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ORIGINAL

Postgraduate Students' Problem-Solving Behaviour through Research Skill Development (RSD) Framework in Research Methodology Course: Case Study in Indonesia and Malaysia

El comportamiento de resolución de problemas de los estudiantes de posgrado a través del marco de desarrollo de habilidades de investigación (RSD) en el curso de metodología de la investigación: estudio de caso en Indonesia y Malasia

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ABSTRACT

Problem-solving ability is a crucial skill for postgraduate students, playing a vital role in research success, particularly in designing, conducting, and evaluating research. However, many students encounter difficulties during the process, such as determining a viable research topic, selecting suitable methods, and accurately interpreting data. The problem-solving behaviors that students exhibit could potentially influence their level of research skills within the Research Skill Development (RSD) framework, which offers six key aspects for developing research skills. This study aimed to explore the relationship between graduate students' problem-solving behaviours and their research skills based on the RSD framework. The study involved eight students from two universities in Malaysia and Indonesia. Data were collected through problem-solving tests and semi-structured interviews. The RSD framework was used to assess the students' level of research skills, which included aspects such as planning, conducting, and evaluating research. Analysis was conducted to identify patterns of problem-solving behaviours associated with the level of RSD. The results showed that students with more sophisticated problem-solving behaviours achieved higher levels of research skills in the RSD framework. Recommendations are provided for the development of more effective programmes so that students can be better prepared to face challenges in the academic and professional world.

Keywords: Problem-Solving Behaviour; Postgraduate Students; Research Skill Development; Thematic Analysis.

RESUMEN

La capacidad de resolución de problemas es una habilidad esencial para los estudiantes de posgrado que desempeña un papel importante en el éxito de la investigación, especialmente en el diseño, la realización y la evaluación de la misma. Sin embargo, muchos estudiantes experimentan dificultades en el proceso, como determinar un tema de investigación viable, elegir los métodos adecuados e interpretar los datos con precisión. Los comportamientos de resolución de problemas que muestran los estudiantes podrían influir en su nivel de habilidades de investigación dentro del marco de desarrollo de habilidades de investigación (RSD), que ofrece seis aspectos clave para desarrollar dichas habilidades. El objetivo de este estudio era

explorar la relación entre los comportamientos de resolución de problemas de los estudiantes de posgrado y sus habilidades de investigación basadas en el marco RSD. En el estudio participaron ocho estudiantes de dos universidades de Malasia e Indonesia. Los datos se recopilaron mediante pruebas de resolución de problemas y entrevistas semiestructuradas. Se utilizó el marco RSD para evaluar el nivel de habilidades de investigación de los estudiantes, que incluía aspectos como la planificación, la realización y la evaluación de la investigación. Se realizó un análisis para identificar patrones de comportamientos de resolución de problemas asociados con el nivel de RSD. Los resultados mostraron que los estudiantes con comportamientos de resolución de problemas más sofisticados alcanzaron niveles más altos de habilidades de investigación en el marco RSD. Se ofrecen recomendaciones para el desarrollo de programas más eficaces, de modo que los estudiantes puedan estar mejor preparados para afrontar los retos del mundo académico y profesional.

Palabras clave: Comportamiento de Resolución de Problemas; Estudiantes de Posgrado; Desarrollo de Habilidades de Investigación; Análisis Temático.

INTRODUCTION

Problem-solving is an essential skill for graduate students.[1,2,3] Problem-solving has become a significant focus of the curriculum in many countries.[4,5] If students possess good problem-solving skills, they can find solutions to the difficulties they face in everyday life.[6,7,8] Postgraduate programmes that lead to a master's degree are obliged to develop problem-solving skills to a higher level compared to undergraduate programmes. Problem-solving ability can be trained or developed as it is not an innate ability. However, achieving problem-solving ability requires cognitive, affective, and psychomotor processes, which in theoretical studies are collectively referred to as problem-solving behavior.[6,9]

Research methodology is one of the courses that can help graduate students develop their problem-solving skills.[10,11] First-year students contract this course. The competencies gained from research methodology courses in postgraduate programs are different from those in undergraduate programs. In the postgraduate programme, the focus is more on how prospective master's students design proposals for each type of research and conduct mini-thesis research. The approach used in the learning process is project-based learning. This approach also helps the university achieve its key performance indicators. In the given project, students are required to understand the problem, determine the method, conduct research, and evaluate the research process that has been carried out. These steps are closely related to the indicators of problem-solving behaviour proposed by Muir[12]. According to Muir[12], a person possesses good problem-solving skills when they can understand the structure of the problem, use appropriate strategies, demonstrate metacognition, conceptual understanding, and interpret information effectively.

