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SOME MEASURES TO TEACH STATISTICS AND PROBABILITY IN GRADE 8 TOWARDS DEVELOPING MATHEMATICAL PROBLEM-SOLVING COMPETENCY

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ABSTRACT

In the 2018 General Education Program, Statistics and Probability is a core knowledge strand that helps students form quantitative thinking and information processing skills. However, reality shows that teaching activities for this content still face difficulties in balancing calculation requirements and statistical thinking. The failure to fully utilize the advantages of technology and real-world data sources has partly limited the development of students' mathematical problem-solving competency. Based on this, the article proposes three pedagogical measures: (1) Constructing a system of questions and exercises attached to real-world contexts; (2) Organizing diverse teaching activities such as investigations and simulation games; (3) Using teaching aids and supporting information technology. Research results show that applying these measures has significantly improved students' problem detection and solving skills, confirming the feasibility and effectiveness of the proposed solutions.

KEYWORDS: Mathematical problem-solving competency; Statistics and Probability; Grade 8 Mathematics; Context-based teaching; ICT application in teaching.

INTRODUCTION

In the context of the fundamental and comprehensive renovation of education in Vietnam, the 2018 General Education Program has marked an important shift from a content-based approach to the development of learner qualities and competencies (Ministry of Education and Training, 2018a). Within this framework, mathematical problem-solving competency is defined as one of the five core components, playing a key role in helping students adapt to the changes of modern society (Ministry of Education and Training, 2018b; Do Duc Thai & Do Tien Dat, 2017). In particular, the Statistics and Probability knowledge strand has been affirmed as an indispensable constituent part, consistent from Primary Education to Upper Secondary Education, aiming to equip students with quantitative thinking and data-driven decision-making capabilities.

International studies indicate that statistics education needs to move beyond purely computational skills to focus on statistical thinking. Watson (2006) emphasized that statistical competency includes the ability to understand context, evaluate data sources, and interpret results. Similarly, Franklin and colleagues (2007) in the GAISE report proposed teaching through the statistical investigation process (formulating questions – collecting data – analyzing data – interpreting results) as an effective method to develop learner's competencies. In Vietnam, recent studies by Pham Dang Quyet (2024) and Nguyen Ngoc Giang and colleagues (2022) also affirmed the necessity of innovating methods of teaching mathematical content associated with real-world practice to develop thinking and problem-solving competency for students.

However, the practical implementation of teaching this content at the Lower Secondary level, especially in Grade 8, still presents significant shortcomings. Practical survey results show that teaching activities still focus heavily on transmitting theoretical knowledge and practicing manual calculation skills, while practical elements and technology application have not been fully exploited. The majority of teachers face difficulties in designing practical situations and balancing knowledge requirements with the organization of experiential activities. This leads to a situation where students lack interest, underestimate statistical content, and face difficulties when applying knowledge to solve practical problems.

Although there have been studies on competency-based teaching, there is still a lack of in-depth research on specific pedagogical measures to develop mathematical problem-solving competency through Statistics and Probability content for Grade 8 students in the context of the 2018 General Education Program. Stemming from the theoretical and practical requirements mentioned above, this study is conducted to propose a system of feasible teaching measures, contributing to improving educational effectiveness and developing student's problem-solving competency.

2. RESEARCH METHODS

2.1. Theoretical research method

The study employs methods of analysis, synthesis, and systematization of scientific documents, including: documents and resolutions on educational innovation; the 2018 General Education Program in Mathematics; Grade 8 Mathematics textbooks; and domestic and international research related to problem-solving competency and Statistics and Probability education. The objective is to establish a theoretical basis, identify the components of mathematical problem-solving competency, and determine the specific expected learning outcomes of this knowledge strand at the lower secondary level.

2.2. Survey investigation method to evaluate the current state of teaching, the study conducted a survey of 50 Mathematics teachers at Lower Secondary Schools (Duc Thang, Co Nhue 2, Dong Ngac) in Hanoi. The study used questionnaires consisting of a system of multiple-choice and constructed-response items to collect data on awareness, teaching organization methods, and the use of supporting

tools. This was combined with classroom observations and in-depth interviews with a number of teachers and students to qualitatively assess the level of engagement and effectiveness of the lessons.

