



APPLYING THE PROBLEM-BASED LEARNING METHOD IN TEACHING PROBABILITY THEORY AND STATISTICS FOR STUDENTS AT UNIVERSITY OF FINANCE - MARKETING

Tran Dinh Tuong^{1*}, Khong Chi Nguyen²

¹Faculty of Economics and Law, University of Finance-Marketing, Vietnam;

Email address: tuongtd@ufm.edu.vn

² Faculty of Basic Science, Tan Trao University, Vietnam

<https://doi.org/10.51453/2354-1431/2023/1035>

Article info

Received: 15/8/2023

Revised: 15/9/2023

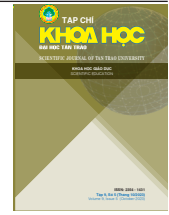
Published: 15/10/2023

Keywords

Probability theory and statistics; Innovating Teaching Methods; Problem-Solving Teaching; Economics Major Students; University of Finance and Marketing.

Abstract

Probability theory and statistics are essential subjects for students majoring in Economics. However, many students face challenges in grasping this subject due to its abstract nature. This paper discusses the application of teaching methods aimed at enhancing the effectiveness of teaching and learning Probability theory and statistics. This approach helps students cultivate critical thinking, apply knowledge to practical scenarios, and improve problem-solving skills.



VẬN DỤNG PHƯƠNG PHÁP DẠY HỌC PHÁT HIỆN VÀ GIẢI QUYẾT VẤN ĐỀ TRONG DẠY HỌC MÔN LÝ THUYẾT XÁC SUẤT THỐNG KÊ ỨNG DỤNG CHO SINH VIÊN TRƯỜNG ĐẠI HỌC TÀI CHÍNH – MARKETING

Trần Đình Tường^{1*}, Không Chí Nguyễn²,

¹Đại học Tài chính - Marketing, Việt Nam

²Trường Đại học Tân Trào, Việt Nam

Địa chỉ email: tuongtd@ufm.edu.vn

<https://doi.org/10.51453/2354-1431/2023/1035>

Thông tin bài báo

Ngày nhận bài: 15/8/2023

Ngày sửa bài: 15/9/2023

Ngày đăng: 15/10/2023

Từ khóa

Lý thuyết xác suất và thống kê; Lý thuyết xác suất và thống kê; Phương pháp dạy học giải quyết vấn đề, sinh viên chuyên ngành Kinh tế.

Tóm tắt

Lý thuyết xác suất và thống kê là môn học quan trọng trong chương trình đào tạo ngành Kinh tế. Tuy nhiên, nhiều sinh viên gặp khó khăn trong việc tiếp thu môn học này do tính trừu tượng và phức tạp. Bài báo này trình bày về việc vận dụng phương pháp dạy học phát hiện và giải quyết vấn đề nhằm nâng cao hiệu quả dạy và học môn Lý thuyết xác suất thống kê và ứng dụng cho sinh viên Đại học Tài chính - Marketing. Phương pháp này giúp sinh viên rèn luyện tư duy phân biện, vận dụng kiến thức vào thực tiễn và cải thiện kỹ năng giải quyết vấn đề. Kết quả nghiên cứu cho thấy phương pháp dạy học này giúp nâng cao hiệu quả học tập của sinh viên.

1. Introduction

Probability theory and statistics is a compulsory subject in undergraduate programs in most economics fields such as: Economics, Finance, Banking, Marketing, etc. This course equips students with fundamental knowledge of probability theory, descriptive statistical methods and statistical inference to analyze and solve economic problems involving uncertainty. At University of Finance and Marketing, the Probability Theory and Statistics and Applications course is designed with 3 credits, in which probability accounts for 2/3 of the content and the rest is statistics. Most students find this course rather dry, with abstract

theories, many formulas and complex computational procedures. In reality, during teaching we observed that students tended to be passive, lacked motivation and interest in learning this course, and could not properly apply knowledge to solve practical problems in their majors.