The difficulties faced by students in making research proposals and carrying out mini-research include: (1) determining problems that are worth researching, (2) choosing the proper research method, (3) developing good research instruments, (4) analysing data, and (5) carrying out research carefully.[13,14] These difficulties cause students to struggle with writing a thesis.[15] This has an impact on their ability to complete their studies.[13,14] Various studies have examined and provided solutions to students' difficulties in research methodology courses. For example, (1) Pfeffer et al.[16] Research combined active learning and discussion learning methods and focused on challenges and rewards in the learning process (2) Shahsavar et al.[17] Research identified students' difficulties in the research process in research courses and applied various collaborative learning strategies, and (3) Noviarni[18] Research applied guided assignments and exercises to help students overcome learning difficulties in research courses.

The lecturers of this course have also implemented various learning strategies, but there are still difficulties in conducting research. Therefore, this research integrates a framework suitable for project-based learning. The chosen framework is the Research Skill Development (RSD) framework. The RSD framework was first designed in 2006 and updated in 2018.[19] The RSD framework offers six aspects and five autonomous dimensions, namely: (1) initiate/clarify, (2) discover/produce, (3) evaluate/reflect, (4) organise/manage, (5) synthesise/analyse, and (6) apply/apply. The RSD framework has been trialed in various countries, including Australia, the United States, Pacific countries, Cambodia, and the United Kingdom.[20] The RSD framework is suitable for undergraduate students, working graduates, postgraduate students, and doctoral students.[21,22] RSD frameworks can also help develop research skills, problem-solving, critical thinking, and other higher-order skills. RSD frameworks are also suitable for integration in project-based.[23,24] However, there is a significant gap in the literature exploring the application of RSD in developing countries. Although previous research demonstrates the benefits of RSD in helping students plan, conduct, and evaluate research, very few studies have examined the adaptation and implementation of this framework in educational contexts in developing countries. Further research is needed to understand how RSD can be effectively integrated into curricula in countries with academic challenges.

Therefore, this study sheds light on how graduate students' problem-solving behaviour is related to the student level in the RSD framework in universities in developing countries.

In this study, researchers will explore six aspects based on the RSD framework. Students observe their skills and abilities by using a problem-solving behaviour rubric. Researchers have developed the problem-solving behaviour rubric by reviewing the affective aspects of Knowledge ownership, self-control, self-confidence, and affective.[6] In the aspect of Knowledge ownership, it is observed how students solve research problems, the use of prior Knowledge in research, variations in methods used for problem-solving, and verbal communication in problem-solving by applying Polya's Heuristic strategy. Self-control was used to examine their metacognitive thinking. In terms of the belief aspect, students' perceptions of the plan's implementation, their beliefs about the strategy used, and affective aspects related to their self-confidence were also investigated. This study aims to describe the relationship between problem-solving behaviour and the level of postgraduate students based on the RSD framework at Universitas Negeri Padang and Sultan Idris University of Education.

METHOD

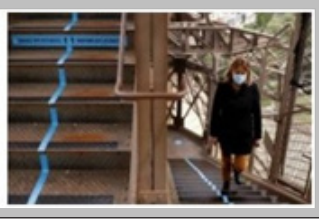
Participants

The sample selection method used in this study was purposive sampling, involving four postgraduate students from a university in Malaysia and four doctoral students from Universitas Negeri Padang who had completed the research methodology course. The selection of doctoral students from two different universities and countries was based on several strategic considerations and academic relevance. Both universities have a strong reputation in education and research, ensuring that participants have a sufficient educational background to participate in this research. The different cultural contexts and education systems between Malaysia and Indonesia provided rich variations in the research data. This not only enriched the research findings but also provided greater insight into the problem-solving behaviours and research skills of postgraduate students in different educational settings. Thus, the collaboration between UPSI and UNP can significantly contribute to the academic literature and educational practices in both countries.

