and a calm state of mind; too much motivation interferes with thinking and not enough strength results in a lack of motivation. Teaching should provide students with clear clues to the stimuli, focus on the use of students' personality traits that are conducive to problem solving, and combine students' directionality and flexibility of thinking. The six elements interact with each other, and any problem will affect the final effect of problem solving.

Clarifying the relationship between the elements affecting problem solving will help to further understand and recognize problem-solving ability.

Problem-solving process

The "trial and error theory" is an early representative of the study of the problem-solving process. Thorndike summarized the process of problem solving as the linkage between stimulus and response, and believed that the process in which learners continuously try out their mistakes, improve their methods and try again is the process of problem solving.

Wallas, G. (1914, p.134) proposed the creative process of problem solving, which consists of the following four phases: (1) Preparation phase: in this phase, the individual continuously collects and accumulates all kinds of information and materials about the problem in preparation for solving the problem. (2) Conception period: also known as the contemplation or brewing stage, in which the individual constantly thinks about and analyses the problem and looks for ways and ideas to solve it. (3) Clarity period: also known as the inspiration or enlightenment stage, in which the individual has a sudden flash of inspiration or revelation of the solution. (4) Validation phase: In this phase, the individual verifies the feasibility and effectiveness of the solution to the problem through practice and experimentation. Wallace's four stages describe the development of creative thinking in the problem-solving process, emphasizing the importance of creativity and inspiration in problem solving, as well as the importance of practice and validation in problem solving.

Quellmalz, E. S. (1985, p.338) describes problem solving as a basic cognitive process that involves the conscious use of four reasoning strategies. These four reasoning strategies include (1) Analyzing: breaking down the problem into its parts and analyzing the relationships and characteristics of each part. (2) Comparison: Finding similarities and differences between different parts by comparing their relationships. (3) Inference and Interpretation: Understand the problem and arrive at possible solutions through inference and interpretation. (4) Evaluation: assessing and judging the possible solutions and determining the best solution. Quilmes' four reasoning strategies describe the basic cognitive operations in the problem-solving process and help us to better understand the problem-solving process.

Torrance, E. (1988, pp.43-73) pointed out that the logical steps of problem solving are as follows: (1) Perceiving the problem: first of all, it is necessary to clarify the reason and purpose of the problem's existence, and to determine the information and resources needed to solve the problem. (2) Making guesses or assumptions about the problem: Based on existing knowledge and experience, initial

guesses or assumptions about the problem are made. (3) Evaluate (Revise): Validate and test the guesses or hypotheses, and continually revise and improve the solution. (4) Expressing the results: finally arriving at the best solution to the problem and expressing the results in an appropriate manner. Torrance's problem-solving steps emphasize the importance of guesses and assumptions in problem solving, as well as the necessity of evaluating and revising them in order to arrive at a final and effective solution.

Bransford, J. D. and Stein, B. S. (1993, p.123) proposed a seven-stage process for problem solving: (1) Identify the Problem: Clarify why the problem exists and for what purpose, and identify the information and resources needed to solve the problem. (2) Define the problem: Define and describe the problem accurately and specify the boundaries and constraints of the problem. (3) Selecting Strategies: According to the characteristics and purposes of the problem, select appropriate methods and strategies for solving the problem. (4) Organize information: Collect and organize a large amount of information related to the problem, and organize and classify it. (5) Allocating resources: According to the needs of the problem, allocate human, material and financial resources reasonably. (6) Monitor the solution process: Monitor and adjust the problem-solving process in real time to ensure the smooth progress of problem solving. (7) Evaluate the results: Evaluate and test the results obtained from problem solving to determine whether the problem has been solved and to consider the next step. The seven-stage theory of Stenberg et al. emphasizes the organic connection and dynamic development of the stages in the problem-solving process, which helps us to better understand and guide the problem-solving process.

Chen Qi (1997, p.56) proposed four stages of the problem-solving process, they are: (1) Understanding and characterizing the problem stage: in this stage, the individual needs to analyze and understand the problem, determine the nature of the problem and the relevant elements, and form a characterization of the problem. (2) Answer-seeking stage: after understanding the problem, the individual begins to search for solutions and answers to the problem. This stage may include formulating hypotheses, searching for relevant information, trying solutions, etc. (3) Implementing a plan or attempting some kind of answer stage: In this stage, the individual needs to implement a solution and attempt to solve the problem. This may involve performing a series of actions or trying different approaches to validate and revise the solution. (4) Evaluating the results stage: after solving the problem, the individual needs to evaluate and reflect on the results. This involves checking whether the

solution was effective, whether further modifications and refinements are needed, and whether the desired outcome was obtained. This four-stage model, which is often used to describe the general problem-solving process, provides a basic understanding of the problem-solving process and offers some guidance for education and training to help individuals improve their problem-solving abilities and effectiveness.

Teng Meifang (2010, pp.9-16) pointed out that the programmed for the International Assessment of Student Ability (PISA2003), planned by the International Organisation for Economic Co-operation and Development (OECD), divides the student problem solving process into seven steps as follows: (1) Identify the problem: students need to explicitly identify and define the problem, and to understand the nature and key features of the problem. (2) Identify information, conditions: Gather all possible information related to the problem, including known conditions, limitations and assumptions. (3) Propose solutions: By analyzing the problem, find possible solutions and make a preliminary assessment of them. (4) Select Solution Strategy: Select the most appropriate solution strategy based on the characteristics and objectives of the problem. (5) Problem Solving: Implement the selected strategy, adhere to and be able to adjust the strategy to achieve the problem-solving goal. (6) Reflecting on the Problem: Reviewing the problem-solving process and thinking about what went well and what needs to be improved. (7) Communicate results: Communicate the problem, method, and results of the solution with others to share the learning and problem-solving experience. This process is designed to help students improve their problem-solving abilities, an important 21st century skill that requires continuous practice and reflection.

Zhang Ping (2013, pp.90-96) divided the problem-solving process into the following five steps: (1) Understanding the problem: In this step, the individual needs to clarify the nature of the problem and the related elements, and understand the relationship and logic behind the problem. (2) Describing the problem: After understanding the problem, the individual needs to describe the problem in an appropriate way so that the problem can be better understood and analyzed. (3) Develop a solution: In this step, the individual needs to come up with a solution or strategy to solve the problem and identify the steps and procedures to solve the problem. (4) Implementing the solution: After identifying the solution, the individual needs to implement the solution and try to solve the problem. This stage may involve performing a series of actions or trying different approaches to validate and revise the solution. (5) Effectiveness evaluation or feedback: After solving the

problem, the individual needs to evaluate and provide feedback on the approach and results of the solution. This includes checking whether the solution was effective, whether further modifications and refinements are needed, and whether the desired results were obtained. This five-step model, which is also commonly used to describe the general problem-solving process, provides a basic understanding of the problem-solving process and offers some guidance for education and training to help individuals improve their problem-solving abilities and effectiveness.

Wu Yuanyue and Xie Wei qi (2013, pp.48-51) classified the process of students' problem solving into the following six steps: (1) Understanding the problem: In this step, students need to clarify the nature of the problem and the related elements, and understand the relationship and logic behind the problem. (2) Describing the problem: After understanding the problem, students need to describe the problem in an appropriate way so that they can better understand and analyze it. (3) Presenting the problem: Students need to present the problem in an appropriate form, which can be achieved by drawing, making models, creating diagrams etc. (4) Solving the problem: In this step, students need to come up with solutions or strategies to solve the problem and identify the steps and procedures to solve the problem. (5) Reflecting on the solution: After solving the problem, students need to reflect on and evaluate the approach and results of the solution, checking whether the solution is effective and whether it needs to be further modified or improved. (6) Communicating the solution: Students need to communicate the solution to others and get more ideas and feedback through communication and co-operation with others.

Yang Bin (2016, p.98) summarized Dewey's theory, arguing that Dewey regarded problem solving as a systematic and scientific operational journey, and constructed a problem-solving model including the following five steps: (1) Feeling the difficulty: in this step, the individual needs to identify and feel the existence of the problem, and clarify the nature and scope of the problem. (2) Locating and defining the difficulty: After sensing the problem, the individual needs to locate and define the problem accurately and clarify the nature and key elements of the problem. (3) Consider possible solutions: In this step, the individual needs to propose various possible solutions and think about the advantages, disadvantages and possible outcomes of each solution. (4) Measuring the outcomes of various options: In this step, the individual needs to evaluate the possible outcomes of each option and determine which option is optimal. (5) Selecting a solution: in this step, the individual needs to select an optimal solution from all possible solutions and start

implementing it. Dewey's problem-solving model is a systematic and scientific approach that provides a basic understanding of the problem-solving process and offers some guidance for education and training to help individuals improve their problem-solving abilities and effectiveness.

In summary, research on the process of problem solving can be broadly classified into the following categories:

1. Discipline teaching category. With the majority of mathematics and physics, the researchers proposed the solution process and steps from the perspective of problem solving in mathematics discipline, which provides a reference for the design of problem-solving teaching programmer in this study, but due to the perspective of only mathematics and physics disciplines, it is not clear whether the proposed process and steps are adapted to problem solving in other disciplines, and the study has certain limitations.

2. Cognitive, empirical category. Researchers have proposed the process of problem solving from cognitive psychology, but they have overemphasized the role of cognitive foundation and experience, missing the important link of reflection and communication after problem solving. The steps of problem solving proposed by Zhang Ping and other scholars basically summarize the general process of problem solving from a practical point of view, while the seven steps of students' problem-solving process proposed by PISA and the seven phases of problem solving proposed by Bransford and Stein (1993) explain the main process of problem solving in different descriptive ways in a more comprehensive way.

Focusing on the theme of this research and considering the problem-solving process based on students' cognition and aiming at innovative practice, this study therefore focuses on the five steps of problem solving proposed by Ping Zhang, integrates the commonality of Chinese and foreign research on the problem-solving process, and proposes six stages of problem solving:

The first stage is to understand the problem. This stage is mainly to answer the question "What is the problem?" It is also the stage of asking questions. Einstein once said that it is even more important to raise the problem than to solve it, and raising the problem determines the direction of the later research and whether the research work is meaningful and valuable.

The second stage is to identify the problem. Identifying the problem reflects the extent to which the student understands the problem, not simply stating the problem, but clearly articulating what the problem is. It enables students to analyze the problem and discuss it.

The third stage is to formulate a solution to the problem. Only by sorting out the first two stages of the problem can a problem-solving programmer be formulated, and this stage is the overall planning for problem solving.

The fourth stage, choosing the strategy of the solution. The choice of strategy is closely related to the design of the solution, is better and faster to achieve the solution of the method design stage. There may be many strategies for the implementation of a solution, and teachers should encourage students to propose different strategies, analyze and verify them, and help them experience the implementation effect of different strategies corresponding to a unified solution.

The fifth stage, the implementation of the problem solution. This stage is the specific implementation stage of problem solving, but also the specific implementation process of students' cooperative and collaborative learning.

The sixth stage, reflecting and communicating the problem. This stage is proposed by absorbing some of the foreign research results, and it is also a stage that is easily ignored in domestic research. Reflection after problem solving is the process of experience summarization, and communication after problem solving is the process of sorting out the ideas of problem solving and explaining the methods.

Compositional analysis of Problem-Solving Ability

In 1910, Dewey's five-stage theory suggested that problem solving involves going through the process of a. sensing the existence of a problem; b. determining the nature of the problem and interpreting it; c. proposing a variety of possible solutions; d. considering a variety of possible outcomes resulting from these solutions; and e. experimenting with the one of these solutions that is most likely to achieve the goal. In 1931 Rothman proposed a six-stage theory of problem solving, which suggested that problem solving consists of a. feeling some need or perceiving the existence of a problem; b. stating the problem systematically; c. making a census of the available information; d. examining critically the various solutions to the problem; e. systematically forming a variety of new ideas; and f. testing these new ideas and accepting the ones that stand up to scrutiny. In 1926, Wallace's four-stage theory argued that the process of problem solving consists of a. preparation; b. contemplation; c. inspiration or enlightenment; and d. verification. The IDEAL model of problem solving proposed by Bransford and Stern argues that problem solving involves a. identifying the problem; b. defining the problem; c. exploring the problem; d. implementing the strategy; and e. examining the effects.

Benard, B. (1995, p.165) states that "problem-solving ability" includes the following abilities: (1) the ability to plan: the ability to develop and implement

effective plans to solve problems and achieve goals. (2) Ability to acquire resources for self-help: the ability to acquire necessary resources and information, and the ability to self-learn and self-improve. (3) Critical and creative thinking skills: the ability to make critical analyses and judgements, and the ability to propose innovative solutions. (4) Ability to propose problem-solving solutions: able to propose effective problem-solving solutions and able to make appropriate adjustments to the situation. (5) Awareness of stress: able to cope with stress and challenges, remain calm and make informed decisions. (6) Ability to adopt appropriate problem-solving strategies: able to select appropriate problem-solving strategies and implement them effectively.

Fleck, D., Thompson, C. L. and Narroway, L. (2001, pp.26-27) classifies problem-solving ability into the following six areas of competence: (1) Identification ability: the ability to identify problems, including sensitivity and accuracy to problems. (2) Analytical ability: the ability to analyze and decompose a problem, and to be able to identify the key elements of the problem and the relationship between them. (3) Communication skills in the problem-solving process: the ability to express one's views and ideas clearly and accurately, as well as the ability to communicate effectively with others. (4) The ability to act in the process of problem solving: the ability to act positively and implement solutions, including execution, leadership and teamwork. (5) Ability to apply methodological skills: the ability to apply appropriate methods and techniques to solve problems, including logical thinking, innovative thinking and decision-making ability. (6) Learning Ability: The ability to learn and improve oneself, and to continuously acquire new knowledge and skills. These competencies are important in different contexts and are mutually supportive of each other, together forming the basic structure of problem-solving competencies. This structure provides a comprehensive framework to help us better understand and assess the different aspects of problem-solving competence.

Zhang Ping (2013, pp.90-96) proposed a structure of problem-solving ability based on the five steps of problem solving that includes the following four aspects: (1) Observation and identification ability: this refers to the ability to be able to observe and identify problems, including sensitivity and accuracy to problems. (2) Expression and communication ability: this refers to the ability to express one's views and ideas clearly and accurately, as well as to communicate effectively with others. (3) Analytical decision-making ability: this refers to the ability to be able to analyze problems and propose solutions, including aspects of logical thinking, innovative thinking and decision-making ability. (4) Action ability: This refers to the ability to be

able to act positively and implement solutions, including aspects of execution, leadership and teamwork. These competencies are all important in problem solving and support each other to form a complete structure of problem-solving competencies.

Wu Yuanyue and Xie Wei qi (2013, p.49) believed that problem-solving ability consists of the following six components: (1) Understanding: the ability to understand the problem and the willingness to solve it. (2) Analysis: the ability to analyze and decompose a problem, and the ability to identify the key elements of a problem and the relationships between them. (3) Reasoning: the ability to use logic and judgement to deduce conclusions and solutions from problems. (4) Practice: the ability to translate theory into practical action, including executing, implementing and adapting programmed. (5) Reflection: Reflecting on and evaluating the problem-solving process, learning from it and improving the approach. (6) Expression: to express one's views and ideas clearly and accurately, both in writing and orally. These constituent elements are interdependent on each other and together form the basic structure of problem-solving competence. This structure provides a comprehensive framework to help us better understand and assess the different aspects of problem-solving competence.

Sternberg, R. J. and Frensch, P. A. (2014, p.134) categorized the process of problem solving into the following six parts: (1) Defining the problem: clarifying the nature and scope of the problem and identifying the goal of the problem. (2) Defining the problem: providing a clear definition of the problem and identifying the relevant factors and constraints of the problem. (3) Formulate strategy: Develop a strategy for solving the problem, including selecting appropriate methods and steps for solving the problem. (4) Organizing information: Collecting and organizing facts and information related to the problem, and analyzing and interpreting them. (5) Resource Allocation: Rationally allocate resources such as manpower, material and time to ensure the solution of the problem. (6) Monitoring and Evaluation: Monitoring and evaluating the process of problem solving, and adjusting strategies and actions in time to ensure that the problem is solved effectively. These six parts constitute a complete problem-solving process, which are interdependent and mutually reinforcing, forming the basic structure of problem solving. This structure is an important guide to understanding and applying problem solving abilities.

Yang Bin (2016, p.56) sorted out the PISA2003 evaluation framework and categorized it into the following six competencies:(1) Comprehension of problems: the ability to understand the nature, background and impact of problems, and to

clarify the main elements and conditions of problems. (2) The ability to identify problems: the ability to distinguish between the major and minor elements of a problem, and to specify the type and scope of the problem. (3) Ability to formulate problems: Be able to formulate problems in clear, precise and concise language, and be able to use appropriate ways of formulating problems (e.g., mathematical symbols, diagrams, etc.). (4) Problem-solving abilities: the ability to solve problems through reasoning, analysis, and practice using appropriate problem-solving strategies and tools. (5) Reflective problem solving: The ability to reflect on problem solving, evaluate the feasibility, strengths and weaknesses of solutions, and learn from experience. (6) Problem-solving communication skills: the ability to communicate clearly and accurately with others about problem-solving methods and results, both in writing and orally. These competencies are developed in a progressive relationship, i.e., students need to have the ability to understand problems before they can further develop the other competencies. the PISA 2003 assessment framework includes all aspects of students' problem-solving competencies in a more comprehensive way, and it can be close to the needs for the cultivation of problem-solving competencies of talents in the new era.

D'zurilla, T. J. and Nezu, A. M. (1990, p.156) believe that the problem-solving process is divided into the following: firstly, defining and formulating the problem, identifying the solution, deciding, implementing the solution, and auditing; and secondly, identifying the problem, defining it, formulating a strategy, organizing the relevant information, allocating the right resources, monitoring and evaluating the results, and so on. In the first division, it is first necessary to define and formulate the problem and clarify the nature and impact of the problem. Then find ways to solve the problem and make decisions. Next, the solution is implemented and periodically reviewed to ensure that the problem has been solved. In the second way of delineation, the problem first needs to be identified and the nature and impact of the problem clarified. Then the problem is defined and a specific description of the problem is clarified. Next, a strategy for solving the problem is developed, relevant information is organized and resources are allocated appropriately. Finally, the results are monitored and evaluated to ensure that the problem has been effectively solved.

Rahman, M. (2019, pp.64-74) in their article "21st Century Skill "Problem Solving": Defining the Concept" argued that problem solving abilities encompass both observation and critical thinking skills. Observation skill is the skill of using the senses to gather and understand information. Through observation, we can identify the

presence of a problem, understand the symptoms of the problem, and gather all the information related to the problem. Critical thinking involves the ability to conceptualize, reason logically, apply strategies, think analytically, make decisions and synthesize solutions to any problem. These skills are also vital for problem solving as they help us to analyze problems, evaluate solutions and make informed decisions.

Zhuang Lina (2020, p.155) through the literature analysis concluded that our scholars on the problem-solving process, although all have their own viewpoints output, the overall can also be summed up in the following six stages: (1) Problem discovery stage: in this stage, people begin to notice the existence of the problem and realize that the existence of the problem needs to be solved. (2) Problem Understanding Stage: In this stage, people need to deeply understand the nature and context of the problem and clarify the key elements of the problem and the relationship between them. (3) Problem solving hypothesis stage: In this stage, people need to propose methods and strategies for solving problems and form some hypotheses for solving problems. (4) Verification of Methods Stage: In this stage, people need to verify the effectiveness of the proposed problem-solving methods and conduct the necessary experiments and verification. (5) Reflective approach stage: In this stage, people reflect on and evaluate the problem-solving process, check the feasibility and applicability of the approach, and learn from it to improve the approach. (6) Communicating Results Stage: In this stage, people communicate the results of their problem-solving with others, share experiences and knowledge, and receive feedback and suggestions from others. This six-stage structure provides a comprehensive framework to help us better understand and describe the different stages of the problem-solving process. This framework is an important guide for both the study of problem solving and the development of problem-solving abilities.

Ma, L. (2020, p.123), based on the theories of scholar Yang Bin, further sorted out the PISA2003 evaluation framework and subdivided the six problem-solving competencies into the following six sub-competencies: (1) Discovering Problems: Being able to identify problems from real life and clarifying the nature, context and impact of the problems. (2) Describing Problems: The ability to describe problems clearly, accurately, and succinctly, and to distinguish between major and minor elements of a problem. (3) Use tools to illustrate problems: be able to use appropriate tools or symbols to represent problems, e.g., mathematical symbols, diagrams, etc. (4) Apply methods and strategies to solve problems: be able to select appropriate problem-solving strategies and tools according to the

characteristics and conditions of the problem, and solve problems through reasoning, analysis, and practice.(5) Reflective communication: be able to reflect after solving a problem, assess the feasibility, strengths and weaknesses of the solution, and communicate clearly and accurately with others. (6) Speaking about experiences and learning methods: being able to summarize learning experiences and lessons and share learning methods with others. These sub-competencies are also developed in a progressive relationship, i.e. students need to have the ability to identify and describe problems before they can further develop the other competencies. the PISA 2003 assessment framework and its sub-competency divisions comprehensively include all aspects of students' problem-solving ability, which is of great guiding significance for the cultivation of problem-solving ability of talents in the new era.

To summarize, the competencies proposed by scholars Zhang Ping and Ng Yuen Ngok have in fact been included in the division of students' problem-solving abilities in the PISA2003 evaluation framework. The division of the six aspects of problem-solving competence in the Vanbrugh Problem-Solving Competence Training Programmer can be incorporated into the PISA2003 evaluation framework. For example, the recognition competence mentioned in the programmer is equivalent to the identification competence, the analytical competence of the problem requires the ability to comprehend, identify and express, the communication competence in the process of problem solving is the communication competence, the ability to take action in the process of problem solving as well as the ability to apply methodologies and techniques all belong to the problem-solving competence, and the proposed learning ability is the problem-solving competence. The proposed learning competencies are very broad and should be integrated into all the above competencies.

Therefore, I believe that the six competencies proposed by scholar Yang Bin in combing the PISA2003 evaluation framework are a comprehensive and reasonable division of students' problem-solving abilities, which are:

1) Comprehension ability: Refers to the learner's ability to identify the problem from the information, to be able to actively explore the information and knowledge related to the problem, and ultimately to understand the problem.

2) Discriminatory ability: Refers to the fact that, based on an understanding of the problem, learners should be able to sift through the information they have been given, briefly analyze the elements that make up the problem, formulate hypotheses about the problem, and collaborate to explore the relevant information.

3) Presentation ability: Understanding and discrimination are the basis for formulating questions, which involves thinking about how to formulate a question using a variety of information; and how to use different formulations to express the same question.

4) Problem-solving ability: Problem solving is centered on the systematic design and diagnosis of problem-solving methods, so problem solving abilities require strategies and methods. Learners are required to collectively discuss, select and use problem solving methods and be able to comment on the effectiveness of problem solving.

5) Reflective ability: Reflection is an important part of problem-solving improvement, the analysis and evaluation of the effectiveness of problem solving, where learners are able to articulate the methods used to solve a problem, evaluate the strengths and weaknesses of the methods used, or provide suggestions for better methods, and work with learning partners to revise the solution, modify the design of the learning activity; and validate the new method.

6) Communication ability: Communication is a process of improvement and refinement based on reflection. Learners with this competency are able to select appropriate mediums and modes of expression, present solutions to problems, and summarize experiences in solving similar problems. Learners can summarize successes, analyze shortcomings, and discuss and reflect on the transferability of the problem-solving approach.

According to scholar Malu's problem solving sub-competencies, problem solving competencies can be further subdivided into the following nine sub-competencies: (1) Identify problems: Refers to the learner's ability to identify the problem from the case situation and to clarify the nature, context and implications of the problem. (2) Searching for problems: Refers to the learner's ability to identify a problem in the information, to be able to actively explore information and knowledge related to the problem, and ultimately to understand the problem. (3) Describe the problems: Refers to the learner's ability to use his/her own understanding to make judgements and describe the problem in the given resource. (4) Analyzing the problems: Refers to the learner's ability to analyze, integrate information based on the information provided. (5) Collaborative enquiry: Refers to learners discussing with each other and identifying problems in the learning process. (6) Demonstrate results to illustrate the problem: Refers to the learner's ability to present a problem clearly and be able to articulate his or her understanding of the problem among classmates. (7) Apply methods to solve problems: Refers to the fact

that learners will choose their own way of learning to solve problems and will communicate with their peers about the effectiveness of problem solving. (8) Continuous reflection on lessons learnt: Refers to the learner's ability to reflect on problem solving through discussion and modification of the learning activity after reflection. (9) Talking about experience and learning methods: Refers to summarizing good experiences in learning as well as problem solving, identifying weaknesses and summarizing methods that can be transferred and used.

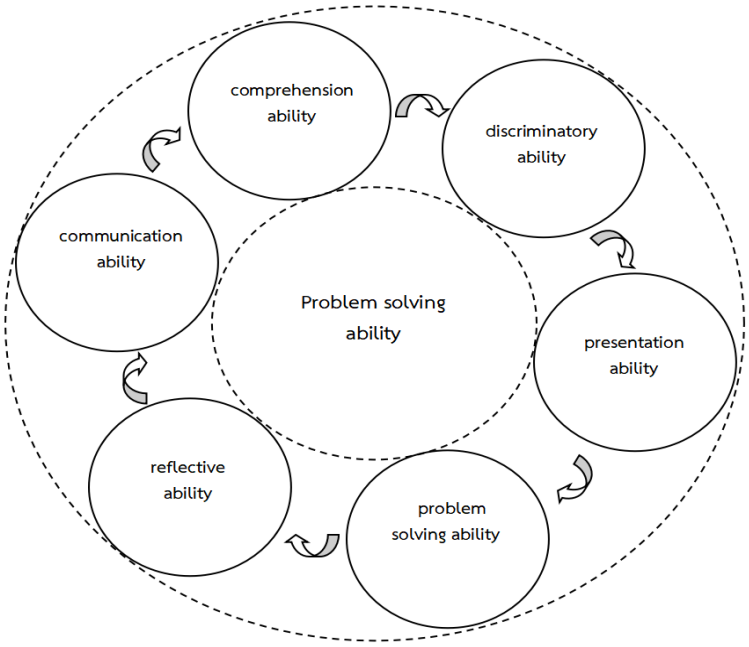

Figure 2.2 Diagram of the composition of students' Problem-Solving Ability

The measurement of students' Problem-Solving Ability

Problem solving is the cognitive process of transforming a known situation into a target state when there is no obvious solution, and problem-solving ability is "a kind of ability used in cognitive process". The characterization of problem-solving ability is often in the form of outcomes, and there have long been difficulties in measuring problem-solving ability, especially quantitatively. At present, international research on the measurement of problem-solving ability focuses mainly on the PISA assessment and the aptitude assessments of the United Kingdom and other countries.