To improve the teaching and learning effectiveness of the Probability Theory and Statistics and Applications course, lecturers need to innovate their teaching methods. Among which, the problem-solving teaching method is considered suitable for this course. This paper presents the application of problem-solving teaching method in teaching Probability Theory and

Statistics and Applications to students at University of Finance and Marketing.

2. Research Content

2.1. *Some perspectives on problem-based learning*

Problem-based learning is a student-centered teaching method, in which students learn by solving real-world problems (Hmelo-Silver, 2004). Problem-based learning helps students develop critical thinking and apply knowledge to practice (Gallagher & Stepien, 1996). In Vietnam, problem-based learning is seen as an inevitable trend in the context of globalization. In problem-based learning, lecturers play the role of facilitators rather than just transmitting knowledge (Hmelo-Silver & Barrows, 2006). Students work in groups to identify the knowledge needed to solve the problem (Barrows, 1996). Thereby, students develop problem-solving, self-study and teamwork skills (Hmelo-Silver, 2004). Compared to traditional methods, problem-based learning enhances learners' ability to remember and apply knowledge (Strobel & Barneveld, 2009). Problem-based learning also improves learners' attitudes and learning experiences (Bearman et al., 2016). However, problem-based learning requires extensive resources and stakeholder consensus (Jacobs, 2003). In the age of technological development, problem-based learning equips learners with adaptability to new situations (Hung, Jonassen, & Liu, 2008). As a learner-centered approach, problem-based learning develops self-study skills necessary for lifelong learning (Hmelo-Silver, 2004). Problem-based learning views learning as a constructive, autonomous, collaborative and contextual activity (Jonassen, 2011). This process reflects real-world problem solving, helping learners become critical practitioners (Savery, 2006). In general, I think that problem-based learning is a modern teaching method, emphasizing learners' proactivity and self-study ability. Through solving real-life problems, learners acquire both knowledge and personal skills. Thus, this method should be widely applied at all educational levels in the current context of educational reform.

2.2. *Problem-based learning process*

The problem-based learning process helps students develop reasoning, analytical, and problem-solving skills for real-life situations. According to Hmelo-Silver

(2004), this process includes the steps: (1) identify the problem; (2) analyze the problem; (3) propose hypotheses; (4) gather data; (5) test the hypotheses; and (6) draw conclusions. In each step, teachers need to guide students to conduct group activities, discussions, and presentations. This encourages critical thinking and collaboration skills (Gallagher et al., 2012). Another process is the model proposed by Bransford & Stein (1984). This process has 5 steps: (I) identify the problem; (D) propose possible solutions; (E) evaluate the proposed solutions; (A) implement the best solution; and (L) review the problem-solving process. This model emphasizes the importance of evaluating and selecting the most appropriate solution.

Thus, problem-based learning processes aim to develop students' critical thinking, analytical skills, and ability to find solutions. It is important that teachers guide activities suitable for each step of the process so students can achieve the learning objectives.

Problem finding and solving is an important 21st-century skill (Jonassen, 2000). Students need to know how to identify problems, analyze causes, propose solutions, and verify the effectiveness of solutions. From researching problem-based learning processes, we propose the following problem-based learning process for the course Probability Statistics and Applications for students at University of Finance and Marketing:

· **Step 1:** The problem statement

Lecturers present a problem related to the content being learned and students' practical major to help them see the role and application of the course in their major.

· **Step 2:** Analyze and solve the problem

Lecturers have students identify the problem requirements, investigate the given information. Lecturers elicit prior knowledge through questions related to the problem so students can recall knowledge and propose solutions.