Tasks

Postgraduate students were given a test consisting of three mathematical problem-solving problems to assess their problem-solving behaviour. Three problems containing indicators of problem-solving behaviour that have gone through a validation process with a difficulty level that has been adjusted to the ability of the selected participants, and the potential for problems to be answered with various strategies such as using equations, measuring the height of an object, and finding patterns or areas. These problems are of a non-routine type, and experts have validated their suitability through the results of validation, as well as supported by colleagues involved in the study. Meanwhile, to see the level of RSD, students were asked to prepare themselves to present project assignments in the research methodology course. The results of the question validation are presented in table 1.

Table 1. Mathematical Problem Solving: Problems and Validation Results

No	Problem	Average Validation Results		Category
		Validator 1	Validator 2	
1	Mr Arya has several rabbits and several cages. When Mr. Arya places two rabbits in each cage, it turns out that one rabbit is left over and does not get a cage. When Mr Arya places three rabbits in each cage, it turns out that there are two free cages. How many rabbits?	5	4,75	Valid
2	Pak Budi owns a company that is engaged in large-scale chicken farming. To feed the chickens, Pak Budi's company grows its corn in a rectangular garden measuring 538 m x 114 m. Illustrate the garden after planting the corn! How much corn does Pak Budi's company plant to feed his chickens if the distance between the corn plants must be 100 cm x 40 cm! Illustrate the garden after planting corn!	5	5	Valid
3	The Eiffel Tower is one of the most famous tourist attractions in France. If you were in the area of the Eiffel Tower and wanted to measure its height, what would you do?  	5	5	Valid

Procedure

Data on problem-solving behaviour was collected using instruments consisting of test questions and semi-structured interviews.[25] The test questions were used to measure students' understanding and application of problem-solving strategies. In contrast, the interviews were used to delve deeper into their thought processes and attitudes when solving problems. This was done because it is often challenging to identify difficulties experienced in solving problems from written results.[26] Therefore, it is essential to conduct oral interviews. Furthermore, data analysis was performed by describing the results and categorizing students' problem-solving behavior based on the rubric of problem-solving behavior[12] in table 2.

Data to determine students' level in the RSD framework was collected using a different procedure from the one used to collect data on problem-solving behaviour. The students were assigned a project in the research methodology course and then presented it. Data were collected through the RSD framework,[20] as well as semi-structured interviews.[25] Aimed at exploring students' experiences and reflections during the project completion process. In addition, the RSD framework was used to categorise students' levels based on the indicators set out in the RSD framework, such as the application of idea generation steps, use of appropriate methodology, level of data accuracy, organisation of information, and other research steps. After data collection, analysis was carried out to evaluate the level of students' ability to solve problems and provide a clear picture of the development of students' abilities based on the RSD framework in figure 1.

After collecting data on problem-solving behaviour categories and student levels based on the RSD framework, the next step is to analyse the results obtained to identify patterns and relationships between problem-solving behaviour and the levels achieved by students. The analysis was conducted by comparing the scores obtained from the rubric of problem-solving behaviour and the application of the RSD steps. After the study was completed, conclusions were drawn based on the findings that showed the relationship between the problem-solving behavior exhibited by the students and their level, as determined by the RSD framework.