2.3. Mathematical - statistical method Quantitative data from questionnaires and experimental results were processed using mathematical statistical methods.

3. RESEARCH RESULTS

3.1. Opportunities to develop mathematical problem-solving competency through Grade 8 Statistics and Probability content

Based on the 2018 General Education Program in Mathematics (Ministry of Education and Training, 2018), mathematical problem-solving competency comprises four core components with specific manifestations as follows:

Table 1. Components and manifestations of mathematical problem-solving competency of Lower Secondary students

No.	Competency components	Manifestations
1	Recognizing and detecting problems that need to be solved mathematically	Detecting the problem that needs to be solved.
2	Choosing and proposing methods and solutions to solve problems	Identifying methods and solutions to solve the problem.
3	Using compatible mathematical knowledge and skills to solve the posed problems	Using compatible mathematical knowledge and skills to solve the problem.
4	Evaluating the proposed solution and generalizing for similar problems	Explaining the solution that has been implemented.

In the 2018 General Education Program, Statistics and Probability is one of the three core knowledge strands, designed consistently and gradually advanced. In Grade 8, this knowledge strand focuses on two major areas: (1) Collecting, organizing, representing, and analyzing data; (2) Describing the probability of random events and its relationship with experimental probability. This is an ideal environment to develop mathematical problem-solving competency through the following specific activities:

Data collection and organization activities provide opportunities for students to practice problem detection skills. When facing diverse data sources (from tables, reports, field investigations), students must evaluate reasonableness and detect noisy or outlying data, thereby forming critical thinking.

Chart selection and data processing activities help develop solution selection and decision-making skills. Deciding whether to use a pie chart or a bar chart to represent data, or calculating the mean to represent a data set, requires students to consider based on the problem-solving purpose[2].

Data analysis and probability experiment activities help develop evaluation and generalization skills. Through observing chart trends or comparing experimental and theoretical probability (Law of Large Numbers), students learn to explain real-world phenomena using mathematical language, identify patterns, and make scientifically grounded predictions.

Especially, integrating practical activities with mathematical software (such as Excel, GeoGebra) in this content helps students reduce the pressure of manual calculation to focus on analytical thinking, and simultaneously allows simulating random experiments with large quantities that are difficult to perform in reality.

Table 2. Analysis of opportunities to develop mathematical problem-solving competency in teaching Grade 8 Statistics and Probability

Content	Required Achievements	Opportunities to Form and Develop Mathematical Problem-Solving Competency
Some Statistical Elements		
Collection and Organization of Data	- Collect, classify, and organize data according to given criteria. - Collect, classify, and organize data from diverse sources. - Explain the reasonableness of data according to basic mathematical criteria.	- Students have the opportunity to detect problems that need to be solved through critical evaluation of provided data (such as advertising figures, survey data), thereby recognizing contradictions, absurdities, or discrepancies in reality. - Students have the opportunity to explain the solutions that have been implemented by presenting reasons for selecting data sources and justifying the methods of classification and organization of the data they have carried out.
Describing and Representing Data in Tables and Charts	- Read, understand, and accurately describe charts such as pie charts, line charts, and bar charts/double bar charts.	- Students have the opportunity to identify methods and solutions to solve problems by analyzing raw data characteristics to decide on the