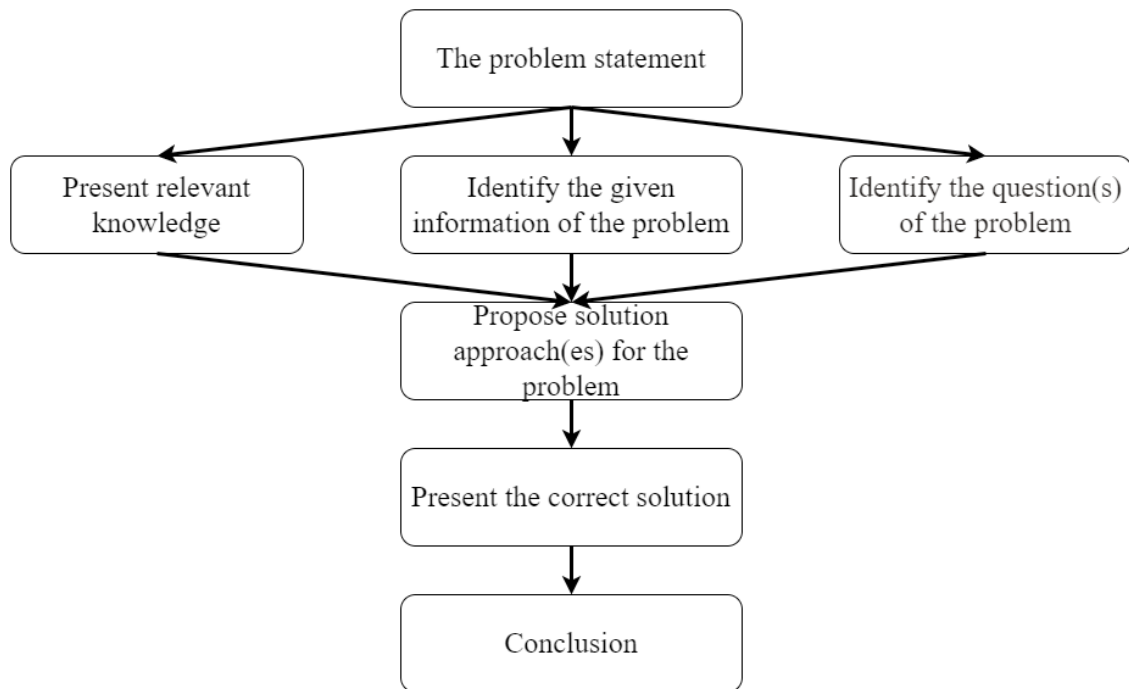
· **Step 3:** Present the solution

Based on the problem analysis, recalled theories, and solution guidance, students present the solution.

· **Step 4:** Conclusion

Lecturers summarize the problem and related knowledge, expand on surrounding issues, and introduce similar problems.

Figure 1. The problem-based learning process for teaching the content of the Probability Statistics and Applications course



2.3 Analysis of the advantages and disadvantages of problem-based learning

In recent decades, problem-based learning has become a progressive educational trend widely applied around the world as well as in Vietnam. With this method, learners are placed in problem situations that require solutions, encouraging problem analysis, hypothesis generation, information gathering, and team coordination to find appropriate solutions. Problem-based learning helps learners develop critical thinking and practice real-world problem-solving skills. Students also become more proactive in participating in the learning process, taking the initiative to apply knowledge to practice. Students have the opportunity to coordinate and exchange ideas with friends to jointly analyze problems and propose suitable solutions together. However, problem-based learning also has some disadvantages to note. First, it is a time-consuming and labor-intensive method for lecturers. Lecturers have to spend time researching and designing problem situations appropriate to the lesson content and learners' level. Second, students with poor background knowledge may find it difficult to solve problems. Therefore, lecturers need to flexibly adjust the complexity of the problems. Third, assessing

learners' learning outcomes in problem-based learning is challenging due to the open and flexible nature of the method. Lecturers need to be trained in appropriate assessment skills to effectively apply problem-based learning.

In general, if applied properly, problem-based learning brings many benefits and promotes learners' proactivity. However, lecturers also need to note potential difficulties to make appropriate adjustments and enhance teaching effectiveness.