Data Analysis

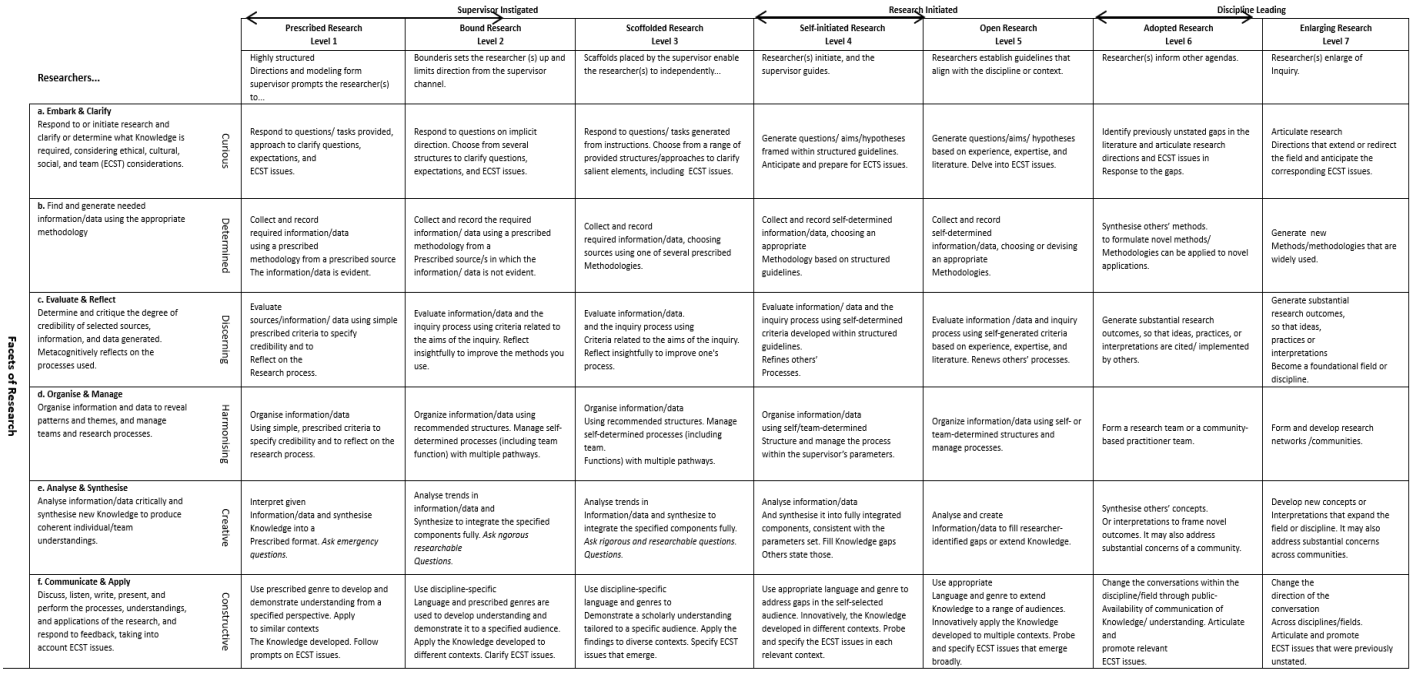
The rating scale in table 2 was used to classify each student's response in terms of utilizing prior Knowledge, employing diverse problem-solving methods, cognitive thinking in mathematical problem-solving, and conformity with Polya's four-stage heuristic model. The assessment of the level of understanding and efficiency in selecting and executing the plan did not depend on the correctness of the answer. For each of the three problems, the recorded information related to the strategies used by each student, their respective ratings for each section of the scale in table 2, their level of confidence in solving the problem, and their communication and trust in outlining similar problems or alternative ways to solve them. This study re-analysed the data with a focus on how each student solved the three issues to check the consistency of individual problem-solving behaviour. Each student counted the number of correct answers and the frequency of their strategy use. The data were then further analyzed to categorize the students' problem-solving behavior. There are three categories of problem-solving behaviour, namely naive, routine, and sophisticated.

Table 2. Problem-Solving Behaviour Rubric

Behaviour Categories		
Naïve	**Routine**	**Sophisticated**
Employs coping strategies such as manipulating numbers	Implements a strategy in a systematic manner	Generates own strategies
Relies on one or two strategies	Does not adapt or switch strategies if one is not working	Willing to use a variety and combination of strategies
Metacognitive thinking is not displayed in written or verbal communication.	Metacognitive thinking is displayed verbally	Metacognitive thinking is evident in written and verbal responses
Errors occur at any and/or all four stages of problem solving	No attempt is usually made to verify the solution	Scores highly for each of the four stages of Polya's heuristic plan and verifies the solution.
Cannot articulate having solved a similar problem before	Can identify a similar problem, but not necessarily based on mathematical structure	Identifies identical issues according to their mathematical structure
Written communication is usually inadequate.	Written and verbal	Written communication is usually inadequate
Often uses the same method to solve all problems	Focuses on one way to solve the problem	Identifies alternative ways to solve problems
Equates confidence with achieving the answer quickly	Often expresses a lack of confidence in problem-solving ability	Display confidence in problem-solving ability

Learners with naive behaviour tend to use limited and straightforward approaches, often relying on just one or two basic strategies without fully understanding the underlying concepts, which makes it difficult for them to solve more complex problems. On the other hand, learners with routine behaviour show persistence in using the same strategies even though they are not always successful, and they tend to follow established procedures without critically evaluating the resulting solutions. Meanwhile, learners with sophisticated behaviour can recognise patterns in problems, apply various strategies with flexibility, and show good metacognition skills, such as monitoring and evaluating their problem-solving process. Thus, the understanding and application of more complex strategies, as well as the ability to adapt to new situations, are key indicators of higher levels of problem-solving ability. To determine whether individuals exhibit consistent behavior across problems, each individual's approach to solving each problem is examined, and their behavior is then classified based on descriptions of naive, routine, and sophisticated problem solvers. Frequency counts were used to document the occurrence of specific behaviours.