Long, I. and Shou Shengliu (1996, pp.60-62) proposed the application of Markov chain to measure students' problem-solving ability, and he believed that the

process of students' problem solving is divided into four stages, all of which can be viewed as a kind of absorption of the four states of Markov chain. And summarized the Markov chain formula, M1=1+2/P23.

In 1997, the Organization for Economic Co-operation and Development (OECD) launched the Definition and Selection of Key Competencies (DSC) programmed with the aim of providing a sound conceptual framework to improve the quality of assessment. Individual thinking and behavioral responses are at the heart of this framework of competencies. 1998 saw the launch of the OECD's programmed for International Student Assessment (PISA) in 32 countries and territories around the world. PISA is an international student assessment designed and organized to assess the reading, mathematical and scientific literacy of pupils near the end of compulsory schooling (age 15), PISA is an international student assessment programmed designed and organized to assess the reading, mathematics and science literacy of students towards the end of compulsory schooling (age 15), and is a collective and collaborative research programmed. It is collaborative research programmed, coordinated by governments and supported by participating scholars, who collaborated and brainstormed on the methodology and procedures for the international assessment of students. It assesses whether students are equipped with the knowledge and skills they will need in the future and whether they are able to apply them to solve problems in real-life situations, and the results of PISA reflect the impact of educational and social systems on students in compulsory education and provide guidance for educational policy-making and research in countries around the world.

Chen Hui (2007 , p.45) summarises that PISA emphasises that knowledge in the three domains of reading, mathematics and science is not self-contained, but is closely related to the ability to reflect on and apply knowledge in real-life situations.PISA 2000 asks students about other aspects of their motivation and attitudes to learning, such as their computer skills and their ability to manage and monitor learning strategies, under the heading of self-directed learning.PISA 2003 develops this further and complements it by measuring knowledge and problem-solving abilities. The PISA framework is organised into three domain-specific areas: the content or structure of knowledge, the process of application, and the real-world application of relevant knowledge and skills. The assessment framework for PISA 2003 is shown in the table below.

Table 2.3 PISA 2003 Assessment Framework

realm	content dimension	process dimension	situational dimension
math literacy	(1) Quantity (2) Space and Shape (3) Variation and Association (4) Uncertainty	(1) Reproduction (simple math operations) (2) Relevance (solving simple problems) (3) Reflection (deeper and wider mathematical thinking)	maths situation
scientific literacy	(1) Biodiversity (2) Force and Motion (3) Physiological Changes (4) Earth and Outer Space	(1) Describe, explain, and predict scientific phenomena (2) Understand scientific inquiry (3) Interpret scientific evidence and conclusions	scientific situation
reading literacy	(1) Continuous texts, e.g., narratives, expository texts, argumentative essays (2) Discontinuous texts, e.g., charts, tables, catalogues	(1) Extracting Information (2) Interpreting the text (3) Reflecting on and evaluating the text	reading situation
Problem -solving ability	(1) Decision-making (2) System analysis and design (3) Finding the root cause of a problem	(1) Understand the problem - make sense of it (2) Identify the problem - portray it (3) Represent the problem - describe it (4) Solve a problem - solve it (5) Examine or reflect on the problem - reflect on it (6) Communicate the results of the solution - pass it on	Problem-solving situations

Score: https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD2008&filename=2007200301.nh

World Class Arena, a British company (2001, p.15), has developed a computer-based test of problem-solving abilities for students aged 9-13. They classified the measurement of problem-solving ability into six areas such as "development of metacognition, applying new forms of representation and symbol systems, discovering rules and relationships, making decisions under constraints, handling complex data, and modelling complex processes and problems".

Liu Dongmei (2020, p.125) combed through the quantitative studies of PISA and concluded that PISA measures three main areas: reading literacy, mathematical literacy, and scientific literacy. 2003 saw the addition of the assessment of students' "problem-solving abilities ". 2012 was a turning point for PISA, and the main area of assessment in 2012 was mathematics. PISA2012 was a turning point, with the main area of assessment in 2012 being mathematics, so the analysis of PISA2012 focuses on the subject. Since then, PISA2015 has focused on science, so the literature has begun to emerge on the impact on academic achievement in science; PISA2018 focused on reading.

In summary, the assessment method of World Class Arena is an assessment for students aged 9 to 13 years old in the UK, and it has not been assessment ed in international multi-country applications, and there is no experimental verification of its applicability to Chinese students, which cannot guarantee the validity of the assessment. Long Yi, Liu Shousheng and other scholars proposed a method for measuring students' problem-solving ability, which has a narrow experimental surface, has not been verified by large-scale experiments, and the scale is not clear, so the reliability and validity of the assessment cannot be guaranteed. On the other hand, PISA has been applied and generally recognized in many countries around the world, and many national education administrations take the PISA assessment results as a yardstick for education reform in their own countries, and the PISA assessment has a high degree of reliability and validity. However, the assessment is at the end of compulsory education, for 15-year-old students, and there is no assessment for university medical students. Due to the wide coverage of the PISA assessment, the author believes that the PISA problem-solving ability assessment is more suitable for the ability assessment needs of this study, and the PISA 2003 problem-solving ability assessment tool will be selected to complete the assessment of students' problem-solving ability in the research work.

Medical course

Teaching standards

Ministry of Education of the People's Republic of China (2019) Published Documents, in order to implement the spirit of the Fifth Plenary Session of the 19th CPC Central Committee and the national strategy of implementing a healthy China and actively responding to the aging of the population, and to implement the spirit of the document "Circular on the Opinions on Accelerating the Development of Rehabilitation Medical Care" (State Healthcare and Medical Care [2021] No. 19), we have strengthened the construction of rehabilitation medical care service system, accelerated the high-quality development of rehabilitation medical care service, and gradually met the diversified and differentiated demands of the masses for rehabilitation medical care service; In order to adapt to the optimization and upgrading needs of the rehabilitation medical field, docking the new trend of digital, networked and intelligent development of the rehabilitation medical industry, docking the new requirements of the position of rehabilitation technician under the new industry, new industry and new mode, continuously meeting the demand for high-quality technical and skilled talents for the high-quality development of the rehabilitation medical field, promoting the professional upgrading and digital transformation of vocational education and improving the quality of talent cultivation, following the general requirements of promoting the high-quality development of modern vocational education, the State Council has decided to adopt the following measures The overall requirements of high-quality development of education, the state preparation of teaching standards. It is the basic standard for teaching rehabilitation medical specialty in higher vocational education across the country.

1. Applicable specialties and basic years of study

Rehabilitation medical specialty, 3 years of study.

2. Cultivation Objectives

This major cultivates students who are able to practice socialist core values, develop morally, intellectually, physically, socially and aesthetically, have a certain level of science and culture, have good humanistic literacy, scientific literacy, professional ethics, innovative consciousness and the spirit of saving lives and helping the injured, have strong interpersonal communication and teamwork ability, employability and sustainable development ability, have a solid foundation of science and culture, basic theoretical knowledge of rehabilitation therapy and commonly used technical skills for rehabilitation therapy, and are capable of solving common rehabilitation problems with a certain degree of difficulty and engaging in

physiotherapy, occupational therapy, speech therapy and other jobs. The students will be able to master solid scientific and cultural foundation, basic theoretical knowledge of rehabilitation therapy and common technical skills of rehabilitation therapy; they will be able to face the occupation of rehabilitation technician; they will be able to solve common rehabilitation problems with a certain degree of difficulty; and they will be able to engage in the work of physiotherapy, occupational therapy and speech therapy.

3. Course Curriculum and Credit Hour Schedule

3.1 Curriculum

It mainly includes public basic courses and professional courses.

1) Public basic courses

The public basic courses shall be fully implemented in accordance with the relevant national regulations. The courses of ideological and political theory, physical education, military theory and military training, mental health education and labor education shall be listed as public basic courses. The courses of ideological and political theory, physical education, military theory and military training, mental health education and labor education shall be listed as compulsory basic public courses. Courses on Party History, New China History, Reform and Opening-up History, History of Socialist Development, Chinese Excellent Traditional Culture, Constitution and Law, College Literature, Higher Mathematics law, university language, higher mathematics, university physics, medical chemistry, biology, public foreign languages, applied writing, national security, information technology, art, and vocational education. National Security Education, Information Technology, Art, Career Development and Employment Guidance, Innovation and Entrepreneurship Education, Scientific Exploration, Health Education, Vocational Literacy, etc. are listed as compulsory courses. The courses are listed as compulsory or elective courses. Schools may offer school-based programmers with local characteristics according to the actual situation.

2) Professional Courses

They generally include professional foundation courses, professional core courses, professional extension courses, and cover practical training and other relevant practical teaching links. The school determines the names of the courses independently, but they should include at least the following contents.

(1) Professional Basic Courses

Generally, set up 8 courses. Including: human anatomy, physiology, pathology, human development, basic human kinesiology, introduction to rehabilitation medicine, summary of clinical diseases, rehabilitation psychology.

(2) Specialized Core Courses

Generally, there are 7 courses. Including: rehabilitation assessment techniques, exercise therapy, physical factor therapy techniques, occupational therapy techniques, speech therapy techniques, Chinese medicine rehabilitation techniques, and rehabilitation of common diseases.

Table 2.4 Major Teaching Content and Requirements of Professional Core Courses

No.	Professional Core Courses	Typical job task descriptions	Main Teaching Content and Requirements
1	Rehabilitation technology	Determine the degree of dysfunction and prognosis of the patient through physical examination and observation; set rehabilitation goals; develop a rehabilitation programme; and determine the effectiveness of rehabilitation.	1) Master the basic knowledge and basic skills of basic physiological index measurements and daily living activities assessment; 2) Familiar with the basic knowledge and basic skills of cardiopulmonary function assessment, advanced brain dysfunction assessment; 3) Be able to correctly implement rehabilitation assessment and formulate rehabilitation plans with the patient as the center.
2	exercise therapy	With functional training and manipulative therapy as the main means, skilled in muscle strength training, joint mobility training, balance and co-ordination training, cardiorespiratory training for patients to restore their motor functions.	1) Master the basic knowledge and coordination training, breathing training, wheelchair training, walking function training; 2) Familiar with joint release, and guided education basic knowledge and basic skills; 3) Be able to choose the appropriate exercise therapy for the dysfunction of the patient, and complete the exercise function training safely and skillfully.

Table 2.4 Major Teaching Content and Requirements of Professional Core Courses(continue)

No.	Professional Core Courses	Typical job task descriptions	Main Teaching Content and Requirements
3	Physical Factor Therapy technology	With various physical factors as the main means to restore, improve and rebuild the patient's physical function	1) Master the clinical application of common physical factors; 2) Familiar with the physiological effects of common physical factors on human tissue; 3) Be able to choose the appropriate physical factor treatment method for the dysfunction of the patient and skillfully.
4	Occupational therapy technology	Use purposeful and selective homework activities to maximize the patient's ability to return to normal life and work	1) Master the indications and contraindications of occupational therapy; 2) Familiar with methods of analyzing operative activities; 3) Be able to correctly instruct patients in the use of various orthopedic appliances and in the design of home environment modifications.
5	Speech Therapy Technology	Treatment or correction of patients with speech and language dysfunction and swallowing dysfunction by means of training and instruction.	1) Master the basic knowledge and basic skills of assessment and delayed speech development in children; 2) Familiar with the causes of speech and swallowing dysfunction; 3) Be able to formulate a reasonable training plan according to the assessment results.

Table 2.4 Major Teaching Content and Requirements of Professional Core Courses(continue)

No.	Professional Core Courses	Typical job task descriptions	Main Teaching Content and Requirements
6	Chinese Rehabilitation Technology	Rehabilitation of functional decline or dysfunction of internal organs and tissues caused by various factors through the use of Chinese medicine.	1) Master the routing of commonly used meridians and channels and basic skills of tuna, moxibustion, guar sha, cupping, and traditional gong methods; 2) Be able to choose the appropriate Chinese medicine rehabilitation treatment method for the dysfunction existing in the patient, and complete the related operation safely and correctly.
7	Rehabilitation of common diseases	Conducting targeted rehabilitation assessment and comprehensive rehabilitation treatment for the characteristics of dysfunctions caused by illnesses or injuries commonly found in various clinical specialties	1) To master the rehabilitation treatment methods of common diseases in various clinical specialties; 2) Familiar with the clinical manifestations and treatment principles of common diseases; 3) Be able to carry out targeted and comprehensive rehabilitation treatment for the characteristics of common diseases in various clinical specialties.

Source:
http://www.moe.gov.cn/s78/A07/zcs_ztzl/2017_zt06/17zt06_bznr/bznr_gzjxbz/gzjxbz_yywsdl/yywsdl_kfzll/201907/P020190730564312748165.pdf

3) Professional Development Courses

Including: medical ethics, health laws and regulations, doctor-patient communication, rehabilitation assistive device technology, child rehabilitation, geriatric rehabilitation, Community Rehabilitation, Vocational Rehabilitation, Cultural and Exercise Therapy, Rehabilitation Robot Assisted Therapy Technology, Remote

Rehabilitation and so on. Specialties with conditions can explore the reconstruction of the curriculum system in combination with the actual teaching reform, such as organically restructuring the content of professional foundation courses, professional core courses, professional extension courses and practical teaching links into corresponding courses according to the needs of project-based and modular teaching.

4) Practical teaching links

Mainly include experiments, internship training, apprenticeship, social practice and so on. Experimental training can be completed on campus; apprenticeship, internship, social practice is organized in hospitals, communities and other off-campus places. Practical teaching content mainly includes: rehabilitation assessment techniques, exercise therapy, physical factor therapy Rehabilitation assessment techniques, exercise therapy, physical factor therapy, occupational therapy, speech therapy, Chinese medicine rehabilitation techniques, Rehabilitation of common diseases, etc. On-campus and off-campus practical training; post internship in the rehabilitation medicine department of Grade 2A or above general hospitals, rehabilitation specialist hospitals (centers), and other units. The students shall carry out internship in the rehabilitation medicine department of general hospitals of Grade A or above, and rehabilitation specialist hospitals (centers). The Regulations on the Administration of Internship for Students in Vocational Schools and the Standards for Internship in Rehabilitation Therapy Technology in Higher Vocational Schools shall be strictly implemented. Standards for Internship in Rehabilitation Therapy in Higher Vocational Schools".

3.2 Arrangement of Credit Hours

The total credit hours are generally 2800, with every 16-18 credit hours counted as 1 credit hour, among which, the total credit hours of the public basic courses are generally not less than 25% of the total credit hours. In principle, the practical teaching hours shall not be less than 50% of the total teaching hours, among which, the clinical internship hours of the core professional courses shall not be less than 15% of the total teaching hours of the practical courses, and the cumulative duration of the internship shall be 6 months, which can be arranged in a centralized manner or in phases according to the actual situation. The total number of hours of various elective courses shall not be less than 10% of the total number of hours. Military training, social practice, entrance education, graduation education and other activities are counted as one credit hour per week.

4. Teaching conditions

4.1 Teaching facilities

It mainly includes professional classrooms, laboratories, training rooms and internship training bases that can meet the needs of normal course teaching and internship training. Practical training base.

(1) Basic requirements of professional classrooms

Have the conditions to carry out blended teaching by means of information technology. Generally equipped with black (white) boards, multimedia computers, projection equipment, audio equipment, and Internet access. Film equipment, audio equipment, with Internet access or wireless network environment and network security measures. Installation of emergency lighting Installation and maintenance of emergency lighting devices in good condition, in line with the requirements of emergency evacuation, security signs are obvious, and keep the escape channel unobstructed.

(2) Basic requirements for on- and off-campus experimental and practical training places

The experimental and practical training places meet the requirements of area, safety and environment, and the experimental and practical training facilities are connected to the real occupational scenes or working situations, and are able to meet the requirements of emergency evacuation. The experimental and practical training facilities are in line with the real occupational scenes or working situations, and can meet the demands of experimental and practical training teaching; the instructors of experiments and practical training are determined to meet the needs of carrying out Rehabilitation assessment, exercise therapy, occupational therapy, physical factor therapy, speech therapy, Chinese medicine rehabilitation, rehabilitation of common diseases and other practical training activities. The requirements for practical training activities are met, and the regulations for the management and implementation of experiments and practical training are complete. Encourage the use of big data, cloud computing in practical training, Artificial intelligence, virtual simulation and other cutting-edge information technologies are encouraged to be used in practical training. Encourage schools and enterprises to jointly build productive practical training bases.

On-campus training rooms for professional courses mainly include: human kinesiology training room, rehabilitation assessment training room, exercise therapy training room, physical factor therapy training room, occupational therapy training room, speech therapy training room, Chinese medicine rehabilitation training

room, rehabilitation assistive devices training room, etc. rehabilitation equipment training room, etc.

(3) Basic requirements for internship sites

In conformity with the relevant requirements for internship units such as "Regulations on the Administration of Internship for Students in Vocational Schools" and "Measures for the Promotion of School-Enterprise Co-operation in Vocational Schools", the units which are legally operated, standardized in management, complete in terms of internship conditions in line with the reality of industrial development, in line with the requirements of laws and regulations on safety production, and which have established a stable relationship of co-operation with the school shall become internship bases after on-site inspection and signing of the tripartite agreement among the school, the students and the internship units. According to the needs of talent cultivation and future employment demand of this major, the internship base should be able to provide rehabilitation assessment, exercise therapy, Occupational Therapy, Physical Therapy, Speech Therapy, Chinese Medicine Rehabilitation, Rehabilitation of Common Diseases, etc. The internship base should be able to provide relevant internship positions corresponding to the major. It can cover the mainstream technology of the current development of the relevant industry and can accept a certain scale of students for internship; the school and the internship unit can jointly formulate the internship plan, can be equipped with a corresponding number of supervisors to supervise and manage the students' internship, and the internship unit arranges the experienced technical or management personnel to act as the internship supervisors to carry out the professional teaching and vocational skills training, complete the evaluation of the quality of internship, and do a good job of the service and management of the internship. service and management, have rules and regulations to ensure the daily work, study and life of the internship students, have safety and insurance protection, and protect the basic rights and interests of the students in accordance with laws and regulations.

4.2 Teaching resources

They mainly include teaching materials, books and digital resources that can meet the needs of students' professional learning, teachers' professional teaching research and teaching implementation. digital resources, etc.

(1) Basic requirements for the selection of teaching materials

In accordance with the national regulations, textbooks are selected through standard procedures, and priority is given to national planning textbooks and

national excellent textbooks. Specialty The teaching materials of professional courses shall reflect the new technology, new norms, new standards and new forms in the industry, and shall be dynamically updated through various methods such as loose-leaf teaching materials. Dynamic updating.

(2) Basic Requirements for Library and Literature Equipment

The books and documents can meet the needs of talent training, professional construction, teaching and research, etc., and are convenient for teachers and students to enquire and borrow. Professional books and literature mainly include: professional standards, technical manuals, operation norms, regulations, professional journals and case books of rehabilitation therapy technology.

(3) Basic Requirements for Digital Teaching Resource Configuration

To build and equip professional teaching resources such as audio and video materials, teaching courseware, digital teaching case library, virtual simulation software, digital teaching materials, etc., which are rich in variety, diversified in form, convenient in use, dynamically updated, and can meet the requirements of teaching.

Exercise Therapy Course Standard

The Department of Education of Shandong Province, China (2017) prepares a teaching guidance programmed for rehabilitation medicine specialties in higher vocational education in Shandong Province, which contains standards for exercise therapy courses. Exercise Therapy is a professional core course of rehabilitation medicine, the main task of this course is that through the study, students master the basic theory of exercise therapy, the operation method and clinical application of various types of exercise therapy, can formulate reasonable exercise therapy prescription according to the characteristics of the patient's movement disorders and the reasons for the implementation of the treatment, as well as caring for the patient, caring for the patient, and to promote the all-round rehabilitation of the patient. After graduation, students can be directly connected to the rehabilitation medicine department, rehabilitation center, community health service center and other exercise therapy jobs.

The prerequisite courses for this programmer include Human Body Morphology and Structure, Outline of Basic Medicine, Fundamentals of Chinese Medicine, Introduction to Clinical Medicine, etc. The synchronous courses include Fundamentals of Rehabilitation Therapy, Rehabilitation Assessment Techniques, Chinese Traditional Rehabilitation Techniques, Physical Factor Therapy Techniques,

Occupational Therapy Techniques, Speech Therapy Techniques, Rehabilitation Engineering Techniques, Rehabilitation of Diseases, Community-based Rehabilitation, Rehabilitation Psychology, Community-based Rehabilitation, etc., and the subsequent course is a follow-up internship.

1. Course Objectives

By the end of this course, students will be able to meet the following requirements.

1) Professional quality objectives

(1) Possess the spirit of truth-seeking and innovation, be diligent in research, and have a sense of love and responsibility.

(2) Have the ability of teamwork, good communication, high humanistic literacy and social adaptability.

(3) Have the quality of hard-working, establish the consciousness of serving the disabled, and build up the professional emotion of loving the rehabilitation career.

2) Professional knowledge and skills

(1) To master the concept, role and types of exercise therapy techniques; the basic principles and operation methods of various exercise therapy techniques; the indications, contraindications and precautions of exercise therapy techniques and other professional knowledge.

(2) To be able to select appropriate exercise therapy techniques according to the causes and characteristics of patients' movement disorders.

(3) Be able to formulate targeted exercise therapy prescriptions for patients.

(4) To be able to implement exercise therapy for patients and receive good results.

2. Course content and requirements

Table 2.5 Course content design proposal form

No.	teaching unit	Course content and teaching requirements	
1	preface	1. Classification of exercise therapy 2. Commonly used equipment for exercise therapy	Students can articulate the difference between physiotherapy and exercise therapy and identify exercise training equipment.

Table 2.5 Course content design proposal form (continue)

No.	teaching unit	Course content and teaching requirements	
2	joint mobility training	1.Upper limb joint mobility training 2.Lower limb joint mobility training 3.Trunk activity training	Students can demonstrate joint mobility techniques; analyze joint mobility influences and problems based on different cases and complete joint mobility training.
3	Balance and Coordination Training	1. Balance function training 2.Coordination training	The student can apply balance and co-ordination training methods to rehabilitate patients and provide targeted rehabilitation instruction training.
4	strength training	1.Upper limb muscle group muscle strength training 2.Lower limb muscle group muscle strength training 3. Head, neck and trunk muscle group muscle strength training	Students can instruct patients in the science of plyometric training based on their plyometric rating.
5	breathing training	1. Techniques to improve lung ventilation 2. Techniques to promote lung cleansing 3. Techniques to improve respiratory function	Students can use breathing training techniques to help rehabilitate patients; conduct health education.
6	Joint Release Technique	1. Upper limb joint release techniques 2. Lower limb joint release techniques 3. Spinal joint release techniques	Students can use joint release techniques to rehabilitate patients; conduct health education
7	muscle stretching technique	1. Upper limb muscle stretching techniques 2. Lower limb muscle stretching techniques 3. Spinal muscle stretching techniques	Students can use muscle stretching techniques to help patients; conduct health education.
8	traction technology	1.Cervical traction techniques 2.Lumbar traction techniques	Students can apply cervical and lumbar traction techniques to rehabilitate and train patients.

Table 2.5 Course content design proposal form (continue)

No.	teaching unit	Course content and teaching requirements	
9	Walking function training	1.Preparation for walking training 2.Walking training 3. Orthopedic training for common abnormal gaits	Students can perform walking breakdown training skills; instruct patients in the use of equipment for indoor walking training.
10	Bobath technology	1.Theoretical foundation 2.Basic technology 3.Clinical application	Students can use Bobath techniques to rehabilitate patients.
11	Brunnstrom Technology	1. Theoretical foundation 2. Basic technology	Students can apply Brunnstrom techniques to rehabilitate patients.
12	Rood technology	1.Theoretical foundation 2.Basic technology	Students can use Rood techniques to rehabilitate patients and direct rehabilitation exercises.

Source:Exercise Therapy Programme Standards. People's Republic of China. China People's Health Publishing House

3. Curriculum Implementation Recommendations

3.1 Teaching suggestions

Based on the work tasks and vocational ability requirements of rehabilitation therapist positions, the course can adopt "teaching-doing integration", project-oriented, task-driven and other teaching modes, use multimedia presentation method, group discussion method, case study method, situational simulation method and other teaching methods, and the teaching process is widely used in the heuristic and participatory mode, making full use of the school-enterprise cooperation to develop teaching materials, network information resources inside and outside the hospital, library collections and other teaching means, so that students can accept advanced concepts and knowledge. The course adopts a wide range of heuristic and participatory teaching methods, and makes full use of the teaching materials developed through cooperation between schools and enterprises, the network information resources inside and outside the hospital, the library collection and other teaching means, so that the students can accept the advanced concepts and knowledge; the practical classes make use of the practical training canter, internship and internship hospitals, and use the gradual clinical method of single practical training, simulated training, comprehensive practical training, clinical internship, and internship, so as to complete the training of practical skills.

This course highlights the characteristics of vocational education of "learning by doing, teaching by doing", there are wards in the school, and there are

classrooms in the wards, and the use of practical training bases both inside and outside the school organically combines the teaching organizational forms of independent learning, cooperative learning and teacher-led teaching of the students.