	- Select appropriate charts to present data. - Detect unreasonable features in data.	most appropriate chart type (bar, pie, or line) for effective information transmission. - Students have the opportunity to detect problems that need to be solved by observing completed charts to find anomalies, inaccurate figures, or illogical points.
Data Analysis and Processing	- Formulate and solve simple problems arising from existing data and statistical charts. - Detect simple problems and patterns based on the analysis of table data and charts. - Solve problems related to collected data in the form of: statistical tables; certain charts. - Recognize the relationship between statistics, other school subjects, and social reality.	- Students have the opportunity to detect problems that need solving by observing increasing or decreasing trends and comparing discrepancies on charts to identify patterns or emerging practical issues (for example: environmental pollution, population growth). - Students have the opportunity to use compatible mathematical knowledge and skills by performing calculations and processing data on charts to find accurate answers to posed problems. - Students have the opportunity to explain the solution that has been implemented by connecting statistical results with interdisciplinary knowledge (History, Geography) to clarify the meaning and causes of figures in specific contexts.
Some Probability Elements		
Some Probability Elements	Describe the probability of random events in simple examples. The relationship between experimental probability of an event and the theoretical probability of that event. - Understand and describe basic concepts of random events and	- Students have the opportunity to use compatible mathematical knowledge and skills by using the "ratio" tool to model and quantify the likelihood of a random event occurring. - Students have the opportunity to explain the solution that has been implemented by comparing experimental results with theory, thereby explaining the differences or

	their probability through simple examples. - Recognize the relationship between experimental probability and theoretical probability through basic experiments.	similarities between them in specific situations.
Practice in Computer Labs with Mathematical Software (if school conditions permit)	- Use software to draw charts. - Use software to determine frequency. - Use software to describe random experiments.	- When using software to draw charts, students have the opportunity to identify methods and solutions to solve problems by making decisions on selecting data visualization tools (choosing which chart type from the software list: bar, pie, or line) to highlight the data's message; they have the opportunity to use compatible mathematical knowledge, skills, and tools by proficiently manipulating software (Excel, GeoGebra, etc.) to convert raw data into visual images accurately and aesthetically, replacing time-consuming manual drawing. - When using mathematical software in Probability, such as using software to describe random experiments, students have the opportunity to detect problems that need solving by observing the fluctuation of frequency in small sample experiments and its stability in large sample experiments (due to computer simulation of thousands of times in seconds), thereby discovering the law of the "Law of Large Numbers." From there, students have the opportunity to explain the solution that has been implemented by comparing simulation results on the computer with theoretical calculation

		results, thereby arguing and reinforcing belief in learned probability formulas. - When using software to determine frequency, students have the opportunity to use compatible mathematical knowledge, skills, and tools by applying automatic command functions (such as COUNT, FREQUENCY, etc.) to process large datasets where manual counting is prone to errors. From there, students have the opportunity to detect problems that need solving by observing frequency results quickly synthesized by the computer, thereby immediately identifying outliers or central tendencies of the data.
Practical and Experiential Activities	Activity 1: Learn some financial knowledge such as: – Planning personal spending. – Getting acquainted with personal investment problems (determining investment capital to achieve expected interest rates). – Understanding bank statements (real or example statements) to identify transactions and track income and expenditure; selecting appropriate payment methods. Activity 2: Practice applying mathematical knowledge to reality and interdisciplinary topics. Activity 3: Organize extracurricular activities such as practice outside the classroom, learning projects,	- Students have the opportunity to fully develop mathematical problem-solving competency (from detection, planning, and implementation to evaluation) through solving complex real-world problems such as creating personal budgets or calculating optimal investment plans.

	math learning games, and Math competitions.	

3.2. Current status of teaching Statistics and Probability content associated with developing problem-solving competency

To establish a practical basis for proposing pedagogical measures, the study conducted a survey of 50 Mathematics teachers at several Lower Secondary Schools in Bac Tu Liem District, Hanoi (Duc Thang Secondary School, Co Nhue 2 Secondary School, Dong Ngac Secondary School). The survey results focused on four main aspects: teachers' awareness, forms of teaching organization, practical difficulties, and the status of information technology application.

a) Teachers' awareness of problem-solving competency and program content

The investigation results show that the majority of teachers have a accurate perception of the role of problem-solving competency in the new educational context. Specifically, 80% of teachers fully understand the nature of problem-solving competency, and 100% of respondents affirm that developing this competency through teaching Statistics and Probability is "necessary" and "very necessary".