The Research Skill Development (RSD) framework.[20] Figure 1 provides a guideline for determining a graduate student's level of managing and directing their research process. The RSD framework can be operationalised as task-specific assessment criteria in a matrix (rubric) structured around six aspects; it provides a breakdown of grades for tasks, clarifying expectations for tasks at specific year levels and levels of autonomy.[20,27] The RSD framework identifies six critical aspects of the research process, encompassing different levels of student autonomy in conducting research.[19] The identification is conducted by examining the steps students take in response to the project assignments presented to them. The aspects assessed were the ability to formulate a research question, collect information and data, analyse and interpret the data collected, integrate information from multiple sources to build an argument, assess the quality and relevance of the information, and communicate the research findings effectively to relevant audiences. There is also an assessment of how much mentoring students do, how many decisions they make themselves, and the extent to which students can manage the research process. The postgraduate students were asked to reflect on their research experience. Based on the projects and interviews, they were categorised against the RSD framework by five reviewers. The researchers' categorisation results were recorded, and then all the data was collected. The results of the data collection served as the basis for determining the students' level of RSD.



Facets of Research		Supervisor Instigated			Research Initiated		Discipline Leading	
		Prescribed Research Level 1	Bound Research Level 2	Scoffolded Research Level 3	Self-initiated Research Level 4	Open Research Level 5	Adopted Research Level 6	Enlarging Research Level 7
Researchers...		Highly structured Directions and modeling form supervisor prompts the researcher(s) to...	Bounderis sets the researcher (s) up and limits direction from the supervisor channel.	Scaffolds placed by the supervisor enable the researcher(s) to independently...	Researcher(s) initiate, and the supervisor guides.	Researchers establish guidelines that align with the discipline or context.	Researcher(s) inform other agendas.	Researcher(s) enlarge of Inquiry.
a. Embark & Clarify Respond to or initiate research and clarify or determine what Knowledge is required, considering ethical, cultural, social, and team (ECST) considerations.	Curious	Respond to questions/ tasks provided, approach to clarify questions, expectations, and ECST issues.	Respond to questions on implicit direction. Choose from several structures to clarify questions, expectations, and ECST issues.	Respond to questions/ tasks generated from instructions. Choose from a range of provided structures/approaches to clarify salient elements, including ECST issues.	Generate questions/ aims/hypotheses framed within structured guidelines. Anticipate and prepare for ECTS issues.	Generate questions/aims/ hypotheses based on experience, expertise, and literature. Delve into ECST issues.	Identify previously unstated gaps in the literature and articulate research directions and ECST issues in Response to the gaps.	Articulate research Directions that extend or redirect the field and anticipate the corresponding ECST issues.
b. Find and generate needed information/data using the appropriate methodology	Determined	Collect and record required information/data using a prescribed methodology from a prescribed source The information/data is evident.	Collect and record the required information/ data using a prescribed methodology from a Prescribed source/s in which the information/ data is not evident.	Collect and record required information/data, choosing sources using one of several prescribed Methodologies.	Collect and record self-determined information/data, choosing an appropriate Methodology based on structured guidelines.	Collect and record self-determined information/data, choosing or devising an appropriate Methodologies.	Synthesise others' methods. to formulate novel methods/ Methodologies can be applied to novel applications.	Generate new Methods/methodologies that are widely used.
c. Evaluate & Reflect Determine and critique the degree of credibility of selected sources, information, and data generated. Metacognitively reflects on the processes used.	Discerning	Evaluate sources/information/ data using simple prescribed criteria to specify credibility and to Reflect on the Research process.	Evaluate information/data and the inquiry process using criteria related to the aims of the inquiry. Reflect insightfully to improve the methods you use.	Evaluate information/data. and the inquiry process using Criteria related to the aims of the inquiry. Reflect insightfully to improve one's process.	Evaluate information/ data and the inquiry process using self-determined criteria developed within structured guidelines. Refines others' Processes.	Evaluate information /data and inquiry process using self-generated criteria based on experience, expertise, and literature. Renews others' processes.	Generate substantial research outcomes, so that ideas, practices, or interpretations are cited/ implemented by others.	Generate substantial research outcomes, so that ideas, practices or interpretations Become a foundational field or discipline.