3.2 Student assessment and evaluation methods

1) The theoretical examination is conducted within the scope required by the syllabus, covering all lecture chapters as far as possible, and the difficulty of the assessment questions is grouped according to the proportion of mastery of 70%, familiarity of 20%, and understanding of 10%. The assessment paper will be drawn from the assessment bank. The assessment bank is required to cover the syllabus, flexible questions, moderate difficulty, focusing on students' mastery of basic theory and the ability to link theory to practice, analysis and problem solving, and close to the rehabilitation technician practice examination, each set of questions is divided into three sets of papers A, B, C, the amount of questions, difficulty is close to the examination, the examination is a randomly selected set of assessment.

2) Skill operation examination adopts the form of drawing lots, each student independently completes 1 specialty skill operation. The content of the lottery includes: the setup of the Department of Rehabilitation Medicine, commonly used equipment, etc., and one of them will be randomly selected.

3.3 Teaching implementation and guarantee

1) Classroom teaching conditions: textbooks, multimedia, auxiliary teaching materials, online teaching, library collection, etc.

2) Practical training conditions: shared laboratories in practical training centers, awareness of internship and internship hospitals, case studies, etc.

3.4 Preparation and selection of teaching materials

1) Compatible with vocational needs and the development of the times.

2) The curriculum arrangement and teaching content closely follow the syllabus of the qualification examination for rehabilitation therapy technician.

3) The textbook is deep-rooted in humanistic education and case studies are added.

4) The content of the textbook should be concise, accurate and scientific.

5) The form of the textbook should be illustrated, with vivid language and lively layout, which is in line with the learning characteristics of secondary students.

6) It is suggested that each chapter should be followed by a generalized sub-section.

In summary, in order to regulate teaching in vocational colleges and universities, comprehensively improve the quality of teaching and improve the quality of talent cultivation, the Chinese Ministry of Education has issued teaching standards for the rehabilitation medicine profession in higher vocational schools, which clearly defines the learning outcomes in terms of knowledge, skills and competence qualities that should be attained by medical students, rather than just the teaching content. This regulates and guides the majority of teachers to change the mode of education and teaching, consciously looking for gaps against the curriculum standards constantly before, during and after class, defining teaching objectives, designing the teaching process, organizing the teaching content and evaluating the students according to the learning outcomes that the students should achieve. The national standards provide a more scientific basis for the training of medical personnel and the certification of learning outcomes, and meet the needs of core competencies (problem-solving and other competencies) for personnel training, lifelong learning and other aspects of governance.

Related research

Problem-Based Learning

The problem-based learning model has been applied in several subject areas and has achieved good teaching results. The details are as follows.

Lamkin, M. P. (2015, p.67) used two biological units as the research object to explore the differences in content knowledge shown by students in multiple choice tests when they were taught by two teaching methods, and studied the comparison of content knowledge between male and female students, and the difference in students' perceptions of the ability learned between the two approaches, the results showed that students improved significantly after the problem-based learning approach.

Al-Salihi, F. and Alobaidi, A. (2018, pp.64-69) proposed to implement problem-based learning in the chemistry department courses of polytechnic colleges, advocated a student-oriented perspective, guided students to make full use of existing knowledge structures, mobilized relevant learning resources, and sought new solutions to related problems. A series of strategies involving Problem-Based Learning, concept mapping, and online communication are proposed to develop Problem-Based Learning modules for teaching organic chemistry.

Bsiso, M. M. et al. (2019, p.69) proposed that students' different cognition of problem-based learning components will have a positive or negative impact on students' deep learning and surface learning. Regarding the problem-solving ability, the "confirmation", "understanding" and "monitoring" links of the problem in the problem-based learning process are the key to the construction, and the effectiveness of problem-based learning set according to the individual differences of students is better.

Wu Hao (2020, p.78) established a research framework of problem-based learning model under the new curriculum standard on the basis of the new curriculum standard, combined with the teaching practice, and applied it to the teaching of physics mechanics in high school, and the results of his analyses proved the advantages of the problem-based learning model in guiding the students to think deeply, improving the subjective initiative in learning, and cultivating the students' ability to solve the real-life problems in life situations, and so on.

Lawal, O., Ramlaul, A. and Murphy, F. (2021, pp.727-732) reviewed the theory, process, key role of problem-based learning and its implications for radiography education and practice. The use of the key finding definition model provides a problem-based learning Practice A useful structure, the role of the facilitator in problem-based learning is important to student learning, helps guide students through learning outcomes and provides support to the group, and key skill development is an important factor to consider in Problem Based Learning. This pedagogical approach is therefore of particular key benefit in radiography education and training, where it has a greater impact on the preparation of students for autonomous clinical practice. The application of problem-based learning in developing students' critical thinking and decision-making ability supports the narrowing of students' cramming expectations, making it a beneficial pedagogical implementation within radiology courses.

Golightly, A. (2023, pp.37-55) researched on Building Bridges: The Impact of Scaffolds in the problem-based learning model on the Learning of South African Pre-Service Geography Teachers. This study explores pre-service geography teachers' assessment of the impact of hard and soft scaffolds used in problem-based learning on their own learning. Respondents had to complete a "Scaffolds in geography problem-based learning" instrument after the problem-based learning intervention. The respondents could also elaborate on the impact of the scaffolds on their learning in the comments section of the instrument. The results indicated that most of the respondents perceived that all the scaffolds used in the problem-based

learning activities had a positive impact on their learning. The soft scaffolds were perceived to have a higher impact on their learning compared to the hard scaffolds. Most of the respondents highlighted in their comments the important impact of the facilitator and group members on their learning. In addition, they indicated the important role of the training video and workshop on problem-based learning as examples of hard scaffolds to give them a good understanding of problem-based learning. No gender differences in the respondents' perceptions of the impact of scaffolds in problem-based intervention on their learning were reported. Respondents with high academic performance in geography rated the impact of the scaffolds on their learning to be larger compared to the lower academic performers.

To sum up, the problem-based learning model research results are very rich and the theory has basically matured. The problem-based learning model has gradually developed and grown, not only reflected in the research of medical education, but also applied in other subject areas, such as the research of students' performance and the research of metacognitive skills acquisition and application. This series of practical applications show that problem-based learning model is a kind of experiential learning, close to students' real life. The problem-based learning model is promoted in various subject areas, which is not only beneficial to the development of students' thinking ability, but also more beneficial to the improvement of students' theoretical level and problem-solving ability.

Problem-Solving Ability

Mehraj, B. H. A. T. (2019, pp.10-20) studied about learning styles in the context of reasoning and problem-solving ability: an approach based on multivariate analysis of variance. Reasoning and problem-solving abilities are not just for researchers; they are also progressively significant for making knowledgeable decisions in our everyday lives. Showing variations in learning styles have any influence on these skills? The current state of research addresses the learning styles in context of reasoning and problem- solving ability. High school students (598) completed the reasoning ability test, problem-solving ability test and learning style inventory. SPSS software was used for evaluating data obtained from three measurement tools. The entire three tools were validated through different techniques and found significant and acceptable. The data was analyzed by using MANOVA and Scheffe's post hoc test. The results indicated that participants showed variations in reasoning and problem-solving ability while using learning styles. Moreover, students having assimilating and diverging learning styles possess better reasoning and problem-solving abilities. The results of this research will contribute to the literature of learning styles and cognitive abilities,

as well as provide a wide range of implications for class room teachers, curriculum developers, researchers and educational planners.

Apriyani, R., Ramalis, T. R. and Suwarma, I. R. (2019 , pp.85-91) studied analyzing students' problem-solving abilities of direct current electricity in STEM-Based Learning. The purpose of this study is to analyze students' STEM-based learning problem solving abilities of Direct Current Electricity. In this study, STEM was implemented to train the areas of scientific practice and engineering practice related to modelling problems and project-based learning. The research method used was a pre-experiment with a set of pre-test and post-test designed. The study population consisted of 27 students in grade 10 of a vocational school in Bandung Barat province. The problem-solving ability instrument in this study was four structured descriptive questions, each consisting of five questions that are indicators of problem-solving ability, namely, imagining the problem, describing the problem using physical description, planning the solution, executing the plan, and checking and evaluating. The results of the study found that students' problem-solving abilities improved when integrating model problems and project-based learning were applied in STEM-based learning.

Nur, A. S. et al. (2020, pp.331-344) studied contextual learning with ethnomathematics in enhancing the problem solving based on thinking levels. differences in the development of students' thinking levels, especially differences in adolescence, can affect the way they perceive problems. Ethnomathematical contextual learning can provide students with opportunities to develop problem-solving abilities based on their level of thinking. This study examined how contextual learning in ethnic mathematics can improve students' problem-solving abilities according to their level of thinking. The participants in this study were 60 students from a junior secondary school in Gowa District, South Sulawesi Province. Data were collected using an observation form to identify local cultural characteristics that emerged at the time of treatment. Thinking level categories were tested using the Group Assessment of Logical Thinking (GALT) test. Students' ability to solve mathematical problems was measured using surface space materials appropriate to the local cultural context. Descriptive statistics and analysis of covariance (ANCOVA) were used for data analysis techniques. The results of the study showed that contextual learning of ethnomathematics influenced problem-solving ability based on the level of thinking. In addition, local cultural characteristics appeared in all categories of students' thinking levels. Students at the formal level of thinking were better problem solvers than students at the transitional and concrete levels of thinking. Ethnomathematics

contextual learning develops students' problem-solving abilities based on their thinking level.

Yonwilad, W. et al. (2022, pp.202-214) studied the improvement of mathematical problem solving abilities through a virtual 5E teaching organization. The study used whole cluster random sampling method to randomly select the sample. Three instruments were used in this study: 1) Mathematical Problem-Solving Competency Programme; 2) Mathematical Problem-Solving Competency Assessment; and 3) Student Behavior Observation Form. Descriptive statistics were used for data analysis and mean, standard deviation and percentage were calculated. The results of the study showed that the study of the Virtual 5E instructional organization improved the students' mathematical problem-solving abilities to an acceptable 70%, producing results that were consistent with their intended goals. Through the study of the effect of inquiry-based learning management of undergraduate mathematics students using digital tools to solve mathematical problems in a virtual classroom, and the effect of inquiry-based learning management using digital tools to solve mathematical problems through a virtual classroom on undergraduate mathematics students, it can be concluded that the students who organized inquiry-based learning activities using digital tools through a virtual classroom had mathematical problem-solving abilities and academic performance that were improved.

Sukontawaree, N., Poonputta, A. and Prasitnok, O. (2022, pp.771-782) investigated the Development of Problem-Solving Abilities in Science by Inquiry-Based Learning with Cooperative Learning for Grade 4 Students. The pedagogical approach of allowing learners to construct knowledge through questioning in collaborative learning activities to develop, action research was conducted with the aim of investigating the impact of inquiry-based collaborative learning on the problem-solving abilities of Grade 4 students and to study the students' satisfaction with inquiry-based collaborative learning in developing their problem-solving abilities. The research instruments included a learning management plan combining inquiry-based learning and cooperative learning, a problem-solving abilities evaluation form, and a satisfaction questionnaire. Data were statistically analyzed using percentages, mean scores and standard deviations. The results showed that the integration of the two methods was beneficial in improving the problem solving abilities of most of the participants. Participants also expressed satisfaction with the learning management throughout the semester in which it was implemented.

Chimmalee, B. and Anupan, A. (2022, pp.981-996) study of effect of model-eliciting activities using cloud technology on the mathematical problem-solving ability of

undergraduate students. Problem solving is considered an important skill for learning mathematics. Incorporating cloud technology into model-eliciting activities (MEAs) is considered a pedagogical approach to study the mathematical problem-solving ability of students. The purpose of this study was to evaluate the applicability of model elicitation activities using cloud technology and to assess the mathematical problem-solving ability of undergraduate students learning the proposed model and compare it with the 50% criterion. The study population was 50 undergraduate students taking a numerical analysis course, selected using purposive sampling techniques. A quasi-experiment was conducted using a single group design to determine the impact of the model on the students and to assess whether the students' mathematical problem-solving ability exceeded the standard. Research tools included lesson plans for multimedia instruction using cloud-based technology, a suitability assessment form, and a math's problem-solving ability assessment. Data were quantitatively analyzed using descriptive statistics (e.g., mean and standard deviation) and t-test. The results showed that five experts evaluated the model as "most suitable" and the mathematical problem-solving ability of undergraduate students exceeded the criterion of 50% with a statistical significance level of 0.05. The students' ability to solve problems by applying the main mathematical concepts was found to be satisfactory.

Chapter 3
Research Methodology

Using problem-based learning model to Improve problem-solving ability of medical students. The research using experimental research methodology have the following procedures.

1. The population /the sample Group
2. Research Instruments
3. Data Collection
4. Data Analysis

The population/Sample Group

Population

There are 150 second-year medical students majoring in exercise therapy of Weifang Nursing Vocational College, 5 classes with 30 students in each class.

The Sample Group

Through cluster random sampling, 30 second-year class 3 medical students with mix abilities (strong, medium, and weak) of Weifang Nursing Vocational College were sampled.

Research Instruments

Using problem-based learning model to Improve problem-solving ability of medical students. The research Instruments is as follows:

1. Lesson plan according to Problem-Based Learning model
2. Problem-Solving Ability assessment

The details are as follows:

Lesson plan according to the Problem-Based Learning model

The development process of creating Lesson plan according to the problem-based learning method and assessment form for validity of lesson plan were followed as.

1. Studying the principles of creating Lesson plan according to the problem-based learning model and assessment form for validity of lesson plan from books, textbooks, articles, and related research.

2. Creating a Lesson plan according to the problem-based learning model and assessment form for validity of lesson plan, 4 plans as follows:

Chapter 1: joint mobility training	3 hours
Chapter 2: Balance and Coordination Training	3 hours
Chapter 3: strength training	3 hours
Chapter 4: breathing training	3 hours

3. Drafting the assessment form for validity of lesson plan at the end of each section, there was a space for experts to write suggestions that could be helpful in improving students' problem-solving ability.

4.Taking the instruments to 3 experts to verify the validity. The test consistency the index of congruency is between 0.67-1.00, the level of consideration is as follows:

Rating is +1. There is an opinion that "Corresponds to definition/measurement objectives."

Rating is 0. There is an opinion that "Not sure it corresponds to definition/measurement objectives."

Rating is -1. There is an opinion that "Inconsistent with definition/measurement objectives."

5. Modifying assessment form for validity of lesson plan according to suggestion.

6. Taking the research instruments to collect data with the research samples.

Problem-Solving Ability assessment

The development process of creating problem-solving ability assessment and assessment form for validity of problem-solving ability assessment were followed as.

1. Studying the principles of the problem-solving ability assessment and the problem-solving ability assessment of validity scale from books, textbooks, articles, and related research.

2. Creating a problem-solving ability assessment and the problem-solving ability validity assessment.

Problem-solving ability assessment consisted of six competencies that proposed in the international PISA (2003) evaluation framework are a comprehensive and reasonable division of students' problem-solving ability, which is classified into the following:

1) Comprehension ability
2) Discriminatory ability
3) Presentation ability
4) Problem-solving ability

5) Reflective ability

6) Communication ability

Referring to scholars Yang Bin (2016) and Ma Lu's (2020) observation and evaluation criteria for the development of students' problem-solving ability, and design the evaluation assessment scale on this basis, as well as synthesize the PISA (2003) evaluation scale.

3. Taking the instruments to 3 experts to verify the content validity and index of items objective congruence (IOC) of the assessment form. The assessment consistency the index of congruency was between 0.67-1.00. The results of the quality assessment found that Every question has a score more than the specified criteria.

4. Modifying assessment form for validity of lesson plan according to suggestion.

5. Taking research instrument to test reliability and the result of reliability was 0.98.

6. Taking the research instruments to collect data with the research samples.

Table 3.1 Problem-Solving Ability Assessment Criteria

Evaluation Items	**Evaluation Content**	**Score and criterion**		
		3	**2**	**1**
Comprehension ability	1.Identify problems	Students can quickly identify issues and clarify the rationale and meaning of issues from case situations.	Students identify some of the issues from the case situation and clarify the rationale and implications of some of the issues.	Students are less likely to identify issues from case situations and less likely to clarify the rationale and meaning of some of the issues.
	2.Searching for problems	Students can quickly identify problems from information and actively explore information related to the problem and ultimately understand it.	Students identify parts of the problem from the information and are able to explore information and knowledge related to the problem and ultimately understand it.	Students have difficulty identifying problems from information and explore less information related to problems.

Table 3.1 Problem-Solving Ability Assessment Criteria (continue)

Evaluation Items	Evaluation Content	Score and criterion		
		3	2	1
Discriminatory ability	3.Describe the problems	Students can use their understanding to make adequate judgements and descriptions of the issues in a given resource.	Students use their understanding to make partial judgements and descriptions of problems in given resources.	Students use their understanding to make few judgements and descriptions of problems in given resources.
	4.Analyzing the problems	Students can analyze and integrate the information provided under the guidance of the teacher.	Students are guided by the teacher to analyze and integrate parts of the information provide.	Students are less likely to be able to analyze and integrate the information provided with the guidance of the teacher.
	5.Collaborative enquiry	Students can discuss with each other and identify problems in the learning process.	Students will identify some of the problems as they discuss with each other during the learning process.	Students discuss with each other and identify fewer problems in the learning process.
Presentation ability	6.Demonstrate results to illustrate the problem	Students can clearly formulate questions, demonstrate steps to results, and express their understanding of the question in a group.	Students ask questions and show some of the steps of their results, but express their understanding of the problem less among their peers.	Students are less likely to ask questions, demonstrate some of the steps of the results, or express their understanding of the problem.

Table 3.1 Problem-Solving Ability Assessment Criteria (continue)

Evaluation Items	Evaluation Content	Score and criterion		
		3	2	1
Problem-solving ability	7.Apply methods to solve problems	Students will choose their own learning styles to solve problems and communicate with peers to solve problems.	Students need to choose their own learning styles to solve problems and communicate with their peers to solve problems under the guidance of the teacher.	Students have difficulty solving problems through their own learning styles and do not communicate effectively with their peers.
Reflective ability	8.Continuous reflection on lessons learnt	Students can reflect on the questions through discussion as well as be able to modify the learning activity after reflection.	Students need to reflect on problem solving with teacher guidance and revise learning activities after reflection.	Students are less likely to reflect on problem solving through discussion and are less likely to revise learning activities.
Communication ability	9.Talking about experience and learning methods	Students can draw on good learning and problem-solving experiences and identify weaknesses.	Students need to summarize their problem-solving experiences with teacher guidance.	Students are not able to draw lessons on problem solving with teacher guidance.

Evaluate quality standards

Score Range	Quality Level
24-27	Strong
20-23	Relatively strong
16-19	General
12-15	Relatively weak
09-11	Weak

Data Collection

In this research, the data collection period is used for the first semester of the 2023 academic year, from 28th August 2023, 29th August 2023, 30th August 2023 to 31st August 2023, total of 12 hours. Follow the steps as follows.

1. This research is experimental research. One Group Pretest – Posttest Design was used with the following experimental design:

Table 3.2 Experimental design

Group	Pretest	Experimental	Posttest
E	T_1	X	T_2

The meaning of the symbols used in the experimental design.

E means Random Sampling

X means experimental

T_1 means Pretest

T_2 means Posttest

2. Took a problem-solving ability assessment to obtained from the analysis, the difficulty value, Discriminant power, and reliability value. Then it was assessed before class with the students that were research samples.

3. Took the Teaching according to lesson Plans that using problem-based learning model to improve problem-solving ability. Organized teaching by the researcher about 3 hours per week, total 12 hours.

4. After completing the teaching, Teacher conducted with using the same problem-solving ability assessment to students. The scores obtained from the assessment were recorded to compare the problem-solving ability of students before and after studying.

5. Got data obtained from teaching activities according to using problem-based learning model to analyze the data according to statistical methods.

Table 3.3 The lesson plans specific teaching time

No.	Date	Time	Content
Lesson 1	August 28th 07:50-12:00	3hours	joint mobility training
Lesson 2	August 29th 08:20-11:30	3 hours	Balance and Coordination Training
Lesson 3	August 30th 08:20-11:30	3 hours	strength training
Lesson 4	August 31th 07:50-12:00	3 hours	breathing training

Data Analysis

The data were collected and analyzed as follows :

1. Quantitative data were analyzed through descriptive statistics; means, and standard deviation.

2. Quantitative data were analyzed through inferential statistics; Then calculate the different score of problem-solving ability before and after using problem-based learning model were analyzed through t-test for dependent samples.

Chapter 4
Results of Analysis

The objective of this study is to improve the problem-solving ability of sophomore medical students in exercise therapy course through problem-based learning model, and to compare the problem-solving ability of the students before and after the implementation of problem-based learning model with sophomore medical students as the research subjects. The results of data analysis are as follows:

1. Symbol and abbreviations
2. Results of data analysis

The details are as follows:

Symbol and Abbreviations

Represent data analysis results based on symbols and semantics. The details are as follows:

n	means the number of students
$\bar{x}$	means the average
SD.	means the standard deviation
D	means the difference in scores between before and after learning
df	means degree of freedom
t	means the statistical value to be used in the T-test
**	means statistical significance at level .01

Results of Data Analysis

1. Results of using the Problem-Based Learning model to improve Problem-Solving Ability

The problem-based learning model is used to improve the problem-solving ability of medical students. Many scholars have studied the stages of the problem-solving process. This study is based on the concept of Barrows (1980), who argues that problem solving requires five stages: organizing study groups, create questions, Implementing Problems, Results showcase, Reflection evaluation. Edens (2000) argues that problem-oriented learning can be divided into three stages: problem development stage, problem inquiry phase and problem validation phase.

Zhao Haitao (2004, p.56) pointed out that the problem-based learning model consists of the following links: Creating a problem situation, Interpreting the problem in relation to what is known, Formulating hypotheses, Consulting information, independent research, Reporting findings in a group, Constructive reflection. In this study, the researcher divided the development of the lesson plan into five steps based on the problem-based learning model: 1) Create questions, 2) Implementation Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded Applications. Three experts analyzed the data on the quality of the lesson plans using the problem-based learning model, and the experts rated the quality of the lesson plans overall as the most applicable to the study for teaching.

The objective of this study is to improve the problem-solving ability of medical students using the problem-based learning model. The results of problem-solving ability scores before and after applying the problem-based learning model in the exercise therapy course are detailed in Table 4.1

Table 4.1 Using Problem-Based Learning model to Improve Problem-Solving Ability of medical students

Problem-Solving Ability	n	Full Scores	Pre-test		Post-test		D
			$\bar{x}$	SD.	$\bar{x}$	SD.	
1. Comprehension ability	30	6	4.07	1.44	4.83	1.21	0.76
2. Discriminatory ability	30	9	5.70	1.47	6.67	1.58	0.97
3. Presentation ability	30	3	1.87	0.82	2.07	0.87	0.20
4. Problem-solving ability	30	3	1.87	0.78	2.27	0.69	0.40
5. Reflective ability	30	3	1.80	0.92	2.20	0.85	0.40
6. Communication ability	30	3	1.97	0.89	2.37	0.81	0.40
total		27	17.28		20.41		3.13

From Table 4.1, it can be seen that the basic score of problem-solving ability of medical students using problem-based learning model of teaching are 17.28 points which is 64.00 percent on average before learning and 20.41 points which is 75.59 percent on average after learning with a difference of 3.13 points on average. These can be arranged in order of differences in before learning and after learning scores,

from highest to lowest are: discriminatory ability (0.97 points),Comprehension ability (0.76 points), reflective ability (0.40 points),communication ability (0.40 points), problem-solving ability (0.40 points) and presentation ability (0.20 points) Higher score after learning than before learning So, after the implementation of problem-based learning model , the students' Problem-Solving Ability improved obviously.

2. Comparative results of Problem-Solving Ability of medical students implementing the Problem-Based Learning model.

Comparison of medical students' problem-solving ability before and after adopting problem-based learning model. The researchers used the problem-solving ability scores before and after learning to analyze the data using mean statistics, standard deviation and t-test. The results of data analysis are shown in Table 4.2

Table 4.2 Results of comparing students' Problem-Solving Ability of medical students before and after using Problem-Based Learning model

Problem-Solving Ability		n	Full Point	$\bar{x}$	SD.	t	p
Total score	Pre- test	30	27	17.28	4.83	9.77	0.00 **
	Post-test	30	27	20.41	4.10		

**Statistically significant at level .01(p <.01)

From Table 4.2, it can be seen that the problem-solving ability scores of the medical students who used problem-based learning model averaged 17.28 before the study and 20.41 after the study with an average difference of 3.13 points. The results showed that the problem-solving ability of the students was higher after the study than before the study p<.01 indicates statistical significance at the .01 level. By implementing the problem-based learning model for students, students' problem-solving ability was significantly higher after the study than before the study, which is consistent with the research hypothesis.

3. Learning Behavior

The problem-based learning model was used to enhance the problem-solving ability of medical students. In order to verify the results, the researcher observed the students' behavior during the teaching process. In this study, when teaching 30 second-year medical students of Weifang Nursing Vocational College using the problem-based learning model, the students' behaviors were observed and recorded during the five teaching sessions of posing problems, implementing problems, presenting results, reflecting on the assessment, and extending the application in each

class. The changes in students' behaviors showed a gradual improvement in all six competencies throughout the learning process. The researcher observed all the learning behaviors of the students during the teaching and learning activities, the teaching model was divided into five steps and the learning behaviors of the students during the teaching and learning arrangements were recorded as follows:

Lesson Plan 1: joint mobility training

Step 1 Create questions

This teaching activity is divided into 2 phases, identifying and exploring problems, with the ultimate aim of improving students' ability to understand problems.

1.1 The teacher introduces the case scenario and guides the students into the classroom. Teacher inspires students to ask questions: what is the patient's current problem? How to make the patient's right limb mobile? Through the teacher's inspiration, students need to complete the task set by the teacher from the case scenario, i.e., to identify the problem and try to answer the nature, context and meaning of the problem. If students can quickly identify the problem from the case scenario and clarify the problem, it shows that they have the ability to identify the problem.

The results of the activity showed that the introduction of the case scenario was of great interest to the students. Eight students completed the questions provided by the teacher and clarified the basic meaning of the questions in the classroom, due to the sufficient pre-study before the class. Twenty-two students were able to identify the problem but did not understand the meaning of the problem, indicating that although the students enjoyed the activity, they had not been integrated into it and therefore did not understand the basic meaning of the problem thoroughly.