However, the assessment of the practicality of the exercise system in current Grade 8 Mathematics textbooks reveals certain limitations. Although 52% of teachers believe that the exercises are "relatively suitable", only 8% evaluate them as "very close to real life". Notably, 20% of teachers stated that the current content has "little application and needs more practical situations" to create interest and opportunities for students to apply their knowledge.

Table 3. Summary of teachers' assessment of the practical applicability of Statistics and Probability exercises in Grade 8 textbooks

Assessment Level	Result Quantity (Votes)
Very close to real life, to students	4
Relatively suitable	26/50
Little application, needs more practical situations	10/50
Too theoretical, far from reality	0

b) Teaching forms and techniques currently being applied

Regarding organizational methods, teachers have made a positive shift from one-way transmission teaching to more interactive forms. "Small group work" is the most common form with a selection rate

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of 76%, followed by "Individual work" (52%). Active teaching techniques such as "Flexible grouping" (88%) and "Posing problems/eliciting" (72%) are frequently used to stimulate student thinking.

However, advanced teaching forms that require significant investment and allow students to experience the statistical process more deeply, such as "Project-based learning" (44%) or "Organizing extracurricular/practical activities" (32%), have not yet been widely implemented. This indicates that teaching activities are still mainly confined to the classroom space with short-term tasks.

Table 4. Statistics on teaching forms of teachers helping students develop mathematical problem-solving competency in Statistics and Probability lessons

Teaching Form	Number of Opinions	Percentage (%)
Individual work	26	52
Small group work	38	76
Project-based learning	22	44
Organizing extracurricular/practical activities	16	32

c) Barriers and difficulties in teaching practice

When implementing teaching oriented towards developing problem-solving competency, teachers face many challenges from both objective and subjective factors.

Regarding the design of situations: 60% of teachers encounter difficulties because students lack background knowledge about practical issues, and 40% are uncertain about how to balance the authenticity of situations with the knowledge requirements of the curriculum.

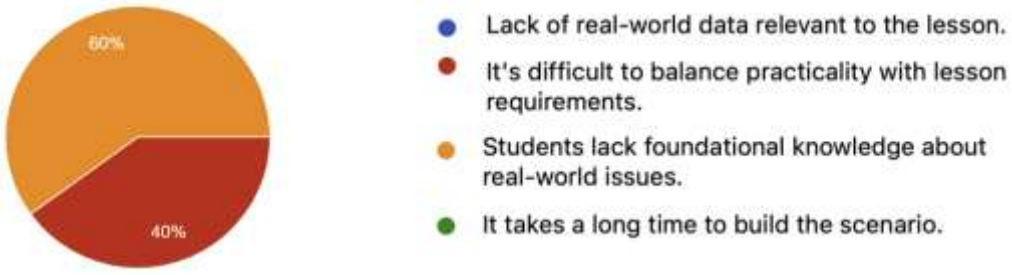

Chart 1. Difficulties of teachers when designing situations in Statistics and Probability lessons to develop problem-solving competency for students

Regarding the organization of activities: Time pressure is the biggest barrier, with 92% of teachers stating that limited instructional time makes it difficult to organize experiential activities. In addition, the students' passive learning attitudes (84% of teachers reflect that students are hesitant to participate)

and large class sizes (80%) are also major factors reducing the effectiveness of active teaching methods.

Table 5. Statistics on difficulties teachers encounter when teaching Statistics and Probability oriented towards developing problem-solving competency for Grade 8 students

Difficulties teachers encounter	Number of Opinions	Percentage (%)
Students are not used to it, hesitant to participate	42	84
Lack of time	46	92
Large class size, difficult to organize activities	40	80
Lack of supporting means and equipment	26	52
Teachers themselves are not used to organizing	28	56
No difficulties	0	0

d) Status of information technology application and supporting tools

In teaching Statistics and Probability, technology plays a key role in processing data and simulation. However, the survey results show that the level of technology integration is still modest. Presentation software such as PowerPoint (72%) and basic Excel spreadsheets (60%) are the most commonly used. Specialized tools that support experiment simulation or the construction of dynamic visual charts receive less attention. The biggest barrier to integrating technology is "Lack of suitable or user-friendly software" (80%) and teachers themselves being "not proficient in technology" (40%).