d. Organise & Manage Organise information and data to reveal patterns and themes, and manage teams and research processes.	Harmonising	Organise information/data Using simple, prescribed criteria to specify credibility and to reflect on the research process.	Organize information/data using recommended structures. Manage self-determined processes (including team function) with multiple pathways.	Organise information/data Using recommended structures. Manage self-determined processes (including team. Functions) with multiple pathways.	Organise information/data using self/team-determined Structure and manage the process within the supervisor's parameters.	Organize information/data using self- or team-determined structures and manage processes.	Form a research team or a community-based practitioner team.	Form and develop research networks /communities.
e. Analyse & Synthesise Analyse information/data critically and synthesise new Knowledge to produce coherent individual/team understandings.	Creative	Interpret given Information/data and synthesise Knowledge into a Prescribed format. *Ask emergency questions.*	Analyse trends in information/data and Synthesize to integrate the specified components fully. *Ask ngorous researchable Questions.*	Analyse trends in Information/data and synthesize to integrate the specified components fully. *Ask rigorous and researchable questions. Questions.*	Analyse information/data And synthesise it into fully integrated components, consistent with the parameters set. Fill Knowledge gaps Others state those.	Analyse and create Information/data to fill researcher-identified gaps or extend Knowledge.	Synthesise others' concepts. Or interpretations to frame novel outcomes. It may also address substantial concerns of a community.	Develop new concepts or Interpretations that expand the field or discipline. It may also address substantial concerns across communities.
f. Communicate & Apply Discuss, listen, write, present, and perform the processes, understandings, and applications of the research, and respond to feedback, taking into account ECST issues.	Constructive	Use prescribed genre to develop and demonstrate understanding from a specified perspective. Apply to similar contexts The Knowledge developed. Follow prompts on ECST issues.	Use discipline-specific Language and prescribed genres are used to develop understanding and demonstrate it to a specified audience. Apply the Knowledge developed to different contexts. Clarify ECST issues.	Use discipline-specific language and genres to Demonstrate a scholarly understanding tailored to a specific audience. Apply the findings to diverse contexts. Specify ECST issues that emerge.	Use appropriate language and genre to address gaps in the self-selected audience. Innovatively, the Knowledge developed in different contexts. Probe and specify the ECST issues in each relevant context.	Use appropriate Language and genre to extend Knowledge to a range of audiences. Innovatively apply the Knowledge developed to multiple contexts. Probe and specify ECST issues that emerge broadly.	Change the conversations within the discipline/field through public-Availability of communication of Knowledge/ understanding. Articulate and promote relevant ECST issues.	Change the direction of the conversation Across disciplines/fields. Articulate and promote ECST issues that were previously unstated.

Figure 1. Researcher Skill Development Framework

RESULTS

Result Problem-Solving Behaviour of Indonesian and Malaysian Postgraduate Students

Table 3 presents the results of identifying the problem-solving behavior of postgraduate students in Indonesia. Of the four Indonesian students who participated in this study, there are two doctoral students whose problem-solving behaviour is routine (EE and FN), one sophisticated student (UFA), and one student (Naive). UFA demonstrated a good ability to understand the problem, plan the solution, and execute the necessary steps. They were able to communicate answers clearly and had high confidence. In addition, UFA demonstrated good metacognitive skills, although it sometimes remained focused on a single solution method

and lacked flexibility in adapting to other strategies. For EE and FN, they have shown more structured problem-solving behaviour, although they still rely on familiar methods. EE and FN have been able to solve problems systematically but have not demonstrated innovation or variation in their approach. UFI, on the other hand, tends to use simpler approaches and often relies on guesswork or unstructured methods. Students in this level also show confidence in answering, but lack in-depth understanding of the problem at hand, and are unable to adapt to other methods when requested.