1.2 In the process of identifying the problem, the teacher guided the students to analyze the case and find information. Based on the case, the question was posed again: What joint mobilization exercises can be carried out on the right limb in order to prevent complications caused by braking? The students were allowed to find out the problem from the data and could actively explore the information and knowledge related to the problem and finally understand the problem.

The results of the activity showed that 5 students quickly identified the problem from the information and explored the information related to the problem, most of the students identified part of the problem from the information with the guidance of the teacher and were able to explore the information and knowledge

related to the problem and eventually understood the problem. Four students did not fully understand the question.

Step 2 Implementation Problems

The teaching activity is divided into three stages, namely describing the problem, analyzing the problem and collaborative enquiry, with the ultimate aim of enhancing students' ability to identify the problem.

2.1 Building on the first session, students begin to describe the structure and components of the problem. For example, what are the factors that affect joint movement? The students' ability to describe the problem in a complete manner, involving their previously learnt knowledge of anatomy, shows that they have the ability to describe the problem.

The results of the activity showed that four students were able to use their understanding to fully judge and describe the problem in the given resource, three students described the problem in the given resource to a lesser extent, and the other students used their understanding to partially judge and describe the problem in the given resource.

2.2 Teacher practical training operation, students observe. During the operation, students are guided to analyze the problems. During the analysis process, students analyzed the problems by themselves when they encountered problems of lower difficulty; when they encountered problems of higher difficulty, the teacher guided them to analyze the problems. Completion of the N/NK table of IMSA revealed that students' ability to analyze the problems in the given resources varied from strong to weak.

The results of the activity showed that the teacher gave timely feedback to the students for the key points in the operation, and at the same time, the teacher communicated with the standardized patients in time during the operation, and the students observed and learnt from the students to experience the communication skills. During the operation, the teacher guided the students to experience treating patients with care, love and patience, and respecting patients. One student was able to analyze and integrate the operation information provided by the teacher and pay attention to the doctor-patient communication skills. 3 students were able to analyze the operation points and integrate the operation process. The rest of the students need to analyze the main points and integrate the process with the help of the teacher, and lack communication skills, which need to be penetrated continuously to ensure that the students can communicate well with patients in the future workplace.

2.3 After the teacher's operation, students work in groups of three, with each member taking a different role within the group, in order of standardized patient, operator and evaluator. Each group of students operated with each other, constantly discussing and communicating between groups to develop cooperative learning, while the teacher provided guidance.

The results of the activity showed that two students did not participate in the discussion and did not identify problems in the learning process. The rest of the students were able to identify problems in the learning process by discussing with each other.

Step 3 Results showcase

This teaching activity is divided into 2 stages, namely, presenting the results to illustrate the problems and will apply the methods and strategies to solve the problems, with the ultimate aim of enhancing students' ability to formulate problems and solve them.

3.1 The teacher randomly selects a group of students to demonstrate the operation on the stage, while the rest of the students observe carefully, identify problems and put forward different opinions. Throughout the process, the teacher guides the students to discover and look for every possible problem in the demonstration, and guides them to think about how to use all kinds of information to formulate a problem; how to express the same problem in different ways. The purpose of this was to enable students to formulate problems clearly and to articulate their understanding of the problem, and ultimately to improve their ability to formulate problems.

The results of the activity showed that five students were able to carefully identify the problems in the presentation and were able to correctly formulate the results, as well as express their understanding of the problem within the group. Most of the students were less able to identify the problems and had more difficulty in expressing their understanding of the problems, which indicated that the students still needed to practice.

3.2 The teacher guided the students to discover to look for problems that might arise during each joint activity training and try to solve these practical problems as well as literacy problems, which ultimately improved their problem-solving ability.

The results of the activity showed that five students would use methods and strategies to solve problems and could communicate with their peers to solve problems. The rest of the students would choose their own learning styles to solve problems under the guidance of the teacher.

Step 4 Reflection evaluation

This stage allows students to continuously reflect on the lessons learnt, through discussion, reflection on problem solving methods, and modification of the learning activity after reflection, with the ultimate aim of improving students' ability to reflect on problems. After the group exchange, students train in groups and begin to evaluate. Students continued to communicate during the training process, reflecting on possible problems that could arise from the training operations of the joint activity.

The results of the activity showed that all 10 students were able to successfully complete the questions in the worksheet and were able to reflect on the problems as well as make modifications to the learning activity after reflection.1 student needed to choose his/her own learning style to reflect on the problems under the guidance of the teacher.

Step 5 Expanded applications

The ultimate goal of this teaching activity is to improve students' ability to communicate their problems by talking about their experiences and learning methods. Through group discussion, summarize good experiences in learning and problem solving, identify shortcomings, and summarize methods that can be transferred and used. Clinical cases are reintroduced to ask questions to test students' problem-solving ability. Students uploaded the answers to the questions to the teaching platform according to the worksheet and the six sub-competencies of students' problem-solving ability were observed from the test results.

The results of the activity showed that 15 students were able to summarize good learning and problem-solving experiences and identify weaknesses.

Lesson Plan II: Balance and Coordination Training

Step 1 Create questions

The teaching activity is divided into 2 stages, namely identifying and exploring the problem, with the ultimate aim of improving students' ability to understand the problem.

1.1 The teacher introduces the case scenario and guides the students into the classroom. The teacher inspires students to ask questions: what is the patient's current problem? What are the factors that affect the ability of balance and coordination? Through teacher-inspired questions, students identify the problem and try to answer the nature, context and significance of the problem. If the students can quickly identify the problem and clarify it from the case scenario, it shows that they have the ability to identify the problem.

The results of the activity showed that 19 students completed the questions provided by the teacher and clarified the basic meaning of the questions in the classroom. While 11 students were able to identify the problem, but there was no understanding about the nature and context of the problem, indicating that the students need to consult more information, find out more and communicate more.

1.2 In the process of students discovering the problem, the teacher guided students to analyze the case and find information. Based on the case, the question is asked again: what balance and coordination training can be carried out according to the patient's condition? The students were allowed to discover the problem from the information and could actively explore the information and knowledge related to the problem and finally understand the problem.

The results of the activity showed that 16 students quickly identified the problem from the data and explored the information related to the problem, 11 students identified part of the problem from the data with the guidance of the teacher and were able to explore the information and knowledge related to the problem and finally understood the problem. Three students did not fully understand the problem. The reason for this was that the balance and coordination problem was difficult and not well understood.

Step 2 Implementation Problems

The teaching activity is divided into three stages, namely describing the problem, analyzing the problem and collaborative enquiry, with the ultimate aim of enhancing students' ability to identify the problem.

2.1 Building on the first session, students begin to describe the structure and components of the problem. For example, what balance and coordination functions can be assessed based on the patient's condition? The students' ability to describe the problem in a complete way, involving their previously learnt knowledge of rehabilitation assessment, shows that they have the ability to describe the problem.

The results of the activity showed that 10 students were able to use their understanding to make full judgements and descriptions of the problems in the given resources, 2 students described less of the problems in the given resources, and the other students used their understanding to make partial judgements and descriptions of the problems in the given resources. It shows that most of the students have a solid grasp of the pre-study knowledge of rehabilitation assessment.

2.2 Teacher's practical training operation and students' observation. Students are guided to analyze the problems during the operation. In the process of analysis, when encountering problems of lower difficulty, students will analyze the problems

by themselves; when encountering problems of higher difficulty, the teacher will guide students to analyze the problems. Completion of the N/NK table of IMSA revealed that the students' ability to analyze the problems in the given resources varied from strong to weak.

The results of the activity showed that 15 students were able to analyze and integrate the operational information provided by the teacher and were able to pay attention to the doctor-patient communication ability. 15 students needed to analyze the main points and integrate the process with the help of the teacher, and analyzing the problem at a later stage remained the focus of the activity.

2.3 After the teacher's operation, students work in groups of three, with each member taking a different role within the group, in order of standardized patient, operator and evaluator. Each group of students operated on each other, with continuous discussion and group-to-group communication to develop cooperative learning, while the teacher provided guidance.

The results of the activity showed that two students did not participate in the discussion and did not identify problems in the learning process. The reason was that the operation was considered mastered and the teacher needed to guide them correctly. The rest of the students were able to identify problems through mutual discussion in the learning process.

Step 3 Results showcase

This teaching activity is divided into 2 stages, namely, presenting the results to illustrate the problems and will apply the methods and strategies to solve the problems, with the ultimate aim of enhancing students' ability to formulate problems and solve them.

3.1 The teacher randomly selects a group of students to demonstrate the operation on the stage, while the rest of the students observe carefully, identify problems and put forward different opinions. Throughout the process, the teacher guides the students to discover and look for every possible problem in the demonstration, and guides them to think about how to use all kinds of information to formulate a problem; how to express the same problem in different ways. The purpose of this was to enable students to formulate problems clearly and to articulate their understanding of the problem, and ultimately to improve their ability to formulate problems.

The results of the activity showed that 10 students were able to carefully identify the problems in the presentation and were able to correctly formulate the results, as well as express their understanding of the problem within the group. Most

of the students were less able to identify the problems and had more difficulty in expressing their understanding of the problems, which indicated that the students still needed to practice.

3.2 The teacher guided the students to discover to look for problems that might arise in each balance and coordination exercise, and to try to solve these practical problems as well as literacy problems, and ultimately to improve their problem-solving ability.

The results of the activity showed that 10 students would apply methods and strategies to solve problems and could communicate with their peers to solve problems. The rest of the students will choose their own learning styles to solve problems under the guidance of the teacher.

Step 4 Reflection evaluation

This stage allows students to continuously reflect on the lessons learnt, through discussion, reflection on problem solving methods, and modification of the learning activity after reflection, with the ultimate aim of improving students' ability to reflect on problems. After the group exchange, students train in groups and begin to evaluate. The students continued to communicate during the training process, reflecting on possible problems with the balance and co-ordination training maneuvers.

The results of the activity showed that all 20 students were able to successfully complete the questions in the worksheet and were able to reflect on the problems as well as make modifications to the learning activity after reflection.1 student needed to choose his/her own learning style to reflect on the problems under the guidance of the teacher.

Step 5 Expanded applications

The ultimate goal of this teaching activity is to improve students' ability to communicate their problems by talking about their experiences and learning methods. Through group discussion, summarize good experiences in learning and problem solving, identify shortcomings, and summarize methods that can be transferred and used. Clinical cases are reintroduced to ask questions to test students' problem-solving ability. Students uploaded the answers to the questions to the teaching platform according to the worksheet and the six sub-competencies of students' problem-solving ability were observed from the test results.

The results of the activity showed that 20 students were able to summarize good learning and problem-solving experiences and identify weaknesses. The rest of the students needed to be guided by the teacher.

Lesson Plan III： strength training

Step 1 Create questions

The teaching activity is divided into 2 stages, namely identifying and exploring the problem, with the ultimate aim of improving students' ability to understand the problem.

1.1 The teacher introduces the case scenario and guides the students into the classroom. The teacher inspires the students to ask the question: now it is proposed to carry out plyometric training for the patient's biceps and triceps brachii, which plyometric training method can be used? The student identifies the problem from the case situation and tries to answer the nature, context and meaning of the question. If students can quickly identify the problem from the case scenario, it means that they have the ability to identify the problem.

The results of the activity showed that after 2 teaching activities, students had a better understanding of the teaching model. Twenty-five students completed the questions provided by the instructor in class and clarified the basic meaning of the questions. There were 5 students who were able to identify the problem but the context about the problem was not understood due to the lack of attention to the problem.

1.2 In the process of students identifying the problem, the teacher guided them to analyze the case and find information. Based on the case, the question was asked again: what kind of plyometric training methods can be used? Students were allowed to find out the problem from the information and could actively explore the information and knowledge related to the problem and finally understand the problem.

The results of the activity showed that 22 students quickly identified the problem from the materials and explored the information related to the problem, 7 students did not fully understand the problem because they did not comprehensively search for the information, and 1 student was on sick leave and did not participate in the activity.

Step 2 Implementation Problems

The teaching activity is divided into 3 stages, namely describing the problem, analyzing the problem and collaborative enquiry, with the ultimate aim of improving students' ability to identify the problem.

2.1 Students begin to describe the structure and components of the problem. For example, what are the functional assessments of muscle strength that can be made depending on the patient's condition? The students' ability to describe the

problem in a complete manner, involving their previously learnt knowledge of rehabilitation assessment, shows that they have the ability to describe the problem.

The results of the activity showed that 15 students were able to use their understanding to make adequate judgements and descriptions of the problems in the given resources, while 2 students described less of the problems in the given resources due to a weak grasp of prior learning. Other students used their own understanding to make partial judgements and descriptions of the problems in the given resources.

2.2 Teacher's practical training operation and students' observation. Students were guided to analyze the problem during the operation. During the analysis process, students analyze the problems by themselves when they encounter problems of lower difficulty; the teacher guides students to analyze the problems when they encounter problems of higher difficulty. Completion of the N/NK table of IMSA revealed that students' ability to analyze the problems in the given resources varied from strong to weak.

The results of the activity showed that the teacher operated in a timely manner with standardized patient communication and students observed and learnt communication skills. Twenty students were able to analyze and integrate the information provided by the teacher for the operation and were able to pay attention to the doctor-patient communication skills. 10 students needed to analyze the points with the help of the teacher and lacked communication skills. The reason for this is that the interpersonal communication course was not firmly grasped.

2.3 After the teacher's operation, students work in groups of three, with each member taking a different role within the group, in order of standardized patient, operator and evaluator. Each group of students operated on each other, with continuous discussion and group-to-group communication to develop cooperative learning, while the teacher provided guidance.

The results of the activity showed that one student did not participate in the discussion and did not identify problems in the learning process. The rest of the students were able to identify problems through mutual discussion in the learning process.

Step 3 Results showcase

This teaching activity is divided into 2 stages, namely, presenting the results to illustrate the problems and will apply the methods and strategies to solve the problems, with the ultimate aim of enhancing students' ability to formulate problems and solve them.

3.1 The teacher randomly selects a group of students to demonstrate the operation on the stage, while the rest of the students observe carefully, identify problems and put forward different opinions. Throughout the process, the teacher guides students to think about how to use various kinds of information to ask questions; how to express the same question in different ways. The purpose of this was to enable students to ask questions clearly and to articulate their understanding of the question, and ultimately to improve their ability to formulate the question.

The results of the activity showed that 23 students were able to carefully identify the problem in the presentation and were able to correctly formulate the results, as well as express their understanding of the problem within the group. A small number of students also had difficulty in expressing their understanding of the problems, which indicates that students' ability to identify problems needs to be improved.

3.2 The teacher guided the students to discover to look for possible problems in each plyometric exercise and try to solve these practical problems as well as literacy problems, which ultimately improved their problem-solving ability.

The results of the activity showed that 23 students would apply methods and strategies to solve problems and could communicate with their peers to solve problems. The rest of the students will choose their own learning styles to solve problems under the guidance of the teacher.

Step 4 Reflection evaluation

This stage allows students to continuously reflect on the lessons learnt, through discussion, reflection on problem solving methods, and modification of the learning activity after reflection, with the ultimate aim of improving students' ability to reflect on problems. After the group exchange, students train in groups and begin to evaluate. Students continued to communicate during training and reflect on possible problems with the plyometric maneuvers.

The results of the activity showed that all 20 students were able to successfully complete the questions in the worksheet and were able to reflect on the problems as well as make modifications to the learning activity after reflection.1 student needed to choose his/her own learning style to reflect on the problems with the guidance of the teacher.

Step 5 Expanded applications

The ultimate goal of this teaching activity is to improve students' ability to communicate their problems by talking about their experiences and learning methods. The group discussion summarizes the good experiences in learning and problem

solving, identifies the shortcomings, and summarizes the methods that can be transferred and used. Re-introduce clinical cases and ask questions to test students' problem-solving ability. Students uploaded the answers to the questions to the teaching platform based on the worksheet and the six sub-competencies of the students' problem-solving ability were observed from the test results.

The results of the activity showed that 25 students were able to summarize good learning and problem-solving experiences and identify weaknesses.

Lesson Plan IV： breathing training

Step 1 Create questions

The teaching activity is divided into 2 stages, namely identifying and exploring the problem, with the ultimate aim of improving students' ability to understand the problem.

1.1 The teacher introduces the case scenario and guides students into the classroom. The teacher inspires students to ask the question: what causes shortness of breath? Through the teacher's inspiration, students try to answer the nature, context and meaning of the question. If students can quickly identify the problem and clarify the question from the case scenario, it shows that they have the ability to identify the problem.

The results of the activity showed that 30 students were able to quickly identify the problem from the case scenario and clarify the basis and meaning of the problem, indicating that through the problem-based learning model, students were able to identify the problem and understand the basic meaning of the problem thoroughly.

1.2 In the process of students discovering the problem, the teacher guides students to analyze the case and find information. According to the case, the question is asked again: how to carry out respiratory training for this patient? The students were asked to find out the problem from the data and could actively explore the information and knowledge related to the problem, and finally understand the problem.

The results of the activity showed that 29 students were able to identify the problem from the data and actively explore the information and knowledge related to the problem and finally understand the problem. 1 student was able to complete the task under the guidance of the teacher. This student raised doubts about the case and the teacher guided the completion.

Step 2 Implementation Problems

The teaching activity is divided into three stages, namely describing the problem, analyzing the problem and collaborative enquiry, with the ultimate aim of enhancing students' ability to identify the problem.

2.1 Building on the first session, students begin to describe the structure and components of the problem. For example, what causes shortness of breath? The students' ability to describe the problem in a complete manner, involving their previously learnt knowledge of anatomy and physiology, shows that they have the ability to describe the problem.

The results of the activity showed that 30 students were able to use their understanding to describe the problems in the given resources, and that with the joint efforts of the teacher and the students to advance their knowledge of the anatomy and physiology of the humerus, the students were fully capable of describing the problems.

2.2 Teacher's practical training operation and students' observation. During the operation, students are guided to analyze the problem. In the process of analysis, students will analyze the problems by themselves when they encounter problems of lower difficulty; when they encounter problems of higher difficulty, the teacher will guide the students to analyze the problems. Completion of the N/NK table of the IMSA revealed that the students' ability to analyze the problems in the given resources varied from strong to weak.

The results of the activity showed that 28 students were able to analyze and integrate the information provided with teacher guidance. The latter sought to complete the analysis without teacher's guidance and the students were able to do so. 2 students were weak in their analytical skills and needed to be tutored individually in the classroom.

2.3 After the teacher's manipulation, students worked in groups of three, with each member taking a different role within the group, in order of standardized patient, manipulator and evaluator. Each group of students operated on each other, with constant discussion, group-to-group communication to develop cooperative learning, and guidance from the teacher.

The results of the activity showed that 19 students identified problems through active discussion, and one student successfully completed the activity under the guidance of the teacher, which improved the students' ability to identify problems.

Step 3 Results showcase

This teaching activity is divided into 2 stages, namely presenting the results to illustrate a problem and being able to apply methods and strategies to solve problems, with the ultimate aim of enhancing students' ability to formulate problems and solve them.

3.1 The teacher randomly selects a group of students to demonstrate the operation on the stage. The teacher guides the students to identify and look for every possible problem in the demonstration, and guides the students to think about how to use various kinds of information to formulate a problem; and how to express the same problem in different ways. The purpose of this was to enable the students to formulate problems clearly and to articulate their understanding of the problem, and ultimately to improve their ability to formulate problems.

The results of the activity showed that 26 students were able to identify and articulate their understanding of a problem in a group. 4 students were able to articulate their understanding of a problem in a group under the guidance of the teacher.

3.2 The teacher guided the students to identify problems that might arise during each breathing exercise and to try to solve these practical and literacy problems, which would ultimately improve their problem-solving ability.

The results of the activity showed that 26 students were able to identify the problems, show the steps to the results, and express their understanding of the problems in small groups. 4 students were able to show the steps to the results under the guidance of the teacher.

Step 4 Reflection evaluation

This stage allows students to continuously reflect on the lessons learnt, through discussion, reflection on problem solving methods, and modification of the learning activity after reflection, with the ultimate aim of improving students' ability to reflect on problems. After the group exchange, students train in groups and begin to evaluate. The students continued to communicate during the training process, reflecting on possible problems that could arise from the breathing training operation.

The results of the activity showed that 26 students were able to choose their own learning style to solve the problem and share the solution with their peers. 4 students were able to solve the problem under the guidance of the teacher.

Step 5 Expanded applications

The ultimate goal of this teaching activity is to improve students' ability to communicate their problems by talking about their experiences and learning methods. The group discussion summarizes the good experiences in learning and problem solving, identifies the shortcomings, and summarizes the methods that can be transferred and used. Re-introduce clinical cases and ask questions to test students' problem-solving ability. Students uploaded the answers to the questions to the teaching platform based on the worksheet and the six sub-competencies of students' problem-solving ability were observed from the test results.

The results of the activity showed that 28 students were able to summarize good learning and problem-solving experiences and identify weaknesses. 2 students were able to identify weaknesses with guidance from the instructor and personalized coaching after class.

To summarize, it can be seen from the students' learning behaviors that their problem-solving ability has been improved under the guidance of the problem-based learning model. In this study, certain results were achieved: students were able to quickly identify the problem from the case situation given by the teacher and actively explore the information and knowledge related to the problem, and finally understand the problem. Students were able to use their understanding to describe the problem, and to analyze and integrate the problem under the guidance of the teacher. Students are able to make full use of group work to identify problems and are able to solve them in a presentation of results. When encountering difficulties, they are able to communicate with group members, reflect on the problem through discussion, summarize good learning and problem-solving experiences, and identify shortcomings. Therefore, the problem-based learning model can enhance the problem-solving ability of sophomore medical students.

Chapter 5
Conclusion Discussion and Recommendations

The purpose of this research were 1) to use problem-based learning model to improve problem-solving ability of medical students and 2) to compare students' problem-solving ability, before and after the implementation base on the problem-based learning model. The sample group are 30 students from class 3 of the second year in Weifang Nursing Vocational College in China. Through the cluster random sampling method, in the first semester of the academic year 2023.

The research instruments used in this study are as follows:

1. Lesson plan based on problem-based learning model.

2. Problem-solving ability assessment that there are 9 subjective assessment questions for improving of medical students.

Conclusion

According to the research topic, the summary of the research on improving the problem-solving ability of medical students through the problem-based learning model is as follows:

1. By using the problem-based learning model and observing students' learning behaviors, it was found that students' Identify problems, searching for problems, Describe the problems, Analyzing the problems, Collaborative enquiry, demonstrate results to illustrate the problem, apply methods to solve problems, Continuous reflection on lessons learnt, talking about experience and learning methods have improved and problem-solving ability has been improved.

2. The comparing students' problem-solving ability before and after teaching in the problem-based learning model, second-year medical students the assessment scores prior the class had the average 17.28 (SD.=4.83) another, the assessment scores after the class had the average 20.41 (SD.=4.10). The assessment scores after the class were higher than prior the class by statistically significant at the .01 level.

Discussion

The research results of using problem-based learning model to improve problem-solving ability of medical students of Weifang Nursing Vocational College in the first semester of the academic year 2023, which used the problem-based learning

model to develop problem-solving ability of 30 second-year medical students, can be discussed as follows:

1. Research results

This study explores the cultivation of students' problem-solving ability in the teaching practice of exercise therapy course, constructs a problem-based learning model for cultivating students' problem-solving ability on the basis of a large number of literature and practice analyses, and designs teaching activities based on this model. Through the study, it is proved that the problem-based learning model constructed in this study is effective in enhancing students' problem-solving ability.

1.1 The problem-based learning model improves students' problem-solving in an exercise therapy programme. Students' problem-solving ability was well understood and learnt in practice as they received learning and training according to the steps of the problem-based learning model during their study of joint training, balance training, plyometrics and respiratory training. The study of many related literatures and the research on the problem-based learning model were summarized into five steps to develop a lesson plan: 1) Create questions, 2) Implement Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications. The assessment concluded that students have problem-solving abilities in the problem-based learning model in six areas: 1) Comprehension ability, 2) Discriminatory ability, 3) Presentation ability, 4) Problem-solving ability, 5) Reflective ability, and 6) Communication ability. among these, the problem-based learning model is necessary to improve the problem-solving ability of medical students, and this teaching model can enhance students' interest, which is consistent with Martí's (2006) The findings are consistent with the fact that problem-based learning as a more actionable approach is more convenient for teachers to teach in the classroom and master the pace of teaching; for students, it raises their awareness of interest in the subject, stimulates motivation and initiative in learning, and improves their problem-solving ability. The problem-based learning model advocates a student-oriented perspective that guides students to make full use of the existing knowledge structure, to Mobilizing relevant learning resources to find new solutions to relevant problems, in line with Amina (2018) study, develops instructional learning modules through a series of learning involving problem-based learning. Problem-based learning is important to student learning as it helps to guide students to get more opportunities to practice and consolidate what they have learnt and develop problem-solving ability. It also corroborates Lawal (2021) that the problem-based learning model has particularly critical benefits in medical education and training, and that it has a greater impact on

students' preparation for autonomous clinical practice. Problem-based learning in developing students' critical thinking and decision-making skills makes it a useful pedagogical implementation in the medical curriculum.

1.2 Methods of summarizing the effectiveness of the application of Problem-Based Learning model teaching practice

To verify the effect of the application of problem-based learning model teaching practice, it is necessary to scientifically reflect the development of students' problem-solving ability, that is, it is necessary to study how to measure students' problem-solving ability. In order to ensure the credibility and validity of the study, the author has created a set of assessment questions for students' problem-solving ability with the internationally shaped PISA assessment as the main body of assessment, which can effectively reflect the development of medical students' problem-solving ability. The assessment questions correspond to nine elements of the six sub-competencies of problem-solving ability, all of which are subjective. The problem-solving ability assessment questions can comprehensively understand and assess the problem-solving ability of medical students, which is a good proof of the good application effect after using problem-based learning model. This corroborates the findings of Finkelstein and Hanson (2010), which found that problem-based learning model were overall more effective than traditional methods in improving students' problem-solving skills. Therefore, the classroom implementation of the problem-based learning model can guide students to find the knowledge concepts of these problems and motivate them to make what they have learnt the source needed to solve the problems, thus accomplishing the improvement of problem solving skills, which coincides with Yennita and Zukmadini (2021) research that the teaching model is an effective teaching strategy that can better guide students' learning and improve the effectiveness of teaching, thus empowering students to solve problems better.