3. Problem-based learning in Probability Statistics and Applications at University of Finance and Marketing

3.1 Rationale for applying problem-based learning in Applied Probability Statistics Theory at University of Finance and Marketing

Probability and statistics theory is an indispensable subject for most undergraduate majors. However, depending on the field and university, this course may have different names, content, and extent. Recently, University of Finance and Marketing has renamed this

course to Applied Probability Statistics Theory, to adapt to the practical application demand in socio-economic fields. This is an appreciable trend, demonstrating flexibility in updating course content to fit practice.

At University of Finance and Marketing, Applied Probability Statistics Theory is a 3-credit course with 2/3 of the time allocated to probability and the rest to statistics. This course aims to equip students with complete and systematic mathematical knowledge as a tool to study optimization problems in economics, apply the knowledge to study economic issues, recognize simple statistical models and apply them to problems in their majors. In addition, students can use some software to solve statistical problems (Excel, R, SPSS). Thereby, students can improve self-study and teamwork skills. And know how to apply statistics in economic and business analysis. The learning objectives for students taking this course are:

- Knowledge: Students can remember basic probability knowledge including: sample space, probability of events, random variables, and some common laws. Understand basic statistical methods like estimation problems, hypothesis testing,

correlation analysis, and simple linear regression. Apply probability statistics knowledge to professional knowledge.

- Skills: Students can calculate probabilities of events, determine probability distributions of random variables. Grasp parameter estimation and testing methods, correlation analysis, and simple linear regression problems.

- Autonomy and responsibility: Students develop logical thinking, accuracy, approach to solve problems, and proactivity in learning.

Due to the interrelated nature of probability statistics knowledge, this course has many good example problems for spotting and correcting mistakes, expanding and reversing problems. The content of Applied Probability Statistics is well suited for problem-based learning.

3.2 Illustrative Examples of Problem-Based Learning in Applied Probability Statistics Theory

Scenario 1. Problem-based learning of full probability formula and Bayes' formula.

Table 1. Lecturer and student activities in Scenario 1.

Numbering order	Implementation steps	Activities of lecturers and students
1	Building a scenario	The students have known the complete probability formula and Bayes' theorem formula but have not known how to apply the formulas to practical problems in their field of study, as well as how to reason to find the solution to the problem. Therefore, this situation evokes the students' cognitive needs and their ability to solve the problem independently.
2	Raising an issue	Suppose a bank receives loan applications from customers. The bank needs to assess the customers' ability to repay loans to decide whether to approve the loans. The bank has the following statistics: <ul style="list-style-type: none"> • The percentage of customers with good debt repayment ability among total customers is 60%. • Among customers with good debt repayment ability, the percentage of those holding a university degree is 80%. • Among customers with poor debt repayment ability, the percentage of those holding a university degree is 30%. A customer with a university degree applies for a loan. What is the probability that he has good debt repayment ability?