Table 6. Statistics on the level of use of some software in teaching Statistics and Probability

Level	Number of Opinions	Percentage (%)
Basic Excel spreadsheet	30	60
PowerPoint	36	72
Simple chart drawing software	14	28
Google Forms (data collection)	30	60
Kahoot/Quizizz (creating games/simulation experiments)	32	56
Do not use any tools	0	0

The above status shows that, although teachers have good level of awareness and efforts to innovate methods, the effectiveness of developing problem-solving competency for students through Statistics and Probability content is still limited due to a shortage of practical resources, limitations in time, and

failure to effectively exploit the power of information technology. These are urgent issues that need to be resolved through specific pedagogical measures.

3.3.3. Some measures to develop mathematical problem-solving competency for Grade 8 students in teaching Statistics and Probability content

Based on theoretical and practical grounds, the study proposes three pedagogical measures to develop mathematical problem-solving competency for Grade 8 students, specifically as follows:

3.3.3.1. Measure 1: Constructing a system of questions and exercises on Statistics and Probability content attached to reality

a) Purpose of the measure

The purpose of this measure is to develop a system of questions and exercises designed according to a competency-based approach, attached to diverse practical contexts (from personal life and school to social and scientific issues). By solving situations containing real data or random elements, the measure aims to shift the teaching focus from practicing pure calculation skills to developing statistical and probabilistic thinking, helping students view mathematics as a powerful tool to explore the real world.

b) Implementation method

Teachers proceed to build exercises according to a 4-step process:

Step 1: Selecting and determining practical contexts. Teachers search for data from official sources (Statistical Yearbook, scientific reports, sports results, etc.) or review interdisciplinary topics (History, Geography, Natural Science) to ensure authenticity and proximity to students.

Step 2: Pedagogical processing of data sources. Teachers clean and simplify complex parameters to suit the level of Grade 8 students but still retain the "problematic" nature (such as outliers, abnormal discrepancies) to stimulate critical thinking.

Step 3: Designing competency-oriented question chains. The question system is built according to 4 groups:

Activation Question Group (problem detection): Requires overall observation to identify contradictions.

Strategic Question Group (proposing solutions): Requires selecting appropriate tools and charts.

Technical Question Group (implementing solutions): Requires performing calculations and drawing charts.

Critical Question Group (evaluating and explaining): Requires connecting mathematical results with the practical context.

Step 4: Appraisal and optimization. Review the difficulty, feasibility, and openness of the exercise before introducing it into teaching.

c) Illustrative example: Topic "Social media and user habits"

Context: Based on the "Digital 2024: Vietnam" report on the percentage of users of social media platforms (Facebook: 89.7%; Zalo: 88.5%; TikTok: 77.8%, etc.).

Organization method:

Activity 1 (Problem detection): The teacher requests students to sum the percentages and comment. Students will detect a sum greater than 100%, thereby recognizing this as "multiple-choice" data (one person uses multiple applications).

Activity 2 (Proposing solutions): The teacher asks: "With a sum greater than 100%, is a pie chart suitable?". Students analyze and propose using a column chart for comparison.

Activity 3 (Implementing solutions): Students use calculators or Excel software to draw a column chart showing the top 5 social media platforms.

Activity 4 (Evaluating): Students rely on the chart to compare the positions of Zalo and Facebook, thereby making judgments about social media usage trends in Vietnam.

3.3.3.2. Measure 2: Organizing experiential teaching activities to create opportunities for developing mathematical problem-solving competency

Purpose of the measure

This measure aims to create a positive learning environment where students are placed in problematic situations and participate actively in the statistical process. Activities such as investigation and experimentation help shift the role of students from passive recipients to active constructors of knowledge.

Implementation method

Teachers organize diverse teaching forms:

- **Field Investigation and survey Activities (Statistics):** Students step out of the classroom to collect primary data, facing practical issues such as missing data and inconsistent data.
- **Experiments and simulation Games Activities (Probability):** Using physical tools or software to create random situations, helping students form probabilistic intuition and verify theories.
- **Small project-based teaching:** Students solve complex problems over a long period (such as financial projects, meteorological projects), performing the complete cycle from collection to reporting.