2. Comparative results of pre- and post-study problem-solving ability

2.1 The application of the Problem-Based Learning model to carry out teaching activities can effectively improve students' problem-solving ability

From the experiment of introducing the problem-based learning model into the classroom, it was found that the sample group of medical students in the third class of the second year of the university had problem-solving ability. Higher after learning than before learning was statistically significant at .01 level, which is in line with the set hypothesis. This is due to the fact that the steps of organizing teaching and learning activities according to the problem-based learning model are ordered

according to academic principles and are appropriate and consistent with the enhancement of problem-solving ability. The dependent variable according to the study consists of 6 sub-competencies with 9 elements: 1) Identify problems, 2) Searching for problems, 3) Describe the problems, 4) Analyzing the problems, 5) Collaborative enquiry, 6) Demonstrate results to illustrate the problem, 7) Apply methods to solve problems, 8) Continuous reflection on lessons learnt, 9) Talking This is consistent with the composition of the PISA evaluation system as sorted out by Yang (2016), in which the international PISA2003 evaluation framework divides students' problem-solving ability into: understanding the problem, identifying the problem, representing the problem, solving the problem, reflecting on the problem after solving it, and communicating the problem solving methods. The PISA2003 assessment framework includes all aspects of students' problem-solving ability in a more comprehensive way, and it can be close to the needs of problem-solving ability cultivation of talents in the new era. For 2nd year university medical students, the problem-based learning model provides specific teaching and learning application steps for the cultivation of students' problem-solving ability, and the five-teaching links proposed in the model correspond to the process of cultivating the six sub-competencies of students' problem-solving ability. That is, "creating problems" corresponds to the cultivation of the ability to recognize problems; "implementing problems" corresponds to the cultivation of the ability to discover problems; "presenting results" corresponds to the cultivation of the ability to express problems and solve problems; "reflecting on evaluation" corresponds to the cultivation of the ability to reflect; and "expanding application" corresponds to the cultivation of the ability to communicate problems. The study proved that the problem-based learning model can effectively improve students' problem-solving ability. The learning process of the problem-based learning model promotes the enhancement of problem-solving ability, which is in line with the study of Finkelstein (2010), who examined the effectiveness of problem-based learning on students' content knowledge and problem-solving ability in comparison with traditional teaching. The effectiveness of problem-based learning model in improving students' problem-solving ability was found to be more effective overall than traditional methods by measuring students' problem-solving ability with closed-ended assessments and open-ended tasks.

2.2 Comparison of students' problem-solving ability before and after learning using a problem-based learning model. Findings: it can be seen that the problem-solving ability scores of the medical students who used problem-based learning model averaged 17.28 before the study and 20.41 after the study, with an

average difference of 3.13 points. The results show that the problem-solving ability of the students after the study is higher than that before the study, which is statistically significant at the .01 level. This is consistent with the research hypothesis. This result proves that the problem-based learning model is effective after its implementation, which confirms the view of Lonergan et al. (2022) that the problem-based learning model has a significant effect on the development of students' key competencies, and this key competency includes problem-solving ability. Wu Hao (2020) established the problem-based learning model, and through the analysis of the data, it also proves that students' real-world problem-solving ability and other Advantages.

Recommendations

General recommendation

1. Problem-based learning model takes students as the main body and consumes more time than other teaching methods. Therefore, in the teaching process of the problem-based learning model, according to the complexity of the problem and the ability level of the students, the learning time should be arranged reasonably to ensure that the learning progress is smoothly advanced.

2. Before organizing teaching activities, teachers should make students aware of their responsibilities and cooperate with the learning process. For the problem-based learning model, teachers must be well prepared for each learning activity. It is possible that each learning activity will take longer than scheduled, so teachers should organize their time wisely.

3. When organizing classroom activities, teachers should create a good learning environment, including learning resources, so that students can be better engaged in learning. At the same time, they should create a good classroom learning atmosphere. Encourage students to show themselves and dare to express their opinions.

4. Teachers need to maintain a good relationship with their students at all times, providing counselling, guidance, assistance and encouragement, and providing opportunities for students to learn. The problem-solving process should not discourage student input, but rather encourage students to have the courage to learn on.

Suggestions for further research

1. Research on teaching modes to enhance students' problem-solving ability. Problem-based learning model is used in combination with other teaching forms to cultivate students' problem-solving ability, such as combining the "5E" teaching mode, combining the theory of collaborative learning, or flipping the classroom teaching mode, etc., to improve the problem-solving ability of medical students.

2. It should expand disciplinary applications. The problem-based learning model constructed in this study focuses on the pedagogical application step of cultivating students' problem-solving ability, but the model has only been validated and modified in the exercise therapy course, and it can be expanded to be applied in other medical courses, and further validated and modified in a wider range of disciplines.

3. The problem-based learning model should be expanded to include other competencies. The problem-based learning model summarized and proposed in this study has been proved to be effective through the testing of teaching practice, and can also be used for the enhancement of other competencies, such as critical thinking ability, communication ability, and so on.

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Appendix

Appendix A
List of Specialists and Letters of Specialists Invitation for IOC Verification

Appendix A
List of Specialists and Letters of Specialists Invitation for IOC Verification

Name of Experts	Position/Office
1.Associate Professor Dr. Jittawisut Wimuttipanya	Ph.D. Curriculum and Instruction Bansomdejchaopraya Rajabhat University
2.Assistant Professor Sarawut Samanya	Master of Public Administration Bansomdejchaopraya Rajabhat University
3.Professor Dr. Dong Shousheng	Ph.D. in Education East China Normal University

Appendix B
Official Letter

Ref.No. MHESI 0643.14/886

Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

18 August 2023

RE: Invitation to validate research instrument

Dear Associate Professor Dr.Jittawisut Wimuttipanya

Miss Jia Zhenzhen is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. She is undertaking research entitled "Using Problem Based Learning Model to Improve Problem Solving Ability of Medical Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

We respectfully request your assistance in validating a research instrument that is attached to this message. We would be grateful for any help you can provide in this matter. We would like to express our sincere appreciation for your time and expertise. If you have any questions or concerns, please do not hesitate to contact Miss Jia Zhenzhen at 110628536@qq.com

Thank you for considering our request.

Sincerely,

Nainapas I

(Dr.Nainapas Injoungjirakit)
Vice Dean, For Dean of the Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000 ext. 1814
www.bsru.ac.th

Ref.No. MIIESI 0643.14/887

Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

18 August 2023

RE: Invitation to validate research instrument

Dear Assistant Professor Sarawut Samanya

Miss Jia Zhenzhen is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. She is undertaking research entitled "Using Problem Based Learning Model to Improve Problem Solving Ability of Medical Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

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Thank you for considering our request.

Sincerely,

Nainapas I

(Dr.Nainapas Injoungjirakit)
Vice Dean, For Dean of the Graduate School

Bansomdejchaopraya Rajabhat University
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Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

18 August 2023

RE: Invitation to validate research instrument

Dear Professor Dr.Dong Shousheng

Miss Jia Zhenzhen is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. She is undertaking research entitled "Using Problem Based Learning Model to Improve Problem Solving Ability of Medical Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

We respectfully request your assistance in validating a research instrument that is attached to this message. We would be grateful for any help you can provide in this matter. We would like to express our sincere appreciation for your time and expertise. If you have any questions or concerns, please do not hesitate to contact Miss Jia Zhenzhen at 110628536@qq.com

Thank you for considering our request.

Sincerely,

Nainapas I

(Dr.Nainapas Injoungjirakit)
Vice Dean, For Dean of the Graduate School

Appendix C
Research Instruments

Lesson Plan I

The first semester of the second academic year

Department	Department of Medicine, Weifang Nursing Vocational College
Course name	exercise therapy: Chapter 1 joint mobility training
Target Audience	Rehabilitation Medicine, Year 2, Class 3
Number of students	30
Teaching Time	3 hours
Lecturer	Jia Zhenzhen

Content

joint mobility training

Objective of Leaning

1. The student can explain problems with joint mobility training.

2. The student can identify manipulative problems involving joint mobility training.

3. The student can formulate operational problems related to joint mobility training.

4. The student can solve problems related to joint mobility training.

5. The student can reflect on problem solving in relation to joint mobility training.

6. The student can summarize and communicate solutions to problems related to joint mobility training and can transfer solutions.

Main point/concept

Joint mobility training is movement therapy training that uses various methods to maintain and restore joint dysfunction caused by a variety of factors such as tissue adhesions or muscle spasm.

1. Human joint mobility training

(1) Shoulder joints: learning shoulder joint forward flexion, shoulder joint back extension, shoulder joint abduction, shoulder joint horizontal abduction and horizontal adduction, shoulder joint internal and external rotation, scapular passive movement and other operational training.

(2) Elbow joint: learning elbow flexion and extension, forearm rotation and posterior rotation, etc.

(3) Wrist joints: learning the flexion and extension of the wrist joint, ulnar and radial deviation movements and other operational training.

(4) Finger joints: learn to flex, extend, adduct and abduct the metacarpophalangeal joints and flex and extend the interphalangeal joints.

(5) Hip joint: learn hip flexion, hip extension, hip abduction and adduction, hip internal rotation and external rotation.

(6) Knee joints: learning knee flexion, knee extension and other operational training.

(7) Ankle and foot joints: learn ankle dorsiflexion, ankle plantar flexion, ankle internal rotation and external rotation, tarsometatarsal rotation, metatarsophalangeal joint flexion and extension and internal abduction and adduction, and other operational training.

(8) Trunk: Learn to move the neck segment and the thoracolumbar segment.

2. Continuous passive mobility training for the joints of the body

(1) Shoulder joints: learn continuous passive movement training for the shoulder joints.

(2) Elbow joints: learning continuous passive movement training for the elbow joints.

(3) Hip joints: Continuous passive movement training for the hip joints.

(4) Knee: Continuous passive knee training.

Learning Activity

The teacher explains to the students the purpose and manner in which the problem-solving ability assessment will be administered and distributes the test questions prior to conducting the formal lesson and asks the students to complete the test in 1 hour.

Problem-based learning activities have 5 stages as follows: 1) Create questions, 2) Implementation Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications.

1. Create questions

In this session, the teacher provides students with clinical case scenarios related to joint mobility training and students develop a desire to explore. During the learning period students were able to identify the problem from the information, were able to

actively explore the information and knowledge related to the problem, and finally understood the problem under the guidance of the teacher. The case is as follows:

The patient, a 57-year-old male, was rushed to a local hospital with sudden onset of headache, nausea and vomiting followed by right-sided limb weakness, and a cranial computed tomography (CT) scan showed cerebral infarction. The patient had no fever, no convulsions, no loss of consciousness and was transferred to the neurology department after 2 days of conservative treatment. On examination, the patient was clear, mentally competent, with no significant abnormalities in the movement or sensation of the left limb, while the muscles of the right limb were flaccid, hypotonic and unable to perform voluntary movements.

1.1 The teacher introduces the case scenario and guides the students into the classroom.

1.2 The teacher inspires students to ask questions: What is the patient's presenting priority problem as identified? How can the patient's right limb be made to move?

1.3 The teacher leads the students to ask the question: What is the information related to the question in the case please search for? what are the factors that affect joint movement?

1.4 The teacher leads the students to analyze the case, find information and ask the question: What joint mobility exercises can be performed on the right limb to prevent complications from braking?

2. Implementation Problems

Building on the first session, students are able to sift through the information they have been given to describe the problem and analyze the structure and components of the problem. If the problem is not too difficult and the teacher is able to see that the students are basically able to analyze the problem on their own, the students will analyze the problem on their own in small groups. Another situation is that if the structure of the problem is more complicated or the problem is more difficult, it is necessary for the teacher to give some guidance to the students. In this case, the N/NK table framework of IMSA is infiltrated in the classroom to guide students to collaborate and explore and analyze the problem.

K/ NK table

Know	Need to know	Need to do

2.1 The teacher guides the students in the execution of question 1: How do you get the patient to move the right limb? (Expect answers: massage, assisted

rehabilitation apparatus.) Students have been grouped before the lesson and the group discusses and speaks enthusiastically.

2.2 Teacher-led execution of question 2: What are the factors that affect joint movement? (Expected answers: physiological and pathological factors) Involving previous knowledge of anatomy, students discuss this on their own in small groups, with representatives from each group taking turns to speak at the end.

2.3 The teacher guides the students in the implementation of question 3: What are the joint mobility exercises for the right side of the limb? This question is difficult and the teacher demonstrates joint movement training operations. The operations include eight items: shoulder joints, elbow joints, wrist joints, finger joints, hip joints, knee joints, ankle and foot joints and trunk movements, which students observe.

2.4 The teacher communicates with the standardized patient in a timely manner during the operation, while the students observe and appreciate the communication skills. The teacher guides the students to appreciate the importance of treating patients with care, love and patience and respect.

2.5 Students have been grouped in appropriate groups of 3 before the lesson, with each member taking on a different role within the group. The teacher organizes students to work with each other in groups of 3. Cooperative learning is initiated through student-student exchanges and group-to-group exchanges, with the teacher providing guidance.

3. Results showcase

This session reports on the group's learning by demonstrating the actions of the group members. Report on the division of labor in the group, the completion of tasks by the group members, the problem solving in the group and the completion of the task by the group. The groups learn from each other by exchanging learning outcomes. After listening to the other groups' reports, they should make some comments, pointing out problems that arise when students operate the joint activities, and taking advantage of their strengths and weaknesses. The teacher should focus on monitoring the comments made by the students during the process, as they sometimes make inappropriate or unrealistic comments due to their learning and life experience, and should stop them when they hear inappropriate comments to keep the debriefing on track.

3.1 A member of the group is randomly selected to demonstrate the joint mobility training exercises on stage, while other students observe and identify problems and offer different opinions, with the teacher providing guidance. For

example: Based on the patient's problem, what joint mobility training can be performed?

3.2 The teacher leads the students in identifying problems that may arise with each joint mobility exercise and tries to solve these practical problems as well as literacy problems. For example: What type of joint mobility training do you think would best improve this patient's discomfort?

4. Reflection evaluation

Through exchanges, the experience and suggestions shared by other groups are critically received, and the suggestions rationalized by other groups or the teacher are absorbed for rethinking and revalidating the problem-solving approach to enhance their problem-solving ability. At the same time, this session reflects on the problem-solving method through discussion, and modifies the learning activity after reflection to enhance students' reflective ability. Eventually, they form their own effective path to discover problems, analyze problems, solve problems, summarize problems and gain experience.

4.1 After the exchange, the teacher and the practical training instructor guide the students to work in groups and carry out the evaluation.

4.2 The groups are divided into groups of 3, with a clear division of labor among the group members. 1 student scores according to the practical training evaluation form, 1 student starts the right limb joint movement operation and 1 student plays the role of the patient and carries out the joint movement training operation, taking turns to score the operation.

4.3 The teacher, with the help of the practical training teacher, evaluates and scores one operation of each student and finally accounts for the practical operation score of each student.

5. Expanded applications

In this session, the clinical case is again introduced and questions are asked to test the students' problem-solving ability. Students' answers are uploaded to the teaching platform, and students' problem-solving ability is observed from their test results. At the same time, students continue to communicate in this session, applying good experiences in the learning and problem-solving process, identifying shortcomings, summing up the methods that can be transferred and used to improve communication ability.

5.1 Case published by a teacher: The patient, male, 26 years old, fell on his left knee while riding an electric bicycle one month ago, resulting in swelling and pain in the left knee with limited movement, and presented to the orthopedic department

of the hospital. A lateral and frontal examination of the knee showed a fracture of the left patella. The patient underwent an incision and internal fixation of the left patellar fracture. One month after the operation, he consulted the rehabilitation department because of pain in the left knee, limitation of movement and difficulty in walking up and down stairs.

(1) What are the patient's current problems? What is the information related to the problem in the case?

(2) What functional assessments can be performed on the patient? Now that we want to train the patient's joint mobility, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

(3) Based on the patient's problem, what joint mobility training can be performed?

(4) What type of joint mobility training do you think would best improve this patient's discomfort?

(5) Reflect and summarize. What are your training strengths and weaknesses?

(6) What are your experiences in dealing with patient problems?

5.2 Teachers guide students in analyzing questions and uploading their conclusions to the platform.

5.3 Teacher displays student answers via the Learning Connect platform, explaining them in a timely manner and addressing any problems that arise with student answers. Students make corrections in a timely manner.

5.4 Assignment: after the lesson students complete a video of the case operation and upload it to the teaching platform, which the teacher reviews.

Instructional Media

1. Chinese " Exercise Therapy" teaching materials

2. China "Exercise Therapy" teaching resources library

3. China Learning Pass online teaching platform (based on which a mixture of online and offline teaching is conducted)

4. Code of Practice for Commonly Used Rehabilitation Therapy Techniques (2012 edition)

5. PPT

Evaluation

1.Pre-test problem-solving ability

2.Observe students' problem-solving ability.

3.Check problem-solving ability while working.

4. post-lesson assignments are used to assess students' mastery in this lesson.

Learning Schedule: joint mobility training 4 hours

Date/time	Teaching Process	Remark
28th August 2023 07.50-08.50	**pre-test** **subjective test**	1 hour
08:50-09:00	**Introduction** (joint mobility training)	10 minutes
09:00-09:30	**Learning Activity:** Using problem-based learning model have 5 stages 1) Create questions	30 minutes
09:30-10:20	2) Implementation Problems	50 minutes
10:20-10:30	Break time	
10:30-11:10	3) Results showcase	40 minutes
11:10-11:40	4) Implementation stage	30 minutes
11:40-12:00	5) Inspection stage	20 minutes

Worksheet for student's Problem-Solving Ability

Worksheet I

The patient, male, 26 years old, fell on his left knee while riding an electric bicycle one month ago, resulting in swelling and pain in the left knee with limited movement, and presented to the orthopedic department of the hospital. A lateral and frontal examination of the knee showed a fracture of the left patella. The patient underwent an incision and internal fixation of the left patellar fracture. One month after the operation, he consulted the rehabilitation department because of pain in the left knee, limitation of movement and difficulty in walking up and down stairs.

(1) What are the patient's current problems? What is the information related to the problem in the case?

.....

.....

(2) What functional assessments can be performed on the patient? Now that we want to train the patient's joint mobility, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

.....

.....

(3) Based on the patient's problem, what joint mobility training can be performed?

.....

.....

(4) What type of joint mobility training do you think would best improve this patient's discomfort?

.....

.....

(5) Reflect and summarize. What are your training strengths and weaknesses?

.....

.....

(6) What are your experiences in dealing with patient problems?

.....

.....

Observation form about Student behavior

Learner behavior
Lesson Plan I Stage 1 Create questions: comprehension ability .... Stage 2 Implementation Problems: discriminatory ability .... Stage 3 Results showcase: presentation ability, problem-solving ability .... Stage 4 Reflection evaluation: reflective ability .... Stage 5 Expanded applications: communication ability ....

Assessment form for Validity of joint mobility training lesson plan

Research Title: Using Problem-Based Learning Model to Improve Problem-Solving Ability of Medical Students

Research Objectives:

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Directions:

Please assess the congruence between components of lesson plan based on problem-based learning model by putting ✓ in the box according to the following criteria.

Rating is +1. There is an opinion that “consistent to relevant.”

Rating is 0. There is an opinion that “Not sure it consistent to relevant.”

Rating is -1. There is an opinion that “Inconsistent with relevant.”

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
1	Learning objectives sort the contents from easy to difficult.				
2	The problem-based learning method encourages students to work in teams and solve problems rationally.				
3	Determining content suitable for the age of students.				
4	Organizing activities suitable for learning objectives.				
5	Problem-based learning activities actually motivate students to learn and creative problem solving.				
6	Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.				
7	The using instructional media are suitable for learning activities.				

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
8	The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.				
9	Measurement and evaluation are suitable for learning activities to develop real ability.				
1 0	Assessment criteria are appropriate for subjective learning.				

Sign.....Assessor

(.....)

Date...../...../.....

Lesson Plan II

The first semester of the second academic year

Department	Department of Medicine, Weifang Nursing Vocational College
Course name	exercise therapy: Chapter 2 Balance and Coordination Training
Target Audience	Rehabilitation Medicine, Year 2, Class 3
Number of students	30
Teaching Time	3 hours
Lecturer	Jia Zhenzhen

Content

Balance and Coordination Training

Objective of Leaning

1. The student can explain problems in balance and coordination training.

2. The student can identify operational problems related to balance and coordination training.

3. The student can formulate operational problems related to balance and coordination training.

4. The student can solve problems related to balance and co-ordination training.

5. The student can reflect on problem solving in relation to balance and co-ordination training.

6. The student can summarize and communicate solutions to problems related to balance and co-ordination training and can transfer solutions.

Main point/concept

Balance training refers to the various training measures taken to improve the patient's ability to maintain body balance. Coordination training involves training the patient to develop pre-programmed programmed in the nervous system under conscious control, thus enabling the patient to reproduce at will the ability of multiple muscles to coordinate active forms of movement.

1. Balance and coordination training

(1) Supine balance training: learn to perform double bridge exercises and single bridge exercises.

(2) Prone balance training with forearm/hand support: learn static balance training, self-dynamic balance training, other dynamic balance training and other operational training.

(3) Sitting balance training: learn long sitting balance training, end sitting balance training and other operational training.

(4) Balance training on hands and knees and kneeling position: learning static balance training, self-dynamic balance training, other dynamic balance training and other operational training.

(5) Standing balance training: learning static balance training, self-dynamic balance training, other dynamic balance training and other operational training.

(6) Co-ordination training: learning upper limb co-ordination training, lower limb co-ordination training and other operational training.

2. Balance and coordination training considerations.

Learning Activity

Problem-based learning activities have 5 stages as follows: 1) Create questions, 2) Implementation Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications.

1. Create questions

In this session, the teacher provides students with clinical case scenarios related to Balance and Coordination Training and students develop a desire to explore. During the learning period students were able to identify the problem from the information, were able to actively explore the information and knowledge related to the problem, and finally understood the problem under the guidance of the teacher. The case is as follows:

Patient, male, 67 years old, with immobility of the left limb for 20 days, diagnosed as "cerebral infarction". Examination: clear consciousness, fluent speech, Brannstrom classification upper limb - hand - lower limb: III-II-IV, sitting balance grade 2, unable to stand alone, left-sided pain and temperature perception impairment, mild dependence on daily life.

1.1 The teacher introduces the case scenario and guides the students into the classroom.

1.2 The teacher inspires students to ask: What is the patient's presenting priority problem as identified? What are the factors that affect balance and coordination?

1.3 The teacher leads the students to ask questions: What is the information related to the question in the case please search for? What balance and coordination functions can be assessed according to the patient's condition?

1.4 The teacher leads the students to analyze the case, find information and ask the question: What balance and coordination training can be done according to the patient's condition?

2. Implementation Problems

Building on the first session, students are able to sift through the information they have been given to describe the problem and analyze the structure and components of the problem. If the problem is not too difficult and the teacher is able to see that the students are basically able to analyze the problem on their own, the students will analyze the problem on their own in small groups. Another situation is that if the structure of the problem is more complicated or the problem is more difficult, it is necessary for the teacher to give some guidance to the students. In this case, the N/NK table framework of IMSA is infiltrated in the classroom to guide students to collaborate and explore and analyze the problem.

K/ NK table

Know	Need to know	Need to do

2.1 The teacher guides students through Question 1: What are the factors that affect balance and co-ordination? (Expect answers: center of gravity, stability, etc.) Students have been grouped before the lesson and the groups discuss and speak enthusiastically.

2.2 The teacher guides the students through question 2: What balance and coordination assessments can be made depending on the patient's condition? (Expected answer: BOBATH method) Involving previously learned assessment knowledge, students discuss this on their own in small groups and finally each group representative takes a turn to speak.

2.3 The teacher guides the student through question 3: What balance and coordination training can be performed depending on the patient's condition? This question is difficult and the teacher demonstrates the balance and coordination training operations, which include six items: supine balance training, prone balance training with forearm/hand support, sitting balance training, balance training on hands and knees and kneeling position, standing balance training and coordination training, which students observe.

2.4 Teachers communicate with standardized patients in a timely manner when operating, and students observe and appreciate communication skills. The teacher guides the students to appreciate the importance of treating patients with care, love and patience and respect.

2.5 Students have been grouped in appropriate groups of 3 before the lesson, with each member taking on a different role within the group. The teacher organizes students to work with each other in groups of 3. Cooperative learning is initiated through student-student exchanges and group-to-group exchanges, with the teacher providing guidance.

3. Results showcase

This session reports on the group's learning by demonstrating the actions of the group members. Report on the division of labor in the group, the completion of tasks by the group members, the problem solving in the group and the completion of tasks by the group. The groups learn from each other by exchanging their learning. After listening to the other groups' reports, some comments are made to point out problems in the students' balancing and co-ordination exercises and to make up for their shortcomings. The teacher should focus on monitoring the comments made by the students during the process, as they sometimes make inappropriate or unrealistic comments due to their learning and life experience, and should stop them when they hear inappropriate comments to put the debriefing on track.

3.1 A member of the group is randomly selected to demonstrate the balance and co-ordination exercises on stage, while other students observe carefully and identify problems and offer different opinions, with the teacher on hand to provide guidance. For example: Based on the patient's problems, what balance and coordination training can be done?

3.2 The teacher leads the students to identify problems that may arise with each balance and coordination exercise and to try to solve these practical problems as well as literacy problems. For example: Which balance and coordination training do you think would best improve this patient's discomfort?

4. Reflection evaluation

Through exchanges, the experience and suggestions shared by other groups are critically received, and the suggestions rationalized by other groups or the teacher are absorbed for rethinking and revalidating the problem-solving approach to enhance their problem-solving ability. At the same time, this session reflects on the problem-solving method through discussion, and modifies the learning activity after reflection to enhance students' reflective ability. Eventually, they form their own

effective path to discover problems, analyze problems, solve problems, summarize problems and gain experience.