Table 3. Category of Problem-Solving Behavior for Postgraduate Students

Country	Naive	Routine	Sophiticated
Indonesia	UFI	FN	UFA
	UFI	EE	
Malaysia	KCL	KNBA	NAB
			SHN

As for the 4 Malaysian students who participated, there were two sophisticated students (SHN and NAB), one routine category (KNBA), and one naive category (KCL). For SHN and NAB, students in the sophisticated category demonstrated a high ability to understand and analyze the problem. Students can plan effective solutions, employ various strategies, and communicate their answers. Their metacognitive skills are seen in the ability to reflect on the problem-solving process and adjust their approach as needed. They demonstrated high confidence and effectively explained the reasoning behind the strategies employed. KNAB students showed more structured problem-solving behaviour. KNAB was also able to solve problems systematically but tended to rely on familiar methods and showed less innovation in their approach. While students may reach the correct solution, they may not always consider alternatives or more effective strategies. In addition, KCL students often employ a more straightforward approach and frequently rely on guesswork or unstructured methods. KCL already had confidence in answering but lacked an in-depth understanding of the problem at hand. Limitations in flexibility and adaptation to problem-solving strategies became a challenge for him.

RSD Framework Level Description

Indonesian Postgraduate Students

The description of the ability of Indonesian postgraduate students, based on the RSD framework, is presented in table 4. This data is based on the assessment of six aspects and five autonomous dimensions of the RSD framework. Based on the results of observations and interviews with the reviewer.

Table 4. Indonesian students' level based on the Research Skill Design (RSD) framework

No	Student	Reviewer	Average Level from Reviewer	RSD Level
1	UFA	SH	4,7	4
		YL	3,7	
		AQ	4,1	
		AN	4,4	
		FZ	3,5	
2	UFI	SH	4,7	3
		YL	1,7	
		AQ	3,9	
		AN	3,9	
		FZ	1,7	
3	EE	SH	4,4	5
		YL	5,1	
		AQ	5,4	
		AN	5,1	
		FZ	4,6	
4	FN	SH	4,5	4
		YL	2,5	
		AQ	3,2	
		AN	5,7	
		FZ	4,2	

UFA

At the RSD level, UFA is at level 4, where UFA determines research ideas by proposing and is guided and assisted by the supervisor's direction. UFA's research objectives analyse students' errors based on Newman's error theory. UFA obtained this research objective based on expertise and literature from previous theses or articles. This research employed a qualitative approach and descriptive research design. UFA chose this research method independently and sought a suitable methodology based on structured guidelines.

The guidelines were appropriate to the research based on the literature. The results of the analysis were evaluated as the research progressed to improve the process used. When collecting data, the UFA identifies sources of research information, collects data using a self-defined structure, and organises the process. The research proposed or presented is an analytical study that aims to examine student errors based on the theory of student error. The results of this research were obtained on a specific subject and can be utilized by educators in the school where the research was conducted.

Ob: Why did you choose qualitative and descriptive research methodology?

UFA: I chose a qualitative and descriptive research approach, based on the articles I read for reference.

Ob: How do you ensure the data you get is correct?

UFA: After getting the data from the test, I rechecked the test results with the school teacher. Additionally, I interviewed the students again regarding their test results.

Ob: Who is included in this data collection?

UFA: The maths subject teacher needs to find a sample that suits the purpose of the study. I also involved experts to validate the questions before conducting the test.

Ob: What are the benefits of your research?

UFA: This research is helpful for teachers at school as an evaluation and reflection material in designing future learning.

UFI

Based on the levels in the RSD framework, UFI is at level 3, where restrictions and directions from the supervisor guide UFA in determining research ideas. UFI's research objective is to examine the effect of using interactive media, specifically quiz applications, on student learning achievement. UFI determined the research objectives to investigate the impact of quizzes on student learning outcomes at SMA N 8 Padang, based on the structure directed by the supervisor. UFI searched for data from sources that were self-reported and employed a methodology consistent with the research, namely a quantitative approach. The results of the analysis were evaluated against the research objectives using the N-Gain test. When collecting data, UFI organised the data collection process itself and used the recommended structure. The results were also self-organised based on the methodology and data collection process. Furthermore, UFI has employed appropriate language and structure to demonstrate a scientific understanding and apply the findings to the learning process. UFI's research results demonstrate the benefits of using interactive media in the learning process, which can improve student learning outcomes in mathematics.

Ob: What research methods did you use in conducting this research?

UFI: To assess and analyze the improvement in students' learning achievement, a quantitative method is used.