Numbering order	Implementation steps	Activities of lecturers and students
3	Resolving the issue	<p>Lecturer: What is the problem that needs to be solved?</p> <p>Student: The bank has statistics on the percentage of customers with good debt repayment ability and the percentage of this type of customers holding a university degree. A customer with a university degree applies for a loan. The question is what is the probability that he can repay the loan well.</p> <p>Lecturer: What are the events here?</p> <p>Student: Event A: “The customer has good debt repayment ability”; Event B: “The customer holds a university degree”.</p> <p>Lecturer: What information does the problem provide?</p> <p>Student: The problem stated: $P(A)$; $P(B / A)$; $P(\overline{B / A})$</p> <p>Lecturer: Which probability needs to be calculated?</p> <p>Student: Need to calculate $P(B / A)$.</p> <p>Lecturer: To calculate probability $P(B / A)$, which formula should be applied?</p> <p>Student: Apply Bayes’ theorem.</p> <p>Lecturer: Please restate the definitions of the full probability formula and Bayes’ theorem.</p> <p>Student: Definition of the full probability formula:</p> <ul style="list-style-type: none"> • $A_1 \cup A_2 \cup \dots \cup A_n = \Omega$ • $A_i \cap A_j = \emptyset ; \forall i \neq j$; and $i, j \in \{1; 2; 3; \dots; n\}$ <p>Then, the probability of event B given event A_j has occurred is given by the formula:</p> $P(B) = P(A_1)P(B / A_1) + P(A_2).P(B / A_2) + \dots + P(A_n)P(B / A_n)$ <p>Bayes’ theorem formula: With the same conditions as the full probability formula, and with the additional assumption that event B has occurred. Then,</p> $P(A_j / B) = \frac{P(A_j)P(B / A_j)}{\sum_{i=1}^n P(A_i)P(B / A_i)} ; \forall i = 1, 2, \dots, n$ <p>Lecturer: What is the complete set of events in this problem?</p> <p>Student: The complete set of events in this problem is A; \overline{A}.</p> <p>Lecturer: How can we address the requirement of the problem?</p> <p>Student: Apply the full probability formula to calculate $P(B)$, then apply Bayes’ theorem to calculate $P(A / B)$.</p>

Numbering order	Implementation steps	Activities of lecturers and students
4	Presenting the solution	<p>Let A be the event “Customer has good repayment ability”. Let \bar{A} be the event “Customer has poor repayment ability”. Let B be the event “Customer has a university degree”</p> <p>According to the problem, we have:</p> $P(A) = 0,6 \Rightarrow P(\bar{A}) = 1 - 0,6 = 0,4; P(B/A) = 0,8;$ $P(B/\bar{A}) = 0,3.$ <p>Since $A; \bar{A}$ is a complete set of events, applying the full probability formula we have:</p> $P(B) = P(A)P(B/A) + P(\bar{A})P(B/\bar{A})$ $= 0,8 \cdot 0,6 + 0,3 \cdot 0,4$ $= 0,62$ <p>Applying Bayes’ theorem we have:</p> $P(A/B) = \frac{P(A)P(B/A)}{P(B)}$ $= \frac{0,8 \cdot 0,6}{0,62} = 0,77$ <p>Therefore, the probability that a graduate customer asking for a loan has good repayment ability is 0,77.</p>
5	Conclusion	Lecturer: Thus, in economics we encounter many problems requiring decision making. Based on calculating probabilities using the full probability formula and Bayes’ theorem, we can make proper decisions.

Scenario 2. Problem-based learning of full probability formula and Bayes’ formula.

Table 2. Lecturer and student activities in Scenario 2

Numbering order	Implementation steps	Activities of lecturers and students
1	Building a scenario	<p>The students have learned about parameter estimation but do not fully understand the nature and do not know how to apply it in practice and relate it to their field of study. Going through the situation will help students master the theoretical knowledge about parameter estimation. It trains the skills to analyze problems and solve practical problems by applying probability and statistics knowledge. It also trains the ability to apply theoretical knowledge to specific business practices. Additionally, it helps students understand the role of probability and statistics in solving forecasting problems, modeling economic phenomena.</p>