4.1 After the exchange, the teacher and the practical instructor guide the students to work in groups and carry out the evaluation.

4.2 Groups have been divided before the class, with groups of 3 and a clear division of labor between group members. 1 student scores according to the practical assessment form, 1 student starts the right limb balance and coordination operation and 1 student plays the role of the patient and carries out the balance and coordination training operation, taking turns to score the operation.

4.3 The teacher, with the help of the practical training teacher, evaluates and scores one operation of each student and finally accounts for the practical operation grade of each student.

5. Expanded applications

In this session, the clinical case is again introduced and questions are asked to test the students' problem-solving ability. Students' answers are uploaded to the teaching platform, and students' problem-solving ability is observed from their test results. At the same time, students continue to communicate in this session, applying good experiences in the learning and problem-solving process, identifying shortcomings, summing up the methods that can be transferred and used to improve communication ability.

5.1 Case published by a teacher: The patient, a 76-year-old female with a previous cerebral infarction, was admitted to hospital with the complaint of "lack of limb movement for 4 weeks". The patient is currently stable, with a clear consciousness, no abnormalities on cardiopulmonary examination and normal left upper limb. The flexor muscles of the right shoulder and elbow are at level 4 and the flexor muscles of the right lower limb are at level 4. He can stand alone for 10 seconds and has poor coordination of the right limb.

(1) What are the patient's current problems? What is the information related to the problem in the case?

(2) What functional assessments can be performed on the patient? Now that we want to train the patient's balance and coordination, which method should we use? Analysing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

(3) Based on the patient's problems, what balance and coordination training can be done?

(4) Which balance and coordination training do you think would best improve this patient's discomfort?

(5) Reflect and summarise. What are your training strengths and weaknesses?

(6) What are your experiences in dealing with patient problems?

5.2 Teachers guide students in analyzing questions and uploading their conclusions to the platform.

5.3 Teacher displays student answers via the Learning Connect platform, explains them in a timely manner and addresses any problems that arise with student answers. Students make corrections in a timely manner.

5.4 Assignment: after the lesson students complete a video of the case operation and upload it to the teaching platform, which the teacher reviews.

Instructional Media

1. Chinese " Exercise Therapy" teaching materials

2. China "Exercise Therapy" teaching resources library

3. China Learning Pass online teaching platform (based on which a mixture of online and offline teaching is conducted)

4. Code of Practice for Commonly Used Rehabilitation Therapy Techniques (2012 edition)

5. PPT

Evaluation

1.Observe students' problem-solving ability.

2.Check problem-solving ability while working.

3. post-lesson assignments are used to assess students' mastery in this lesson.

Learning Schedule: Balance and Coordination Training 3 hours

Date/time	Teaching Process	Remark
29th August 2023 8.20-8.30	**Introduction** (Balance and Coordination Training)	10 minutes
8.30-9.00	**Learning Activity:** Using problem-based learning model have 5 stages 1) Create questions	30 minutes
9.00-9.50	2) Implementation Problems	50 minutes
9.50-10.00	Break time	
10.00-10.40	3) Results showcase	40 minutes
10.40-11.10	4) Implementation stage	30 minutes
11.10-11.30	5) Inspection stage	20 minutes

Worksheet for student's Problem-Solving Ability

Worksheet II

The patient, a 76-year-old female with a previous cerebral infarction, was admitted to hospital with the complaint of "lack of limb movement for 4 weeks". The patient is currently stable, with a clear consciousness, no abnormalities on cardiopulmonary examination and normal left upper limb. The flexor muscles of the right shoulder and elbow are at level 4 and the flexor muscles of the right lower limb are at level 4. He can stand alone for 10 seconds and has poor coordination of the right limb. (1) How would you assess the patient for his current condition? (2) Please develop an appropriate balance and coordination training programmer for this patient.

(1) What are the patient's current problems? What is the information related to the problem in the case?

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(2) What functional assessments can be performed on the patient? Now that we want to train the patient's balance and coordination, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

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(3) Based on the patient's problems, what balance and coordination training can be done?

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(4) Which balance and coordination training do you think would best improve this patient's discomfort?

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(5) Reflect and summarize. What are your training strengths and weaknesses?

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(6) What are your experiences in dealing with patient problems?

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Observation form about Student behavior

Learner behavior
Lesson Plan II Stage 1 Create questions: comprehension ability .... Stage 2 Implementation Problems: discriminatory ability .... Stage 3 Results showcase: presentation ability, problem-solving ability .... Stage 4 Reflection evaluation: reflective ability .... Stage 5 Expanded applications: communication ability ....

Assessment form for Validity of balance and coordination training lesson plan

Research Title: Using Problem-Based Learning Model to Improve Problem-Solving Ability of Medical Students

Research Objectives:

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Directions:

Please assess the congruence between components of lesson plan based on problem-based learning model by putting ✓ in the box according to the following criteria.

Rating is +1. There is an opinion that “consistent to relevant.”

Rating is 0. There is an opinion that “Not sure it consistent to relevant.”

Rating is -1. There is an opinion that “Inconsistent with relevant.”

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
1	Learning objectives sort the contents from easy to difficult.				
2	The problem-based learning method encourages students to work in teams and solve problems rationally.				
3	Determining content suitable for the age of students.				
4	Organizing activities suitable for learning objectives.				
5	Problem-based learning activities actually motivate students to learn and creative problem solving.				
6	Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.				

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
7	The using instructional media are suitable for learning activities.				
8	The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.				
9	Measurement and evaluation are suitable for learning activities to develop real ability.				
1 0	Assessment criteria are appropriate for subjective learning.				

Sign.....Assessor

(.....)

Date...../...../.....

Lesson Plan III

The first semester of the second academic year

Department	Department of Medicine, Weifang Nursing Vocational College
Course name	exercise therapy: Chapter 3 strength training
Target Audience	Rehabilitation Medicine, Year 2, Class 3
Number of students	30
Teaching Time	3 hours
Lecturer	Jia Zhenzhen

Content

strength training

Objective of Leaning

1. The student can explain the problems involved in strength training.
2. The student can identify operational issues related to strength training.
3. The student can formulate operational problems related to strength training.
4. The student can solve problems related to strength training.
5. The student can reflect on solutions to problems related to strength training.
6. The student can summarize and communicate solutions to problems related to strength training and transfer the solutions.

Main point/concept

Strength training is an exercise method whose main objective is to increase the strength of absolute random muscle contractions. The emphasis during training is on large weights and few repetitions.

1. Muscle training for upper limb muscle groups

(1) Shoulder muscles: learn to train the muscles of shoulder forward flexion, shoulder back extension, shoulder abduction, shoulder adduction, shoulder internal rotation and external rotation.

(2) Elbow and forearm muscles: learn to flex, extend and rotate the elbow.

(3) Wrist and hand muscles: wrist flexion, wrist extension, radial/ulnar deviation, flexion of palmar fingers, flexion of fingers and opposite palmar muscles.

2. Muscle strength training for lower limb muscle groups

(1) Hip muscle groups: learn hip flexion, hip extension, hip abduction, hip adduction, hip internal rotation and external rotation.

(2) Knee muscles: learn to flex the knee, extend the knee and other muscle groups muscle training.

(3) Ankle muscles: ankle plantarflexion, ankle dorsiflexion, foot inversion/extrusion, etc.

3. Head, neck and trunk muscle group strength training

(1) Head and neck muscles: learn to train the anterior neck flexion, posterior neck extension and other muscle groups.

(2) Trunk muscles: learning to train the muscles of trunk forward flexion, trunk back extension and trunk rotation.

Learning Activity

Problem-based learning activities have 5 stages as follows: 1) Create questions, 2) Implementation Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications.

1. Create questions

In this session, the teacher provides students with clinical case scenarios related to strength training and students develop a desire to explore. During the learning period students were able to identify the problem from the information, were able to actively explore the information and knowledge related to the problem, and finally understood the problem under the guidance of the teacher. The case is as follows:

The patient, a 35-year-old male, was involved in a motorbike accident which resulted in a comminuted fracture of the surgical neck of the left humerus. Three months later, the patient went to the rehabilitation department of the hospital, where he was assessed to have limited flexion, extension, posterior extension, internal and external rotation and rotation of the left shoulder, and atrophy of the shoulder muscles. Please ask.

1.1 The teacher introduces a case scenario to guide the students into the classroom.

1.2 The teacher inspires the students to ask: What is the patient's presenting priority problem as identified? What functional assessments can be performed on the patient?

1.3 The teacher leads the students to analyze the case, find information and ask questions: What is the information related to the question in the case please search

for? What types of muscle training methods can be used? What are the different forms?

2. Implementation Problems

Building on the first session, students are able to sift through the information they have been given to describe the problem and analyze the structure and components of the problem. If the problem is not too difficult and the teacher is able to see that the students are basically able to analyze the problem on their own, the students will analyze the problem on their own in small groups. Another situation is that if the structure of the problem is more complicated or the problem is more difficult, it is necessary for the teacher to give some guidance to the students. In this case, the N/NK table framework of IMSA is infiltrated in the classroom to guide students to collaborate and explore and analyze the problem.

K/ NK table

Know	Need to know	Need to do

2.1 The teacher guides the students through Question 1: What functional assessments can be performed on the patient? (Expect answers: muscle strength, muscle power assessment.) Students have been grouped before the lesson and the group discusses and speaks enthusiastically.

2.2 The teacher guides the students through Question 2: Which plyometric training methods can be used? What are the different forms?

This is a difficult question. The teacher will show the plyometric exercises, which include 8 exercises for shoulder muscles, elbow and forearm muscles, wrist and hand muscles, hip muscles, knee muscles, ankle muscles, head and neck muscles and trunk muscles, while the students observe.

2.3 The teacher communicates with standardized patients in a timely manner during operation, while students observe and appreciate communication skills. The teacher guides the students to appreciate the importance of treating patients with care, love and patience and respect.

2.4 Students have been grouped in appropriate groups of 3 before the lesson, with each member taking on a different role within the group. The teacher organizes students to work with each other in groups of 3. Cooperative learning is initiated through student-student exchanges and group-to-group exchanges, with the teacher providing guidance.

3. Results showcase

This session reports on the group's learning by demonstrating the actions of the group members. Report on the division of labor in the group, the completion of tasks by the group members, the problem solving in the group and the completion of the task by the group. The groups learn from each other by exchanging learning outcomes. After listening to the other groups' reports, they should give some comments and point out the problems that occurred during the students' muscular manipulation to make up for their shortcomings. The teacher should focus on monitoring the comments made by the students during the process, as they sometimes make inappropriate or unrealistic comments due to their learning and life experience, and should stop them when they hear inappropriate comments to put the debriefing on the right track.

3.1 A member of the group is randomly selected to demonstrate the plyometric exercises on stage, while other students observe carefully and identify problems and offer different opinions, with the teacher on hand to point them out. For example: Based on the patient's problem, what kind of muscle strength training can be performed?

3.2 The teacher leads the students to identify and look for problems that may arise with each plyometric exercise and try to solve these practical problems as well as literacy problems. For example: Which type of strength training do you think would best improve this patient's discomfort?

4. Reflection evaluation

Through exchanges, the experience and suggestions shared by other groups are critically received, and the suggestions rationalized by other groups or the teacher are absorbed for rethinking and revalidating the problem-solving approach to enhance their problem-solving ability. At the same time, this session reflects on the problem-solving method through discussion, and modifies the learning activity after reflection to enhance students' reflective ability. Eventually, they form their own effective path to discover problems, analyze problems, solve problems, summarize problems and gain experience.

4.1 After the exchange, the teacher and the practical training instructor guide the students to work in groups and carry out the evaluation.

4.2 Groups have been divided before the class, with groups of 3 and a clear division of labor among the group members. 1 student scores according to the practical training evaluation form, 1 student starts the right limb muscular

manipulation and 1 student plays the role of the patient and carries out the muscular training manipulation, taking turns to score the manipulation.

4.3 The teacher, with the help of the practical training teacher, evaluates and scores one operation of each student and finally accounts for the practical operation grade of each student.

5. Expanded applications

In this session, the clinical case is again introduced and questions are asked to test the students' problem-solving ability. Students' answers are uploaded to the teaching platform, and students' problem-solving ability is observed from their test results. At the same time, students continue to communicate in this session, applying good experiences in the learning and problem-solving process, identifying shortcomings, summing up the methods that can be transferred and used to improve communication ability.

5.1 Case published by a teacher: The patient, male, 31 years old, suffered a "right femoral stem fracture" caused by a fall from a height 3 months ago. X-rays show continuous bone scab formation at the fracture site. The examination reveals impaired flexion and extension of the right knee, grade 4 knee flexion and extension muscle strength, and muscle atrophy of the right lower limb.

(1) What are the patient's current problems? What is the information related to the problem in the case?

(2) What functional assessments can be performed on the patient? Now that we want to train the patient's muscle strength, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

(3) Based on the patient's problem, what kind of muscle strength training can be performed?

(4) Which type of strength training do you think would best improve this patient's discomfort?

(5) Reflect and summarize. What are your training strengths and weaknesses?

(6) What are your experiences in dealing with patient problems?

5.2 Teachers guide students in analyzing questions and uploading their conclusions to the platform.

5.3 Teacher displays student answers via the Learning Connect platform, explains them in a timely manner and addresses any problems that arise with student answers. Students make corrections in a timely manner.

5.4 Assignment: after the lesson students complete a video of the case operation and upload it to the teaching platform, which the teacher reviews.

Instructional Media

1. Chinese " Exercise Therapy" teaching materials

2. China "Exercise Therapy" teaching resources library

3. China Learning Pass online teaching platform (based on which a mixture of online and offline teaching is conducted)

4. Code of Practice for Commonly Used Rehabilitation Therapy Techniques (2012 edition)

5. PPT

Evaluation

1.Observe students' problem-solving ability.

2.Check problem-solving ability while working.

3. post-lesson assignments are used to assess students' mastery in this lesson.

Learning Schedule: strength training 3 hours

Date/time	Teaching Process	Remark
30th August 2023 08.20-08.30	**Introduction** (strength training)	10 minutes
08.30-09.00	**Learning Activity:** Using problem-based learning model have 5 stages 1) Create questions	30 minutes
09.00-09.50	2) Implementation Problems	50 minutes
09.50-10.00	Break time	
10.00-10.40	3) Results showcase	40 minutes
10.40-11.10	4) Implementation stage	30 minutes
11.10-11.30	5) Inspection stage	20 minutes

Worksheet for student's Problem-Solving Ability

Worksheet III

The patient, male, 31 years old, suffered a "right femoral stem fracture" caused by a fall from a height 3 months ago. X-rays show continuous bone scab formation at the fracture site. The examination reveals impaired flexion and extension of the right knee, grade 4 knee flexion and extension muscle strength, and muscle atrophy of the right lower limb.

(1) What are the patient's current problems? What is the information related to the problem in the case?

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(2) What functional assessments can be performed on the patient? Now that we want to train the patient's muscle strength, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

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(3) Based on the patient's problem, what kind of muscle strength training can be performed?

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(4) Which type of strength training do you think would best improve this patient's discomfort?

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(5) Reflect and summarize. What are your training strengths and weaknesses?

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(6) What are your experiences in dealing with patient problems?

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Observation form about Student behavior

Learner behavior
Lesson Plan III Stage 1 Create questions: comprehension ability .... Stage 2 Implementation Problems: discriminatory ability .... Stage 3 Results showcase: presentation ability, problem-solving ability .... Stage 4 Reflection evaluation: reflective ability .... Stage 5 Expanded applications: communication ability ....

Assessment form for Validity of strength training lesson plan

Research Title: Using Problem-Based Learning Model to Improve Problem-Solving Ability of Medical Students

Research Objectives:

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Directions:

Please assess the congruence between components of lesson plan based on problem-based learning model by putting ✓ in the box according to the following criteria.

Rating is +1. There is an opinion that “consistent to relevant.”

Rating is 0. There is an opinion that “Not sure it consistent to relevant.”

Rating is -1. There is an opinion that “Inconsistent with relevant.”

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
1	Learning objectives sort the contents from easy to difficult.				
2	The problem-based learning method encourages students to work in teams and solve problems rationally.				
3	Determining content suitable for the age of students.				
4	Organizing activities suitable for learning objectives.				
5	Problem-based learning activities actually motivate students to learn and creative problem solving.				
6	Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.				
7	The using instructional media are suitable for learning activities.				

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
8	The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.				
9	Measurement and evaluation are suitable for learning activities to develop real ability.				
1 0	Assessment criteria are appropriate for subjective learning.				

Sign.....Assessor

(.....)

Date...../...../.....

Lesson Plan IV

The first semester of the second academic year

Department	Department of Medicine, Weifang Nursing Vocational College
Course name	exercise therapy: Chapter 4 breathing training
Target Audience	Rehabilitation Medicine, Year 2, Class 3
Number of students	30
Teaching Time	3 hours
Lecturer	Jia Zhenzhen

Content

breathing training

Objective of Leaning

1. The student can explain aspects of breath training.
2. The student can identify operational problems involving breath training.
3. The student can articulate operational problems related to breath training.
4. The student can solve problems related to breath training.
5. The student can reflect on problem solving in relation to breath training.
6. The student can summarize and communicate solutions to problems involving breath training and can transfer solutions.

Main point/concept

Breathing training is a training method that targets the form, amplitude and speed of respiratory movements, improves the endurance and coordination of the respiratory machine, increases the efficiency of lung capacity and gas exchange, and establishes an effective breathing pattern.

1. Improving lung ventilation techniques: learning breathing exercises such as abdominal breathing exercises, lip retraction breathing exercises, respiratory muscle training, local breathing exercises and chest release exercises.

2. techniques to promote lung cleansing: learning breathing exercises such as postural drainage and cough training

3. Techniques to improve respiratory function: learning respiratory training such as physical facilitation training and functional activities.

Learning Activity

Problem-based learning activities have 5 stages as follows: 1) Create questions, 2) Implementation Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications.

1. Create questions

In this session, the teacher provides students with clinical case scenarios related to breathing training and students develop a desire to explore. During the learning period students were able to identify the problem from the information, were able to actively explore the information and knowledge related to the problem, and finally understood the problem under the guidance of the teacher. The case is as follows:

Patient, male, 60 years old, retired worker, chronic cough and sputum for 20 years, diagnosed with COPD 7 years ago, can perform activities of daily living on his own. Patient reports fever, shortness of breath and worsening wheezing after a cold 2 weeks ago, symptoms reduced with respiratory medicine, now he feels short of breath when walking at a faster speed or walking up stairs and on slopes and wishes to improve his symptoms and can go for a walk downstairs. Smoked for 40 years, 20 cigarettes per day. No history of toxic exposure, history of dust exposure.

1.1 The teacher introduces the case scenario and guides the students into the classroom.

1.2 The teacher inspires students to ask questions: What is the patient's presenting priority problem as identified? What causes shortness of breath?

1.3 The teacher leads the students to analyze the case, find information and ask questions: What is the information related to the question in the case please search for? which breathing training method can be used? How can this patient be trained to breathe?

2. Implementation Problems

Building on the first session, students are able to sift through the information they have been given to describe the problem and analyze the structure and components of the problem. If the problem is not too difficult and the teacher is able to see that the students are basically able to analyze the problem on their own, the students will analyze the problem on their own in small groups. Another situation is that if the structure of the problem is more complicated or the problem is more difficult, it is necessary for the teacher to give some guidance to the students. In this case, the N/NK table framework of IMSA is infiltrated in the classroom to guide students to collaborate and explore and analyze the problem.

K/ NK table

Know	Need to know	Need to do

2.1 The teacher guides students in the execution of question 1: What causes shortness of breath? (Expect answers: impaired ventilation, impaired air exchange.) Students have been grouped before the lesson and the group discusses and speaks enthusiastically.

2.2 The teacher guides the students in the implementation of question 2: Which breathing training methods can be used? What are the different forms?
The question is difficult and the teacher demonstrates breathing training operations, which include five items of breathing training, including abdominal breathing training, lip retraction breathing training, respiratory muscle training, local breathing training and chest release training, while students observe.

2.3 The teacher communicates with standardized patients in a timely manner during operation, while students observe and appreciate communication skills. The teacher guides the students to appreciate the importance of treating patients with care, love and patience and respect.

2.4 Students have been grouped in appropriate groups of 3 before the lesson, with each member taking on a different role within the group. The teacher organizes students to work with each other in groups of 3. Cooperative learning is initiated through student-student exchanges and group-to-group exchanges, with the teacher providing guidance.

3. Results showcase

This session reports on the group's learning by demonstrating the actions of the group members. Report on the division of labor in the group, the completion of tasks by the group members, the problem solving in the group and the completion of tasks by the group. The groups learn from each other by exchanging learning outcomes. After listening to the other groups' reports, they should make some comments, pointing out problems that arise when students breathe in and out to make up for their shortcomings. It is important for teachers to monitor the comments made by students during this process, as they may be inappropriate or unrealistic due to their learning and life experience.

3.1 A member of the group is randomly selected to demonstrate breathing exercises on stage, while other students observe carefully and identify problems and offer different opinions, with the teacher on hand to give pointers. For example: Based on the patient's problems, what breathing training can be performed?

3.2 The teacher leads the students in identifying problems that may arise with each breathing exercise and tries to solve these practical problems as well as literacy problems. For example: Which type of breathing training do you think would best improve this patient's discomfort?

4. Reflection evaluation

Through exchanges, the experience and suggestions shared by other groups are critically received, and the suggestions rationalized by other groups or the teacher are absorbed for rethinking and revalidating the problem-solving approach to enhance their problem-solving ability. At the same time, this session reflects on the problem-solving method through discussion, and modifies the learning activity after reflection to enhance students' reflective ability. Eventually, they form their own effective path to discover problems, analyze problems, solve problems, summarize problems and gain experience.

4.1 After the exchange, the teacher and the practical instructor guide the students in groups and carry out the evaluation.

4.2 The groups are divided before the class and are made up of groups of 3 with a clear division of labor. 1 student scores according to the practical training evaluation form, 1 student starts the right limb breathing operation and 1 student plays the role of the patient and carries out the breathing training operation, taking turns to score the operation.

4.3 The teacher, with the help of the practical training teacher, evaluates and scores one operation of each student and finally accounts for the practical operation grade of each student.

5. Expanded applications

In this session, the clinical case is again introduced and questions are asked to test the students' problem-solving ability. Students' answers are uploaded to the teaching platform, and students' problem-solving ability is observed from their test results. At the same time, students continue to communicate in this session, applying good experiences in the learning and problem-solving process, identifying shortcomings, summing up the methods that can be transferred and used to improve communication ability.

5.1 Case published by a teacher: Patient, male, 70 years old, with a history of previous smoking for 40 years. A CT of the lungs shows an emphysematous left pulmonary space and he was admitted to the outpatient clinic with "COPD pulmonary space". The patient now feels short of breath and has difficulty breathing and wants to improve his symptoms.

(1) What are the patient's current problems? Please search the case for information related to the problem.

(2) What functional assessment can be performed on the patient?

(3) What kind of BREATHING TRAINING can be performed based on the patient's problems?

(4) What are the steps in breathing training?

(5) What did the student discover through the breathing training demonstration?

(6) What other ways can students perform breathing training?

5.2 The teacher instructs the students to analyze the problem and upload their findings to the platform.

5.3 The teacher displays student answers via the Learning Connect platform, explains them in a timely manner and addresses any problems that arise with student answers. Students correct in a timely manner.

5.4 Assign homework: after the lesson students complete a video of the case operation and upload it to the teaching platform, which the teacher reviews.

The teacher explains to the students at the end of the lesson the purpose and manner in which the Problem-Solving Ability Assessment will be conducted and distributes the test questions, which the students will be asked to complete in 1 hour.

Instructional Media

1. Chinese " Exercise Therapy" teaching materials

2. China "Exercise Therapy" teaching resources library

3. China Learning Pass online teaching platform (based on which a mixture of online and offline teaching is conducted)

4. Code of Practice for Commonly Used Rehabilitation Therapy Techniques (2012 edition)

5. PPT

Evaluation

1.Observe students' problem-solving ability.

2.Check problem-solving ability while working.

3.post-lesson assignments are used to assess students' mastery in this lesson.

4.Post-test problem-solving ability

Learning Schedule: breathing training 4 hours

Date/time	Teaching Process	Remark
31th August 2023 07.50-08.00	**Introduction** (breathing training)	10 minutes
08.00-08.30	**Learning Activity:** Using problem-based learning model have 5 stages 1) Create questions	30 minutes
08.30-09.20	2) Implementation Problems	50 minutes
09.20-09.30	Break time	
09.30-10.10	3) Results showcase	40 minutes
10.10-10.40	4) Implementation stage	30 minutes
10.40-11.00	5) Inspection stage	20 minutes
11.00-12.00	**Post-test** **subjective test**	1 hour

Worksheet for student's Problem-Solving Ability

Worksheet IV

Patient, male, 70 years old, with a history of previous smoking for 40 years. A CT of the lungs shows an emphysematous left pulmonary space and he was admitted to the outpatient clinic with "COPD pulmonary space". The patient now feels short of breath and has difficulty breathing and wants to improve his symptoms.

(1) What are the patient's current problems? What is the information related to the problem in the case?

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(2) What functional assessments can be performed on the patient? Now that we want to train the patient's respiratory function, which method should we use? Analyzing the results of the collaborative group inquiry in class, what aspects of training need to be taken into account in this patient's case?

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(3) Based on the patient's problems, what breathing training can be performed?

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(4) Which type of breathing training do you think would best improve this patient's discomfort?

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(5) Reflect and summarize. What are your training strengths and weaknesses?

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(6) What are your experiences in dealing with patient problems?

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Observation form about Student behavior

Learner behavior
Lesson Plan IV Stage 1 Create questions: comprehension ability .... Stage 2 Implementation Problems: discriminatory ability .... Stage 3 Results showcase: presentation ability, problem-solving ability .... Stage 4 Reflection evaluation: reflective ability .... Stage 5 Expanded applications: communication ability ....