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Illustrative example: Investigation activity "Means of transport to school and travel time"

Problem: "Which means of transport helps students arrive at school more on time and safely?"

Organization method:

Phase 1: Task assignment (Activation). The teacher divides groups, guides students to identify variables (means, time, number of times late), and design survey forms.

Phase 2: Implementation (Execution). Students proceed to collect real data from classmates; clean data (remove invalid forms); create frequency tables; calculate the mean/median travel time of each type of transport.

Phase 3: Reporting and discussion (Evaluation). Groups present results using charts; debate the reliability of data; and make recommendations on choosing means of transport to ensure punctuality.

3.3.3.3. Measure 3: Using teaching aids and supporting information technology

Purpose of the measure

Integrating information technology (such as handheld calculators, spreadsheet software, simulation software) aims to: optimize the processing of large data so students can focus on analytical thinking; visualize statistical objects; and create virtual experimental environments to verify probabilistic hypotheses (Law of Large Numbers).

Implementation method

Teachers guide students to use technology according to the problem-solving process:

- *Problem detection phase:* Use Google Forms/Microsoft Forms to collect and diagram data quickly.
- *Solution execution phase:* Use Excel or handheld calculators to calculate statistical parameters (mean, standard deviation) accurately and draw charts.
- *Evaluation phase:* Use simulation software (such as GeoGebra) to perform thousands of random trials, helping to verify experimental results.

Illustrative example: Applying Excel to select the optimal chart

Problem: "Spending structure of Grade 8 students in 1 week".

Organization method:

Step 1 (Standardization): Students enter group spending data into Excel, converting to percentage proportions.

Step 2 (Testing): The teacher requests students to use Chart Tools to draw both a pie chart and a 100% stacked column chart for the same dataset.

Step 3 (Selection and Analysis): Students observe and compare: Which chart helps compare spending structure between groups more easily? (Result: Stacked column charts are usually superior when comparing multiple objects). From there, students decide to choose the most suitable chart for reporting.

Illustrative example: Using handheld calculators to evaluate the degree of variation

Problem: "8,000 steps/day challenge".

Organization method:

Step 1: Students collect step count data for 5 days.

Step 2: Enter data into statistical mode (Statistics/1-VAR) on a handheld calculator (e.g., Casio fx-580VN X).

Step 3: The calculator outputs indicators: arithmetic mean ($\bar{x}$), maximum value (max), minimum value (min).

Step 4: Students use these indicators to evaluate: Which student has more stable performance (based on the range $R = \max - \min$)? Which student achieves the average goal? Instead of wasting time on manual addition and subtraction, students focus on interpreting the meaning of the numbers.

4. CONCLUSION

The study has systematized the theoretical and practical basis for teaching Grade 8 Statistics and Probability content oriented towards developing mathematical problem-solving competency. The status survey results show that although teachers have a correct perception of the innovation requirements, practical implementation still faces many barriers due to a shortage of real-world resources and limitations in exploiting technological tools.

To overcome the above limitations, the article has proposed three synchronous pedagogical measures: (1) Constructing a system of questions and exercises attached to practical contexts; (2) Organizing diverse experiential activities (investigation, experimentation, projects); and (3) Enhancing the use of teaching aids and information technology. These measures do not operate in isolation but support each

other in the problem-solving process: practical context creates motivation, experiential activities create an operational environment, and technology plays the role of a cognitive tool helping to optimize the data processing process.

From the research results, the author proposes several recommendations: (1) Teachers need to proactively build a digital learning resource warehouse attached to reality and frequently update new statistical data; (2) Schools need to create conditions regarding facilities (computer rooms, projection equipment) so that the application of technology in teaching Statistics and Probability becomes a regular activity; (3) It is necessary to continue expanding research on forms of assessing problem-solving competency through learning projects or major assignments instead of relying solely on traditional written tests.

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