Numbering order	Implementation steps	Activities of lecturers and students
2	Raising an issue	<p>To check the production situation of an automatic production line, 800 products produced by the production line were taken, of which 128 products were defective.</p> <p>a) When estimating the defective product ratio of the production line, if the upper bound of the estimation exceeds 17%, it is concluded that the production line is abnormal and needs repair. With 95% confidence, determine the production status of the production line.</p> <p>b) Determine the smallest sample size to estimate the defective product ratio with an accuracy smaller than 0.023 and 95% confidence.</p> <p>c) Determine the confidence level if you want to estimate the defective products with an accuracy of 0.022.</p>
3	Resolving the issue	<p>Lecturer: What is the issue that needs to be addressed?</p> <p>Student: Estimating the ratio, determining sample size, determining confidence interval.</p> <p>Lecturer: Please recall the theory of ratio estimation.</p> <p>Student: Let p be the unknown ratio of element A. We find the interval $(p_1; p_2)$ containing p such that $P(p_1 < p < p_2) = 1 - \alpha$. The confidence interval $(p_1; p_2) = (f - \varepsilon; f + \varepsilon)$ where</p> <ul style="list-style-type: none"> • f is the ratio calculated from the sample. • ε is called the accuracy of the estimate, calculated as: $\varepsilon = \sqrt{\frac{f(1-f)}{n}} t_{\frac{1-\alpha}{2}}$ <p>Lecturer: What are the components in the accuracy formula?</p> <p>Student: It includes 3 components - the accuracy ε; the confidence level; the sample size n.</p> <p>Lecturer: What do you think about the questions in this problem?</p> <p>Student: The problem revolves around the accuracy formula when given 2 components to find the remaining one.</p> <p>Lecturer: How can we solve the requirements of the problem?</p> <p>Student: Apply the accuracy formula to solve the problem.</p>
4	Presenting the solution	<p>a) Let f be the defective product ratio calculated from the sample</p> $f = \frac{128}{800} = 0,16$ <p>p is the defective product ratio produced by the factory.</p> <p>The accuracy of the estimate</p> $\varepsilon = \sqrt{\frac{f(1-f)}{n}} t_{\frac{1-\alpha}{2}}$ $= \sqrt{\frac{0,16(1-0,16)}{800}} \cdot 1,96$ $= 0,0245$

Numbering order	Implementation steps	Activities of lecturers and students
		<p>The estimated ratio of defective products produced by the production line is</p> $p \in (f - \varepsilon; f + \varepsilon)$ $\Leftrightarrow p \in (0,16 - 0,0254; 0,16 + 0,0254)$ $\Leftrightarrow p \in (0,1346; 0,1854)$ <p>We have the upper bound of the estimate $0,1854 > 0,17$, we can conclude that the production line is abnormal, requiring inspection and repair.</p> <p>b) Determine the sample size</p> $n = \left[\frac{f(1-f)}{\varepsilon^2} \left(t_{\frac{1-\alpha}{2}} \right)^2 \right] + 1$ $= \left[\frac{0,16(1-0,16)}{0,023^2} \cdot 1,96^2 \right] + 1 = 977$ <p>Therefore, a sample size of 977 products is needed for the accuracy to be less than 0.023.</p> <p>c) Determine the confidence level $1 - \alpha$</p> $t_{\frac{1-\alpha}{2}} = \varepsilon \sqrt{\frac{n}{f(1-f)}}$ $= 0,022 \sqrt{\frac{800}{0,16(1-0,16)}} = 1,96$ <p>Looking up the table of values, we calculate</p> $\frac{1-\alpha}{2} = 0,4545.$ <p>It follows that we calculate $1 - \alpha = 0,909$.</p>
5	Conclusion	<p>Lecturer: Please explain the meanings of the ratio estimation problem that the student has learned.</p> <p>Student: Answers the question based on their understanding.</p> <p>Lecturer: It helps estimate economic indicators and ratios such as inflation rate, unemployment rate, GDP growth rate, etc. when there is not enough full data. Accurately estimating these ratios helps assess the situation and propose appropriate economic policies. It helps predict trends and ratios in the future based on current estimated figures. For example, predicting inflation and growth rates in the coming years. It is the basis for monetary policy, fiscal policy and other macroeconomic policy making. The government needs to rely on estimated ratios to adjust interest rates, inflation, exchange rates, etc. It helps investors and businesses assess industry and sector prospects to have appropriate investment and business strategies.</p> <p>Thus, estimating ratios is very necessary in economics, helping policy makers and other economic entities make the right decisions.</p>