Assessment form for Validity of breathing training lesson plan

Research Title: Using Problem-Based Learning Model to Improve Problem-Solving Ability of Medical Students

Research Objectives:

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Directions:

Please assess the congruence between components of lesson plan based on problem-based learning model by putting ✓ in the box according to the following criteria.

Rating is +1. There is an opinion that "consistent to relevant."

Rating is 0. There is an opinion that "Not sure it consistent to relevant."

Rating is -1. There is an opinion that "Inconsistent with relevant."

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
1	Learning objectives sort the contents from easy to difficult.				
2	The problem-based learning method encourages students to work in teams and solve problems rationally.				
3	Determining content suitable for the age of students.				
4	Organizing activities suitable for learning objectives.				
5	Problem-based learning activities actually motivate students to learn and creative problem solving.				
6	Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.				
7	The using instructional media are suitable for learning activities.				

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
8	The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.				
9	Measurement and evaluation are suitable for learning activities to develop real ability.				
1 0	Assessment criteria are appropriate for subjective learning.				

Sign.....Assessor

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Date...../...../.....

Problem-Solving Ability Assessment Criteria

Evaluation Items	Evaluation Content	Score and criterion		
		3	2	1
Comprehension ability	1.Identify problems	Students can quickly identify issues and clarify the rationale and meaning of issues from case situations.	Students identify some of the issues from the case situation and clarify the rationale and implications of some of the issues.	Students are less likely to identify issues from case situations and less likely to clarify the rationale and meaning of some of the issues.
	2.Searching for problems	Students can quickly identify problems from information and actively explore information and knowledge related to the problem and ultimately understand it.	Students identify parts of the problem from the information and are able to explore information and knowledge related to the problem and ultimately understand it.	Students have difficulty identifying problems from information and explore less information related to the problem, so knowledge is not understood.
Discriminatory ability	3.Describe the problems	Students can use their understanding to make adequate judgements and descriptions of the issues in a given resource.	Students use their understanding to make partial judgements and descriptions of problems in given resources.	Students use their understanding to make few judgements and descriptions of problems in given resources.
	4.Analyzing	Students can	Students are	Students are

Evaluation Items	Evaluation Content	Score and criterion		
		3	2	1
	the problems	analyze and integrate the information provided under the guidance of the teacher.	guided by the teacher to analyze and integrate parts of the information provide.	less likely to be able to analyze and integrate the information provided with the guidance of the teacher.
	5.Collaborative enquiry	Students can discuss with each other and identify problems in the learning process.	Students will identify some of the problems as they discuss with each other during the learning process.	Students discuss with each other and identify fewer problems in the learning process.
Presentation ability	6.Demonstrate results to illustrate the problem	Students can clearly formulate questions, demonstrate steps to results, and express their understanding of the question in a group.	Students ask questions and show some of the steps of their results, but express their understanding of the problem less among their peers.	Students are less likely to ask questions, demonstrate some of the steps of the results, and have difficulty expressing their understanding of the problem among their peers.
Problem-solving ability	7.Apply methods to solve problems	Students will choose their own learning styles to solve problems and communicate with peers to	Students need to choose their own learning styles to solve problems and communicate with their peers to solve problems	Students have difficulty solving problems through their own learning styles and do not

Evaluation Items	Evaluation Content	Score and criterion		
		3	2	1
		solve problems.	under the guidance of the teacher.	communicate effectively with their peers.
Reflective ability	8.Continuous reflection on lessons learnt	Students can reflect on the questions through discussion as well as be able to modify the learning activity after reflection.	Students need to reflect on problem solving with teacher guidance and revise learning activities after reflection.	Students are less likely to reflect on problem solving through discussion and are less likely to revise learning activities.
Communication ability	9.Talking about experience and learning methods	Students can draw on good learning and problem-solving experiences and identify weaknesses.	Students need to summarize their problem-solving experiences with teacher guidance.	Students are not able to draw lessons on problem solving with teacher guidance.

Evaluate quality standards

Score Range	Quality Level
24-27	Strong
20-23	Relatively strong
16-19	General
12-15	Relatively weak
09-11	Weak

Problem-Solving Ability Assessment

Please answer the questions according to the title, each question is worth 3 points, 9 questions in total, 27 points in total.

1. The patient, male, 65 years old, was admitted to the hospital with chronic cough and sputum for 20 years. The patient had obvious shortness of breath and wheezing when going up three flights of stairs, which improved at rest. Fever often appeared after being exposed to cold, often cyanosis of lips and mouth, shortness of breath, wheezing increased, and dyspnea was felt when resting. The sputum is white and frothy in the morning.

What is the patient's presenting priority problem as identified?

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2. Patient, female, 60 years old, chronic cough and sputum for 20 years, diagnosed with COPD 7 years ago, can complete daily life activities by herself. The patient reported fever, shortness of breath, and increased wheezing after getting cold 2 weeks ago, and the symptoms were reduced after respiratory medicine, and now she feels short of breath when she walks at a faster speed or when she goes up the stairs and inclines, and she hopes to improve her symptoms, and she can go for a walk downstairs. No history of toxic exposure, history of dust exposure.

What is the information related to the question in the case please search for?

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3. The patient, a 60-year-old woman, reported that she had shoulder pain in the past month, and that her right upper limb was unable to comb her hair and her dressing movements were limited. She had been treated with sealing, acupuncture, physiotherapy and other treatments at an outpatient clinic with poor results. In the past week, the pain had increased, and the slightest touch of the affected limb caused severe pain; on examination, there were widespread pressure points around the shoulder joint, and the pressure around the rostro-humeral and short head of the biceps muscle was obvious, and the pressure around the acromion and supraspinatus muscle was obvious, and the X-ray showed that there were no abnormalities of the bone quality.

What functions can be assessed by judgement?

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4. The patient, female, 50 years old, was rushed to the local hospital because of a sudden headache, nausea and vomiting followed by weakness of the right side of the limbs, and cranial computed tomography (CT) showed cerebral infarction. The patient had no fever, no convulsions, and no loss of consciousness. He was transferred to the Department of Neurology after 2 days of conservative treatment, and at the same time, early bedside rehabilitation was started. Physical examination: The patient's mental state was clear, his spirit was fine, there was no obvious abnormality in the movement and sensation of the left side of the limbs, and the muscles of the right side of the limbs were flaccid and hypotonic, and he was unable to carry out voluntary movement.

Now we are going to train the patient's joint movement, which kind of maneuvers should be used?

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5. Female, 60 years old, left limb immobility for 20 days, diagnosed as "cerebral infarction". Examination: mental clarity, fluent speech, Brannstrom's classification of upper limb-hand-lower limb: III-II-IV, seated balance level 2, inability to stand alone, impaired pain and temperature sensation on the left side, and mild dependence on daily life.

Analyzed in relation to the findings of the collaborative group inquiry in class, what aspects of training need attention in this patient?

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6. The patient, male, 19 years old, was accidentally crushed by a collapsed shelf during construction at a construction site, resulting in a fracture of the left femoral stem, which was then subjected to internal fixation with an incision and reduction plate.

What kind of training can the patient do 1 week after the operation?

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7. Patient, female, 36 years old, fell down accidentally 3 months ago, resulting in a fracture of the left patellar cleavage, which was fixed in a plaster cast. After the removal of the external fixation, her knee activities were significantly limited, and her quadriceps muscle became atrophied, with a muscle strength of grade 4.

What solution do you have to improve the muscle strength of quadriceps?

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8. The patient, female, 76 years old, was admitted to the hospital for half a month with a cerebral hemorrhage, and was now transferred to the Department of Rehabilitation with normal vital signs and stable status. The patient was mainly suffering from right side limb dyskinesia, hypotonia, low balance and coordination, and was able to maintain static balance in sitting position.

The practitioner trained the patient with bridging and rotational movements, is this the right way to train? If it were you, what training would you use?

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9. The patient, female, 30 years old, was involved in a motorbike accident, resulting in a comminuted fracture of the surgical neck of the left humerus. She was sent to the hospital for internal fixation of the humerus and other treatments, and was discharged home to recuperate 1 week later. 3 months later, the patient went to the rehabilitation department of the hospital for treatment, and was assessed to have significant limitation of flexion, extension, and retroflexion of the left shoulder joint, with atrophy of the shoulder muscles, and the strength of the deltoid muscle, the biceps muscle, and the triceps muscle were all at grade 4.

What is your experience in dealing with the patient's problem?

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Consistency of the Expert Review Form Assessment Variables measuring Problem-Solving Ability of second-year university medical students

Directions:

Please check the correspondence/appropriateness of the variables to be investigated against the definition of problem-solving ability. Please put a "√" in the box to assess the consistency of the problem-solving ability variable among second-year university medical students based on the following criteria.

Rating is +1. There is an opinion that "consistent to relevant."

Rating is 0. There is an opinion that "Not sure it consistent to relevant."

Rating is -1. There is an opinion that "Inconsistent with relevant."

Part 1 Defines the main variables and sub-variables of Problem-Solving Ability

variable/indicator	define	expert			suggestion
		+1	0	-1	
1.Comprehension ability	Refers to the learner's ability to identify the problem from the information, to be able to actively explore the information and knowledge related to the problem, and ultimately to understand the problem.				
1.1 Identify problems	Refers to the learner's ability to identify the problem from the case scenario and clarify the rationale, meaning of the problem.				
1.2 Searching for problems	Refers to the learner's ability to identify a problem in the information, to be able to actively explore information and knowledge related to the problem, and ultimately to understand the problem.				

variable/indicator	define	expert			suggestion
		+1	0	-1	
2. Discriminatory ability	Refers to the fact that, based on an understanding of the problem, learners should be able to sift through the information they have been given, briefly analyse the elements that make up the problem, formulate hypotheses about the problem, and collaborate to explore the relevant information.				
2.1 Describe the problems	Refers to the learner's ability to use his/her own understanding to make judgements and describe the problem in the given resource.				
2.2 Analyzing the problems	Refers to the learner's ability to analyse, integrate information based on the information provided.				
2.3 Collaborative enquiry	Refers to learners discussing with each other and identifying problems in the learning process.				
3. Presentation ability	Understanding and discrimination are the basis for formulating questions, which involves thinking about how to formulate a question using a variety of information; and how to use different formulations to				

variable/indicator	define	expert			suggestion
		+1	0	-1	
	express the same question.				
3.1 Demonstrate results to illustrate the problem	Refers to the learner's ability to clearly present the problem, demonstrate the steps to the outcome, and be able to articulate their understanding of the problem amongst their peers.				
4. Problem-solving ability	Problem solving is centred on the systematic design and diagnosis of problem solving methods, so problem-solving ability require strategies and methods. Learners are required to collectively discuss, select and use problem solving methods and be able to comment on the effectiveness of problem solving.				
4.1 Apply methods to solve problems	Refers to the fact that learners will choose their own way of learning to solve problems and will communicate with their peers about the effectiveness of problem solving.				
5. Reflective ability	Reflection is an important part of problem solving improvement, the analysis and evaluation of the				

variable/indicator	define	expert			suggestion
		+1	0	-1	
	effectiveness of problem solving, where learners are able to articulate the methods used to solve a problem, evaluate the strengths and weaknesses of the methods used, or provide suggestions for better methods, and work with learning partners to revise the solution, modify the design of the learning activity; and validate the new method.				
5.1 Continuous reflection on lessons learnt	Refers to the learner's ability to reflect on problem solving through discussion and modification of the learning activity after reflection.				
6.Communication ability	Communication is a process of improvement and refinement based on reflection. Learners with this competency are able to select appropriate mediums and modes of expression, present solutions to problems, and summarise experiences in solving similar problems. Learners can summarise successes, analyse shortcomings, and discuss and reflect on the				

variable/indicator	define	expert			suggestion
		+1	0	-1	
	transferability of the problem-solving approach.				
6.1 Talking about experience and learning methods	Refers to summarising good experiences in learning as well as problem solving, identifying weaknesses and summarising methods that can be transferred and used.				

Part 2 The Problem-Solving Ability Assessment

No.	Assessment Program	expert			suggestion
		+1	0	-1	
1. Comprehension ability					
1.1	Identify problems				
	The patient, male, 65 years old, was admitted to the hospital with chronic cough and sputum for 20 years. The patient had obvious shortness of breath and wheezing when going up three flights of stairs, which improved at rest. Fever often appeared after being exposed to cold, often cyanosis of lips and mouth, shortness of breath, wheezing increased, and dyspnea was felt when resting. The sputum is white and frothy in the morning. What is the patient's presenting priority problem as identified?				
1.2	Searching for problems				
	Patient, female, 60 years old, chronic cough and sputum for 20 years, diagnosed with COPD 7 years ago, can complete daily life activities by herself. The patient reported fever, shortness of breath, and increased wheezing after getting cold 2 weeks ago, and the symptoms were reduced after respiratory medicine, and now she feels short of breath when she walks at a faster speed or when she goes up the stairs and inclines, and she hopes to improve her symptoms, and she can go for a walk downstairs. No history of toxic exposure, history of dust exposure. What is the information related to the question in the case please search for?				

No.	Assessment Program	expert			suggestion
		+1	0	-1	
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2. Discriminatory ability					
2.1	Describe the problems				
The patient, a 60-year-old woman, reported that she had shoulder pain in the past month, and that her right upper limb was unable to comb her hair and her dressing movements were limited. She had been treated with sealing, acupuncture, physiotherapy and other treatments at an outpatient clinic with poor results. In the past week, the pain had increased, and the slightest touch of the affected limb caused severe pain; on examination, there were widespread pressure points around the shoulder joint, and the pressure around the rostro-humeral and short head of the biceps muscle was obvious, and the pressure around the acromion and supraspinatus muscle was obvious, and the X-ray showed that there were no abnormalities of the bone quality. What functions can be assessed by judgement?					
2.2	Analyzing the problems				
The patient, female, 50 years old, was rushed to the local hospital because of a sudden headache, nausea and vomiting followed by weakness of the right side of the limbs, and cranial computed tomography (CT) showed cerebral infarction. The patient had no fever, no convulsions, and no loss of consciousness. He was transferred to the Department of Neurology after 2 days of conservative treatment, and at the same time, early bedside rehabilitation was					

No.	Assessment Program	expert			suggestion
		+1	0	-1	
started. Physical examination: The patient's mental state was clear, his spirit was fine, there was no obvious abnormality in the movement and sensation of the left side of the limbs, and the muscles of the right side of the limbs were flaccid and hypotonic, and he was unable to carry out voluntary movement. Now we are going to train the patient's joint movement, which kind of maneuvers should be used?				
2.3	Discussion of problems				
Female, 60 years old, left limb immobility for 20 days, diagnosed as "cerebral infarction". Examination: mental clarity, fluent speech, Brannstrom's classification of upper limb-hand-lower limb: III-II-IV, seated balance level 2, inability to stand alone, impaired pain and temperature sensation on the left side, and mild dependence on daily life. Analyzed in relation to the findings of the collaborative group inquiry in class, what aspects of training need attention in this patient?					
3. Presentation ability					
3.1	Demonstrate results to illustrate the problem				
The patient, male, 19 years old, was accidentally crushed by a collapsed shelf during construction at a construction site, resulting in a fracture of the left femoral stem, which was then subjected to internal fixation with an incision and					

No.	Assessment Program	expert			suggestion
		+1	0	-1	
reduction plate. What kind of training can the patient do 1 week after the operation?					
4. Problem-solving ability					
4.1	Apply methods to solve problems				
Patient, female, 36 years old, fell down accidentally 3 months ago, resulting in a fracture of the left patellar cleavage, which was fixed in a plaster cast. After the removal of the external fixation, her knee activities were significantly limited, and her quadriceps muscle became atrophied, with a muscle strength of grade 4. What solution do you have to improve the muscle strength of quadriceps?					
5. Reflective ability					
5.1	Continuous reflection on lessons learnt				
The patient, female, 76 years old, was admitted to the hospital for half a month with a cerebral hemorrhage, and was now transferred to the Department of Rehabilitation with normal vital signs and stable status. The patient was mainly suffering from right side limb dyskinesia, hypotonia, low balance and coordination, and was able to maintain static balance in sitting position. The practitioner trained the patient with bridging and rotational movements, is this the right way to					

No.	Assessment Program	expert			suggestion
		+1	0	-1	
train? If it were you, what training would you use?					
6. Communication ability					
6.1	Talking about experience and learning methods				
The patient, female, 30 years old, was involved in a motorbike accident, resulting in a comminuted fracture of the surgical neck of the left humerus. She was sent to the hospital for internal fixation of the humerus and other treatments, and was discharged home to recuperate 1 week later. 3 months later, the patient went to the rehabilitation department of the hospital for treatment, and was assessed to have significant limitation of flexion, extension, and retroflexion of the left shoulder joint, with atrophy of the shoulder muscles, and the strength of the deltoid muscle, the biceps muscle, and the triceps muscle were all at grade 4. What is your experience in dealing with the patient's problem?					

Part 3 Suggestion

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Assessment form for Validity of lesson plan I-IV

Research Title: Using Problem-Based Learning Model to Improve Problem-Solving Ability of Medical Students

Research Objectives:

1. To use problem-based learning model to improve problem-solving ability of medical students.

2. To compare students' problem-solving ability, before and after the implementation base on the problem-based learning model.

Directions:

Please assess the congruence between components of lesson plan based on problem-based learning model by putting ✓ in the box according to the following criteria.

Rating is +1. There is an opinion that "consistent to relevant."

Rating is 0. There is an opinion that "Not sure it consistent to relevant."

Rating is -1. There is an opinion that "Inconsistent with relevant."

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
1	Learning objectives sort the contents from easy to difficult.				
2	The problem-based learning method encourages students to work in teams and solve problems rationally.				
3	Determining content suitable for the age of students.				
4	Organizing activities suitable for learning objectives.				
5	Problem-based learning activities actually motivate students to learn and creative problem solving.				
6	Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.				
7	The using instructional media are suitable for learning activities.				

No.	Questions	Assessment Results			Suggestions
		+1	0	- 1	
8	The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.				
9	Measurement and evaluation are suitable for learning activities to develop real ability.				
1 0	Assessment criteria are appropriate for subjective learning.				

Sign.....Assessor

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Date...../...../.....

Appendix D
The Results of the Quality Analysis of Research Instruments

Table 1 Analysis of the Index of Coherence (IOC) of lesson plans to improve Problem-Solving Ability of sophomore medical students with Problem-Based Learning model

Evaluation checklist	experts			Sum of scores	IOC value
	1	2	3		
Lesson Plan I: joint mobility training					
1. Learning objectives sort the contents from easy to difficult.	+1	+1	+1	3	1
2. The problem-based learning method encourages students to work in teams and solve problems rationally.	+1	+1	+1	3	1
3. Determining content suitable for the age of students.	+1	+1	+1	3	1
4. Organizing activities suitable for learning objectives.	+1	0	+1	2	0.67
5. Problem-based learning activities actually motivate students to learn and creative problem solving.	+1	+1	+1	3	1
6. Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.	+1	+1	+1	3	1
7. The using instructional media are suitable for learning activities.	+1	+1	+1	3	1
8. The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.	+1	+1	+1	3	1
9. Measurement and evaluation are suitable for learning activities to develop real ability.	+1	+1	+1	3	1
10. Assessment criteria are appropriate for subjective learning.	+1	+1	+1	3	1

Table 1 (continue)

Evaluation checklist	experts			Sum of scores	IOC value
	1	2	3		
Lesson Plan II: Balance and Coordination Training					
1. Learning objectives sort the contents from easy to difficult.	+1	+1	+1	3	1
2. The problem-based learning method encourages students to work in teams and solve problems rationally.	+1	+1	+1	3	1
3. Determining content suitable for the age of students.	+1	+1	+1	3	1
4. Organizing activities suitable for learning objectives.	+1	0	+1	2	0.67
5. Problem-based learning activities actually motivate students to learn and creative problem solving.	+1	+1	+1	3	1
6. Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.	+1	+1	+1	3	1
7. The using instructional media are suitable for learning activities.	+1	+1	+1	3	1
8. The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.	+1	+1	+1	3	1
9. Measurement and evaluation are suitable for learning activities to develop real ability.	+1	+1	+1	3	1
10. Assessment criteria are appropriate for subjective learning.	+1	+1	+1	3	1

Table 1 (continue)

Evaluation checklist	experts			Sum of scores	IOC value
	1	2	3		
Lesson Plan III: strength training					
1. Learning objectives sort the contents from easy to difficult.	+1	+1	+1	3	1
2. The problem-based learning method encourages students to work in teams and solve problems rationally.	+1	+1	+1	3	1
3. Determining content suitable for the age of students.	+1	+1	+1	3	1
4. Organizing activities suitable for learning objectives.	+1	0	+1	2	0.67
5. Problem-based learning activities actually motivate students to learn and creative problem solving.	+1	+1	+1	3	1
6. Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.	+1	+1	+1	3	1
7. The using instructional media are suitable for learning activities.	+1	+1	+1	3	1
8. The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.	+1	+1	+1	3	1
9. Measurement and evaluation are suitable for learning activities to develop real ability.	+1	+1	+1	3	1
10. Assessment criteria are appropriate for subjective learning.	+1	+1	+1	3	1

Table 1 (continue)

Evaluation checklist	experts			Sum of scores	IOC value
	1	2	3		
Lesson Plan IV: breathing training					
1. Learning objectives sort the contents from easy to difficult.	+1	+1	+1	3	1
2. The problem-based learning method encourages students to work in teams and solve problems rationally.	+1	+1	+1	3	1
3. Determining content suitable for the age of students.	+1	+1	+1	3	1
4. Organizing activities suitable for learning objectives.	+1	0	+1	2	0.67
5. Problem-based learning activities actually motivate students to learn and creative problem solving.	+1	+1	+1	3	1
6. Learning activities are linked from basic knowledge to ask questions, express their real ideas and effective discussion.	+1	+1	+1	3	1
7. The using instructional media are suitable for learning activities.	+1	+1	+1	3	1
8. The duration of the activity was appropriate to improve creative problem-solving ability of undergraduate students in the Photography Course.	+1	+1	+1	3	1
9. Measurement and evaluation are suitable for learning activities to develop real ability.	+1	+1	+1	3	1
10. Assessment criteria are appropriate for subjective learning.	+1	+1	+1	3	1

Table 2 Consistency Index (IOC) Analysis of Problem-Solving Ability with survey variables

variable/indicator	define	experts			Sum of scores	IOC value
		1	2	3		
1.Comprehension ability	Refers to the learner's ability to identify the problem from the information, to be able to actively explore the information and knowledge related to the problem, and ultimately to understand the problem.	+1	+1	+1	3	1
1.1 Identify problems	Refers to the learner's ability to identify the problem from the case scenario and clarify the rationale, meaning of the problem.	+1	+1	+1	3	1
1.2 Searching for problems	Refers to the learner's ability to identify a problem in the information, to be able to actively explore information and knowledge related to the problem, and ultimately to understand the problem.	+1	+1	+1	3	1
2. Discriminatory ability	Refers to the fact that, based on an understanding of the problem, learners should be able to sift through the information they have been given, briefly analyse the elements that make up the problem, formulate hypotheses about the problem, and collaborate to explore the	+1	+1	+1	3	1

variable/indicator	define	experts			Sum of scores	IOC value
		1	2	3		
	relevant information.					
2.1 Describe the problems	Refers to the learner's ability to use his/her own understanding to make judgements and describe the problem in the given resource.	+1	+1	+1	3	1
2.2 Analyzing the problems	Refers to the learner's ability to analyse, integrate information based on the information provided.	+1	+1	+1	3	1
2.3 Collaborative enquiry	Refers to learners discussing with each other and identifying problems in the learning process.	+1	+1	+1	3	1
3. Presentation ability	Understanding and discrimination are the basis for formulating questions, which involves thinking about how to formulate a question using a variety of information; and how to use different formulations to express the same question.	+1	+1	+1	3	1
3.1 Demonstrate results to illustrate the problem	Refers to the learner's ability to clearly present the problem, demonstrate the steps to the outcome, and be able to articulate their understanding of the problem amongst their peers.	+1	+1	+1	3	1
4. Problem-	Problem solving is centred					

variable/indicator	define	experts			Sum of scores	IOC value
		1	2	3		
solving ability	on the systematic design and diagnosis of problem solving methods, so problem-solving ability require strategies and methods. Learners are required to collectively discuss, select and use problem solving methods and be able to comment on the effectiveness of problem solving.	+1	+1	+1	3	1
4.1 Apply methods to solve problems	Refers to the fact that learners will choose their own way of learning to solve problems and will communicate with their peers about the effectiveness of problem solving.	+1	+1	+1	3	1
5. Reflective ability	Reflection is an important part of problem solving improvement, the analysis and evaluation of the effectiveness of problem solving, where learners are able to articulate the methods used to solve a problem, evaluate the strengths and weaknesses of the methods used, or provide suggestions for better methods, and work	+1	+1	+1	3	1

variable/indicator	define	experts			Sum of scores	IOC value
		1	2	3		
	with learning partners to revise the solution, modify the design of the learning activity; and validate the new method.					
5.1 Continuous reflection on lessons learnt	Refers to the learner's ability to reflect on problem solving through discussion and modification of the learning activity after reflection.	+1	+1	+1	3	1
6.Communication ability	Communication is a process of improvement and refinement based on reflection. Learners with this competency are able to select appropriate mediums and modes of expression, present solutions to problems, and summarise experiences in solving similar problems. Learners can summarise successes, analyse shortcomings, and discuss and reflect on the transferability of the problem-solving approach.	+1	+1	+1	3	1
6.1 Talking about experience and learning methods	Refers to summarising good experiences in learning as well as problem solving, identifying weaknesses and summarising methods that can be transferred and used.	+1	+1	+1	3	1

Table 3 Consistency Index (IOC) Analysis of Problem-Solving Ability assessment of Medical Students