4. Conclusion

When applying the teaching method of problem discovery and problem solving in teaching Probability Theory and Statistics and Applications to students at University of Finance and Marketing, we found that students were more proactive and motivated towards the course. Students were more interested in the course, and the results of the final exam showed that the failure rate decreased significantly compared to previous classes. Therefore, the application of problem discovery and problem solving teaching method in teaching Probability Theory and Statistics and Applications at University of Finance and Marketing is absolutely necessary and suitable to the current trend of innovating teaching methods in universities. By presenting practical situations related to the course, this method helped improve students' proactiveness, enhance their problem discovery and problem solving skills. The research results also showed that the problem discovery and problem solving teaching method had positive impacts on students, demonstrated by their improvement in knowledge, skills and learning attitudes. To further promote the effectiveness of this method, lecturers need to select appropriate problems, design practical situations relevant to students' cognitive levels. This study opens up a new direction for innovating teaching methods of theoretical courses at the university level, contributing to improving training quality.

References

[1] Garfield, J. & Ben-Zvi, D. (2008). *Developing students' statistical reasoning: Connecting research and teaching practice*. Springer Science & Business Media. ISBN: 978-1-4020-8382-2

[2] Hmelo-Silver, C. E. (2004). *Problem-based learning: What and how do students learn?* Educational Psychology Review, 16(3), 235-266.

<https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>

[3] Barrows, H. S. (1996). Problem-based learning in medicine and beyond. In L. Wilkerson & W. Gijsselaers (Eds.), *Bringing problem-based learning to*

higher education: Theory and practice (pp. 3-13). San Francisco, CA: Jossey-Bass.

<https://doi.org/10.1002/tl.37219966804>

[4] Strobel, J., & Van Barneveld, A. (2009). *When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms*. Interdisciplinary Journal of Problem-Based Learning, 3(1), 4.

DOI: [10.7771/1541-5015.1046](https://doi.org/10.7771/1541-5015.1046)

[5] Jacobs, A. E. (2007). An in-depth investigation of the purposes and utilization of problem-based learning within academic programs for occupations therapists and physical therapists in Victoria, Australia and Ontario, Canada (Doctoral dissertation, Drexel University).

DOI: [10.1007/978-0-387-71164-5_4](https://doi.org/10.1007/978-0-387-71164-5_4)

[6] Hung, W., Jonassen, D. H., & Liu, R. (2008). *Problem-based learning*. Handbook of research on educational communications and technology, 3, 485-506. eBook ISBN9780203880869

[7] Jonassen, D. H. (2011). *Supporting problem solving in PBL*. Interdisciplinary Journal of Problem-Based Learning, 5(2), 95-119.

<https://doi.org/10.7771/1541-5015.1256>

[8] Savery, J. R. (2006). *Overview of problem-based learning: Definitions and distinctions*. Interdisciplinary Journal of Problem-based Learning, 1(1), 3.

<https://doi.org/10.7771/1541-5015.1002>

[9] Gallagher, S. A., Sher, B. T., Stepien, W. J., & Workman, D. (2010). *Implementing problem-based learning in science classrooms*. School science and mathematics, 95(3), 136-146.

DOI: [10.1111/j.1949-8594.1995.tb15748.x](https://doi.org/10.1111/j.1949-8594.1995.tb15748.x)

[10] Bransford, J. D., & Stein, B. S. (1984). *The IDEAL problem solver: A guide for improving thinking, learning, and creativity*. New York: W.H. Freeman. ISBN 0-7167-2204-6 (cloth). ISBN 0-7167-2205-4 (pbk.)

[11]. Nguyen Cao Van, Tran Thai Ninh, *Probability Theory & Mathematical Statistics Textbook*, National Economics University Publishing House, 2008.

[12]. Nguyen Cao Van, Tran Thai Ninh, *Exercises in Probability & Mathematical Statistics*, National Economics University Publishing House, 2009.