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
1. Comprehension ability						
1.1	Identify problems					
	The patient, male, 65 years old, was admitted to the hospital with chronic cough and sputum for 20 years. The patient had obvious shortness of breath and wheezing when going up three flights of stairs, which improved at rest. Fever often appeared after being exposed to cold, often cyanosis of lips and mouth, shortness of breath, wheezing increased, and dyspnea was felt when resting. The sputum is white and frothy in the morning. What is the patient's presenting priority problem as identified?	+1	+1	+1	3	1
1.2	Searching for problems					
	Patient, female, 60 years old, chronic cough and sputum for 20 years, diagnosed with COPD 7 years ago, can complete daily life activities by herself. The patient reported fever, shortness of breath, and increased wheezing after getting cold 2 weeks ago, and the symptoms were reduced after respiratory medicine, and now she feels short of breath when she walks at a faster speed or when she goes up the stairs and inclines, and she hopes to improve her symptoms, and she can go for a walk downstairs. No history of toxic exposure,	+1	+1	+1	3	1

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
history of dust exposure. What is the information related to the question in the case please search for?						
2. Discriminatory ability						
2.1	Describe the problems					
The patient, a 60-year-old woman, reported that she had shoulder pain in the past month, and that her right upper limb was unable to comb her hair and her dressing movements were limited. She had been treated with sealing, acupuncture, physiotherapy and other treatments at an outpatient clinic with poor results. In the past week, the pain had increased, and the slightest touch of the affected limb caused severe pain; on examination, there were widespread pressure points around the shoulder joint, and the pressure around the rostro-humeral and short head of the biceps muscle was obvious, and the pressure around the acromion and supraspinatus muscle was obvious, and the X-ray showed that there were no abnormalities of the bone quality. What functions can be assessed by judgement?		+1	+1	+1	3	1
2.2	Analyzing the problems					

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
	The patient, female, 50 years old, was rushed to the local hospital because of a sudden headache, nausea and vomiting followed by weakness of the right side of the limbs, and cranial computed tomography (CT) showed cerebral infarction. The patient had no fever, no convulsions, and no loss of consciousness. He was transferred to the Department of Neurology after 2 days of conservative treatment, and at the same time, early bedside rehabilitation was started. Physical examination: The patient's mental state was clear, his spirit was fine, there was no obvious abnormality in the movement and sensation of the left side of the limbs, and the muscles of the right side of the limbs were flaccid and hypotonic, and he was unable to carry out voluntary movement. Now we are going to train the patient's joint movement, which kind of maneuvers should be used?	+1	+1	+1	3	1
2.3	Discussion of problems					
	Female, 60 years old, left limb immobility for 20 days, diagnosed as "cerebral infarction". Examination: mental clarity, fluent speech, Brannstrom's classification of upper limb-hand-lower limb: III-II-IV, seated balance level 2, inability to stand alone, impaired pain and temperature sensation on the left side, and mild dependence on daily life.	+1	+1	+1	3	1

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
	Analyzed in relation to the findings of the collaborative group inquiry in class, what aspects of training need attention in this patient?					
3. Presentation ability						
3.1	Demonstrate results to illustrate the problem					
	The patient, male, 19 years old, was accidentally crushed by a collapsed shelf during construction at a construction site, resulting in a fracture of the left femoral stem, which was then subjected to internal fixation with an incision and reduction plate. What kind of training can the patient do 1 week after the operation?	+1	+1	+1	3	1
4. Problem-solving ability						
4.1	Apply methods to solve problems					
	Patient, female, 36 years old, fell down accidentally 3 months ago, resulting in a fracture of the left patellar cleavage, which was fixed in a plaster cast. After the removal of the external fixation, her knee activities were significantly limited, and her quadriceps muscle became atrophied, with a muscle strength of grade 4. What solution do you have to improve the muscle strength of quadriceps?	+1	+1	+1	3	1

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
....						
5. Reflective ability						
5.1	Continuous reflection on lessons learnt					
The patient, female, 76 years old, was admitted to the hospital for half a month with a cerebral hemorrhage, and was now transferred to the Department of Rehabilitation with normal vital signs and stable status. The patient was mainly suffering from right side limb dyskinesia, hypotonia, low balance and coordination, and was able to maintain static balance in sitting position. The practitioner trained the patient with bridging and rotational movements, is this the right way to train? If it were you, what training would you use?		+1	+1	+1	3	1
6. Communication ability						
6.1	Talking about experience and learning methods					
The patient, female, 30 years old, was involved in a motorbike accident, resulting in a comminuted fracture of the surgical neck of the left humerus. She was sent to the hospital for internal fixation of the humerus and other treatments, and was discharged home to recuperate 1 week later. 3 months later, the patient went to the rehabilitation department of the hospital for treatment, and was assessed to		+1	+1	+1	3	1

No.	Assessment Program	experts			Sum of scores	IOC value
		1	2	3		
have significant limitation of flexion, extension, and retroflexion of the left shoulder joint, with atrophy of the shoulder muscles, and the strength of the deltoid muscle, the biceps muscle, and the triceps muscle were all at grade 4. What is your experience in dealing with the patient's problem?						

Table 4 Results of Problem-Solving Ability scores before and after applying the Problem-Based Learning model in an exercise therapy course

Student	Pre-study test scores (Pre–test)	Post-study test scores (Post–test)	Difference scores (D)
1	13	16	3
2	12	16	4
3	15	20	5
4	12	15	3
5	20	22	2
6	14	19	5
7	23	24	1
8	22	26	4
9	25	26	1
10	21	26	5
11	21	24	3
12	10	14	4
13	22	23	1
14	23	24	1
15	21	24	3
16	12	19	7
17	21	23	2
18	12	15	3
19	21	22	1
20	13	17	4
21	13	14	1
22	12	18	6
23	16	19	3
24	9	13	4
25	13	19	6
26	22	22	0
27	20	24	4
28	16	18	2
29	23	25	2
30	21	25	4
$\bar{x}$	17.27	20.40	3.13

Appendix E
Certificate of English

BANSOMDEJCHAOPRAYA
RAJABHAT UNIVERSITY

This is to certify that

Ms. Jia Zhenzhen

Achieved BSRU English Proficiency Test (BSRU-TEP) level

C1

Given on 25th January 2021

(Assistant Professor Dr Kulsirin Aphiratvoradej)

Director

Appendix F

The Document for Accept Research / Full Paper

SPU
SRIPATUM UNIVERSITY

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2410/2
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AMPHUR MUANG,
KHON KAEN 40000
TEL. 0 4322 4111
FAX. 0 4322 4119
www.khonkaen.spu.ac.th

SPU: 0203/4267

17 October 2023

Title: Paper Acceptance

Dear Jia Zhenzhen

On behalf of the Organizing Committee and Peer Review Committee, we are pleased that your paper titled,

"Using Problem Based Learning model to Improve problem solving ability of medical students"

submitted for presentation at the 18th National and the 8th International Sripatum University Conference (SPUCON2023) on Research and Innovations to Sustainable Development, held on 27October 2023, is formally accepted for inclusion in the conference program.

The conference program is shaping up to reflect a wonderful event. We hope that you will be able to fully participate in the conference and take advantages of all the benefits that this conference offer participants and attendees. Besides, your presented paper will be published in the on-line proceedings which will be available at http://spucon.spu.ac.th

We are looking forward to meeting you.

Sincerely yours,

(Assoc. Prof. Subin Yurarach, Ph.D.)
Chairman of Peer Review Committee
SPUCON2023

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The 18th National and the 8th International Sripatum University Conference (SPUCON2023)

Using Problem Based Learning model to Improve problem solving ability of medical students

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ABSTRACT

The purposes of this research were 1) to use a Problem Based Learning model to improve a problem solving ability of medical students, and 2) to compare students' problem solving ability, before and after the implementation based on the Problem Based Learning model. The sample group included 30 second-year medical students of a college in Weifang, China, in the first semester of the academic year 2023, The research instruments involved 1) four lesson plans based on the Problem Based Learning model, including 12 hours of teaching time, and 2) the Problem Solving ability scoring criteria. The test question is designed to test the 6 sub variables in the dependent variable, including comprehension ability, discriminatory ability, presentation ability, problem solving ability, reflective ability, and communication ability. The data were analyzed by mean ($\overline{X}$), standard deviation (S.D.) and Paired Sample t-test for dependent samples. The results revealed the followings: 1) By using Problem Based Learning model and observing students' learning behavior, it was found that students' Problem-Solving ability has been improved. Using a problem-based learning instructional model, medical students' basic scores on problem-solving ability were 17.28 with an average of 64.00 per cent before the study and 20.41 with an average of 75.59 per cent after the study, with an average difference of 3.13 points. These can be arranged in order of differences in before learning and after learning scores, from highest to lowest are: discriminatory ability (0.97 points), Comprehension ability (0.76 points), reflective ability (0.40 points), communication abilities (0.40 points), problem solving ability (0.40 points) and presentation ability (0.20 points). The scores were higher after learning than before learning. So, after the implementation of Problem Based Learning model, the students' Problem-Solving Ability improved obviously. 2) Using Problem Based Learning model, the Problem solving ability of second-year medical students after class is significantly higher than before class, with statistical significance at the level. 01. The problem solving ability scores of the medical students using the problem-based learning model averaged 17.28 before the study and 20.41 after the study, with an average difference of 3.13 points. The results showed that the problem solving ability of the students after the study was higher than before the study, which was statistically significant at the 0.01 level.

KEYWORDS: Problem Based Learning model, Problem solving ability, medical students

1. Introduction

One of the higher-order abilities required of students in the twenty-first century is the ability to solve problems. Cultivating problem-solving ability is the demand of China's quality education reform and the cultivation of creative talents, and this ability is not the ability of students to simply solve problems, but the ability to consider them in a comprehensive manner and to apply what they have learnt to solve some complex problems. Problem solving is a process in which every student should be trained. China's National Programme for Medium- and Long-Term Educational Reform and Development (2010-2020) clearly puts forward: "Promote the diversification of cultivation modes, and endeavor to improve students' problem-solving abilities." Therefore, improving students' problem-solving ability has become the entry point for cultivating creative talents, and it is also the necessary way for China's education and teaching reform to go deeper. The development of medical students' problem-solving ability is a new direction for the development of university education. At present, the ability of medical students to solve problems in clinical practice is not satisfactory. For medical students, when they enter the university after experiencing primary education and secondary education, the content they learn for a long time is refined, filtered, and rich in logical knowledge system, and the exercises they practise are also general exercises with just enough conditions. Such learning and connection can make students in a shorter period of time, master a large amount of knowledge, has the characteristics of high efficiency. However, this traditional education and teaching method will make students' thinking rigid and lack the ability to solve problems when facing clinical problems (Liu et al., 2019). And the lack of talent resources for rehabilitation medicine professionals in China has a huge gap, and the cultivation of medical talents has a long way to go. In summary, educational institutions have the responsibility to promote and support the cultivation of medical students' problem-solving ability, while the traditional teaching mode has limitations in the teaching of exercise therapy courses. The traditional teaching model is not student-centred, which seriously restricts the cultivation of students' problem-solving ability and makes it difficult to achieve the expected results. Chinese scholars suggest the need to find an appropriate teaching mode to enhance the problem-solving ability of medical students in the study of improving assessment for medical students based on the Programme for International Student Assessment (PISA). Therefore, the researchers studied and developed a "problem-based learning" model that promotes problem solving for medical students for improving their problem solving ability.

2. Research Objective

(1) To use Problem Based Learning model to improve problem solving ability of medical students.

(2) To compare students' problem solving ability, before and after the implementation base on the Problem Based Learning model.

3. Literature Review

3.1 Theory, Concept and Related Research

(1) Problem Based Learning model: Barrows, & Tamblyn (1980) states that the Problem Based Learning model is a model of education. The curriculum is problem-focused, with problems carefully selected and designed, while the problems need to be challenging. There are five steps, which are: 1) organizing group work, 2) creating a situation to raise a problem, 3) cooperative learning to explore the problem, 4) problem solving to share and exchange, and 5) summarizing and reflecting to evaluate the feedback. Liu (2001) believes that through problem-based learning, students can acquire knowledge related to problems. Yang (2005) pointed out that the Problem Based Learning model is a collaborative group effort in which learners work together to solve real problems in complex, meaningful situations, and in the process acquire scientific knowledge and develop problem-solving, independent learning and lifelong learning skills. Savery (2015) pointed out that Problem Based Learning model is a practical solution for students to solve problems based on specific problems and theory after combining theory and practice. To sum up, Problem Based Learning model is a teaching mode that takes teachers as the guide, puts students at the center of teaching and learning, and guides students to collect information, discover problems, and carry out group cooperation and investigation, and ultimately achieve the solution of the problem. Many scholars have different views on the implementation process of Problem Based Learning model. In the process of implementing Problem Based Learning model, the general learning process of Problem Based Learning model involves the following steps: "grouping, guiding, analyzing, solving and evaluating".

(2) Problem solving ability: Warner (2002) suggested that problem solving competence is "the ability to create the best solution to a problem at work". The 2003 PISA testing framework's understanding of the meaning of problem-solving ability focuses on students' integrated use of knowledge gained in reading, mathematics, and science to solve real problems. Sternberg & Frensch (2014) divided the problem solving process into six parts: identifying the problem, defining the problem, forming a strategy, organizing information, allocating resources, and monitoring and evaluation. Ma (2020) continues to sort out the PISA2003 evaluation framework based on the theory of scholar Yang Bin, which is divided into six sub-competencies: 1) identifying a problem, 2) describing a problem,3) using tools to explain a problem, 4) being able to apply methods and strategies to solve a problem, 5) communicating in a reflective way, and 6) speaking about experiences and learning methods. In summary, a more comprehensive meaning of students' problem solving ability should be proposed with due consideration of the factors affecting the development of problem solving ability. The delineation of problem-solving ability can be integrated by referring to the arguments of scholars and the PISA2003 assessment framework.

(3) Medical course: Ministry of Education of the People's Republic of China (2019) Published Documents, medical course mainly refers to the rehabilitation medicine course, including the professional basic course, professional core course and professional extension course. The professional core courses are generally 7 courses. These include: rehabilitation assessment techniques, exercise therapy, physical factor therapy techniques, occupational therapy techniques, speech therapy techniques, Chinese medicine rehabilitation techniques, and rehabilitation of common diseases.

3.2 Research Framework

The National Programme for Medium- and Long-term Educational Reform and Development (Ministry of Education of China, 2010) proposes the need to enhance students' problem-solving abilities. Using the medical course "Exercise Therapy" as the course of study, we will deeply explore the mode and method of cultivating students' problem-solving ability in the teaching of the discipline, design the content of the problem-based learning mode and problem-solving ability according to the policy of the Professional Teaching Standards for Vocational Schools of Higher Learning (Ministry of Education of the People's Republic of China ,2019), prepare the teaching plan, design the teaching process of the problem-based learning mode, and form the lesson plan based on the problem-based learning mode, which can be used to enhance the problem-solving ability of medical students' problem-solving ability. The research concept framework is as follows:

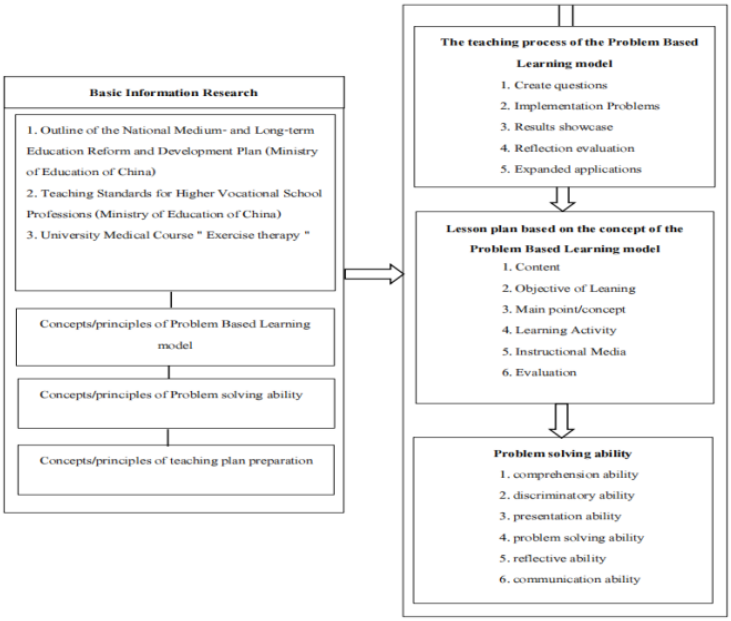

Figure 1 Research Framework

3.3 Research Hypotheses

After the implementation of Problem based learning model, the students' Problem-Solving Ability improved explicitly.

4. Research Methodology

Use the Problem Based Learning model to improve. The research using experimental research methodology have the following procedures.

4.1 Research Design

The research "Using Problem Based Learning model to Improve problem solving ability of medical students" aims to improve the Problem-Solving ability of medical students by using the Problem Based Learning model, and compare the Problem-Solving ability of students before and after class when using the Problem Based Learning method. Before and after teaching test: This research is experimental research. One Group Pretest – Posttest Design was used with the following experimental design:

Table 1 Experimental design

Group	Pretest	Experimental	Posttest
E	T_1	X	T_2

The meaning of the symbols used in the experimental design.

E means Random Sampling

X means Experimental

T_1 means Pretest

T_2 means Posttest

4.2 Population and Sample

Population

In the first semester of the 2023 academic year, there are 150 medical students in the second year of medical specialty in a college in Weifang, China, with 5 classes and 30 students in each class.

The Sample Group

One class out of 5 classes was taken as a sample by class based on the principle of randomness. One of the 5 classes of Year 2 of the first semester of the academic year 2023 in the institution was randomly selected by random whole cluster sampling, which was class 3 with 30 students.

4.3 Research Instrument

Using Problem Based Learning model to Improve problem solving ability of medical students. The research Instruments is as follows:

1. Four lesson plans according to Problem Based Learning model, including 12 hours of teaching time.

2. Problem Solving Ability Test. Under the background and assessment framework of the Programme for International Student Assessment (PISA), the researcher explored the structure of the PISA 2003 Problem Solving Ability (PISA2003), and designed a test of students' problem solving ability in the light of the current situation of education in China. Problem solving ability consists of 6 sub-competencies that are tested separately:1) comprehension ability,2) discriminatory ability,3) presentation ability,4) problem solving ability,5) reflective ability,6) communication ability.

4.4 Data Collection

The data were collected as follows:

1. Pre-experimental phase: 1) Organize a briefing session before the start of the experiment to inform students about the learning objectives and evaluation methods, as well as the benefits of taking part in aptitude tests and learning activities during the experiment. 2) Conduct a pre-test (Pre-test) on second-year medical students at a university in Weifang, China, taking second-year students from the first semester of the academic year 2023, a total of 30 students, as the sample group, and checking the records of the score in order to analyze the data.

2. Experimental phase: The phase in which the researcher teaches the sample group according to the teaching plan he developed. The total teaching time was 12 hours, excluding the pre-test and post-test.

3. Post-experimental phase: After teaching all the contents, the students in the sample group were tested on their ability (post-test). The researchers checked and scored the test according to the developed scoring criteria and the scores were reviewed and submitted for further data analysis.

4.5 Data Analysis

1. Analyze and validate the effectiveness of the course plan, and self guide the consistency index of the Problem Based Learning model learning ability scoring criteria as the consideration criterion (objective consistency index: IOC).

2. Based on the Problem Based Learning model, evaluate students' learning ability before and after the implementation of Problem Solving ability, and analyze the bias and t-test of statistical data related samples through means and standards from experiments. In this research, the researcher has synthesized the creative problem-solving abilities that will be promoted in students. This ability can be classified into 6 sub-abilities: 1) comprehension ability,2) discriminatory ability,3) presentation ability,4) problem solving ability,5) reflective ability,6) communication ability.

Taking 30 second-year medical students of a college in Weifang, China, as research objects, the "Problem Based Learning model" was adopted to observe and record the students' behavioural performance in each lesson during the five teaching sessions of "Create questions, Implementation Problems, Results showcase, 4Reflection evaluation, 5) Expanded applications". In the "Create questions, Implementation Problems, Results showcase, Reflection evaluation, expanded applications" five teaching sessions, the students' behaviours were observed and recorded in each session. The changes in students' behaviours indicated that students' learning awareness, learning strategies, learning activities, learning evaluation and problem solving ability were gradually improved throughout the learning process. Quantitative data were analysed through inferential statistics; Then calculate the different score of problem solving ability before and after using Problem Based Learning model were analysed through t-test for dependent.

5. Research Findings

5.1 Results of using the Problem Based Learning model to improve problem-solving ability

The objective of this study is to improve the problem solving ability of medical students using the Problem Based Learning model. Based on the Problem-Based Learning model approach further improves students' problem-solving ability, and in particular, significantly improves their discriminatory ability. The task sheets reflect an upward trend in students' problem-solving ability as instruction continues. The results of problem solving ability scores before and after applying the Problem Based Learning model in the exercise therapy course are detailed in Table 2.

Table 2 Using Problem Based Learning model to Improve problem solving ability of medical students

n=30

Problem Solving Ability	Full Scores (27)	Pre-test		Post-test		D
		$\overline{X}$	Percentage (100%)	$\overline{X}$	Percentage (100%)	
1.comprehension ability	6	4.07	67.83	4.83	80.50	0.76
2.discriminatory ability	9	5.70	63.33	6.67	74.11	0.97
3.presentation ability	3	1.87	62.33	2.07	69.00	0.20
4.problem solving ability	3	1.87	62.33	2.27	75.67	0.40
5.reflective ability	3	1.80	60.00	2.20	73.33	0.40
6.communication abilities	3	1.97	65.67	2.37	79.00	0.40
total		17.28	64.00	20.41	75.59	3.13

From Table 2, it can be seen that the basic score of problem solving ability of medical students using Problem Based Learning model of teaching are 17.28 points which is 64.00 percent on average before learning and 20.41 points which is 75.59 percent on average after learning with a difference of 3.13 points on average. These can be arranged in order of differences in before learning and after learning scores, from highest to lowest are: discriminatory ability (0.97 points),Comprehension ability (0.76 points), reflective ability (0.40points),communication abilities (0.40 points), problem solving ability (0.40 points) and presentation ability (0.20 points) Higher score after learning than before learning So, after the implementation of Problem Based Learning model , the students' Problem-Solving Ability improved obviously.

5.2 Comparative results of problem-solving ability of medical students implementing the Problem Based Learning model.

Comparison of medical students' problem solving ability before and after adopting Problem Based Learning model. Compared with traditional teaching, Problem Solving ability teaching based on the Problem Based Learning model is more helpful in enhancing students' problem-solving ability. The researchers used the problem solving ability scores before and after learning to analyze the data using mean statistics, standard deviation and t-test. The results of data analysis are shown in Table 3.

Table 3 Results of comparing students' Problem-Solving Ability of medical students before and after using Problem Based Learning model

		N	Full Point	$\overline{X}$	.SD	T	P
Total score	Pre- test	30	27	17.28	4.83	9.771	0.009**
	Post-test	30	27	20.41	4.10		

Statistically significant at level. .01(p <.01)

From Table 3, it can be seen that the problem solving ability scores of the medical students who used Problem Based Learning model averaged 17.28 before the study and 20.41 after the study, with an average difference of 3.13 points. The results show that the problem solving ability of the students after the study is higher than that before the study, which is statistically significant at the .01 level. This is consistent with the research hypothesis.

6. Discussion

(1) The Problem Based Learning model improves students' problem-solving in an exercise therapy programme. Students' problem-solving ability was well understood and learnt in practice as they received learning and training according to the steps of the Problem Based Learning model during their study of joint training, balance training, plyometrics and respiratory training. The study of many related literatures and the research on the problem-based learning model were summarized into five steps to develop a lesson plan: 1) Create questions, 2) Implement Problems, 3) Results showcase, 4) Reflection evaluation, 5) Expanded applications. The assessment test concluded that students have problem-solving abilities in the Problem Based Learning model in six areas: 1) comprehension ability, 2) discriminatory ability, 3) presentation ability, 4) problem solving ability, 5) reflective ability, and 6) communication ability. among these, the Problem Based Learning model is necessary to improve the problem solving ability of medical students, and this teaching model can enhance students' interest, which is consistent with Martí, et al. (2006). The findings are consistent with the fact that problem-based learning as a more actionable approach is more convenient for teachers to teach in the classroom and master the pace of teaching; for students, it raises their awareness of interest in the subject, stimulates motivation and initiative in learning, and improves their problem-solving ability. The Problem Based Learning model advocates a student-oriented perspective that guides students to make full use of the existing knowledge structure, to mobilize relevant learning resources to find new solutions to relevant problems, in line with Al-Salihi & Alobaidi (2018) study, develops instructional learning modules through a series of learning involving problem-based learning. Problem-based learning is important to student learning as it helps to guide students to get more opportunities to practice and consolidate what they have learnt and develop problem solving ability. It also corroborates Lawal et al. (2021) that the Problem Based Learning model has particularly critical benefits in medical education and training, and that it has a greater impact on students' preparation for autonomous clinical practice. Problem-based learning in

developing students' critical thinking and decision-making skills makes it a useful pedagogical implementation in the medical curriculum.

(2) Comparison of students' problem-solving ability before and after learning using a problem-based learning model. Findings: it can be seen that the problem solving ability scores of the medical students who used Problem Based Learning model averaged 17.28 before the study and 20.41 after the study, with an average difference of 3.13 points. The results show that the problem solving ability of the students after the study is higher than that before the study, which is statistically significant at the .01 level. This is consistent with the research hypothesis.

7. Suggestion

(1) Research on teaching modes to enhance students' problem-solving ability. Problem Based Learning model is used in combination with other teaching forms to cultivate students' problem-solving ability, such as combining the theory of collaborative learning, or flipping the classroom teaching mode, etc., to improve the problem-solving ability of medical students.

(2) It should expand disciplinary applications. The problem-based learning model constructed in this study focuses on the pedagogical application step of cultivating students' problem-solving ability, but the model has only been validated and modified in the exercise therapy course, and it can be expanded to be applied in other medical courses, and further validated and modified in a wider range of disciplines.

(3) The Problem Based Learning model should be expanded to include other competencies. The Problem-Based Learning model summarized and proposed in this study has been proved to be effective through the testing of teaching practice, and can also be used for the enhancement of other competencies, such as critical thinking ability, communication ability, and so on.

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