Ob: Are you sure that's the correct approach, or is there an alternative method?

UFI: I don't think there is any other way, and I'm sure this method is the one used.

Ob: How are you sure this method is correct?

UFI: I believe that based on the results of the data analysis you have done, the research data is correct.

Ob: You have conducted the research and drawn your conclusions. Now, how do you conclude?

UFI: Based on the calculation using N-gain, there is a 72,92 % increase in learning outcomes, indicating a significant improvement.

Ob: What do you think are the benefits of the research you have done?

UFI: The benefits of this research are primarily for educators, as it provides information on how the use of quizzes can improve learning outcomes.

EE

For the RSD level, EE is at level 4, where in this category, EE is more guided by the discipline and context, as evidenced by the paper presented, which focuses on ethnomathematics. In generating ideas, EE said he read other people's research studies on ethnomathematics and then linked them to ethnomathematics in the foods of the area where he lives, creating questions/goals/hypotheses based on his experience, expertise, and the literature, by gathering information from various sources. Collect and record self-

determined information/data, and select and plan an appropriate methodology based on reading sources from existing articles. Evaluate the information/data and the inquiry process using self-defined criteria based on experience, expertise, and literature by analysing the shapes of traditional foods based on expertise in mathematics education. EE analyses the relationship between conventional foods and mathematics. EE organizes information/data using a self- or team-defined structure and organizes the process where EE makes observations and documents typical West Sumatran foods, then examines whether mathematical ideas are contained therein. Analyze and create information/data to fill gaps identified by researchers or increase Knowledge where existing papers suggest that no one has studied ethnomathematics in a particular area. The researcher then undertakes the study, innovatively applying the developed Knowledge to a different context, namely their domicile.

Ob: How can you assure that your data is correct?

EE: In this research, I purchased the traditional food that I had researched.

Ob: How do you determine the methodology used?

EE: The methodology is derived from the articles I read and aligns with my research idea.

Ob: Who is involved in this research?

EE: For this research, I did it myself and was assisted by guidance from my lecturer.

Ob: You've done your research and concluded. Then, how did you make that conclusion?

EE: Conclusions are made based on the results of the research. Then, the conclusion is made.

Ob: Can the research that has been conducted fill the gaps that exist in previous research? And what are the benefits of the results of this research?

EE: Yes, this research has the main benefit of making classroom mathematics learning more contextualised with classroom learning.

FN

FN is classified at RSD level 4. FN in choosing ideas, FN is more likely to propose, and the mentor directs. Creating questions/objectives/hypotheses based on structured guidelines, where FN presented a paper with the theme of analysing students' mathematical problem-solving skills. FN formulated her goal based on the existing structure by using Polya's steps. FN Collects and records self-determined information/data, selects appropriate methodology based on structured guidelines by reading a paper, and then follows the procedure/methodology in the paper. FN also evaluated the information and data/data and the investigation process, using criteria that she had developed and chosen based on structured guidelines. FN used rubrics to assess students' problem-solving skills against guidelines that others had reviewed. FN organizes information/data using a self-determined or team-determined structure and organizes the process using guiding parameters, i.e., existing parameters. For example, to analyse problem-solving ability, FN only looks at how students understand the problem, plan strategies, implement the problem-solving approach, and re-evaluate. FN also analyzes information and data, synthesizing them into fully integrated components that are consistent within their parameters. In the gap section, FN employs appropriate language and flow to address the gap in the self-selected audience, specifically in the case presented by FN, which involves choosing a Boarding School for Algebra Material. This topic is still rarely researched by others.

Ob: Why did you choose a qualitative research method?

FN: I chose qualitative research because it aligns with my research idea and has sufficient samples to support its conduct.

Ob: How can you be sure your research data is correct?

FN: I have an article as my reference for conducting research, so that the data obtained is based on an explicit and systematic approach. Therefore, this research data is correct.

Ob: Who is involved in this data collection?

FN: I did the data collection by myself.

Ob: Can the conclusions of your research fill the gaps that exist in previous research? Or do you have new findings?

FN: I concluded from the research results obtained, including the quiz results.

Malaysia Postgraduate Student

Before presenting the results of a more in-depth analysis, table 5 below provides a clear picture of the distribution of research skill levels among students, covering various aspects such as problem understanding, solution strategies, and solution implementation. This data is drawn from the observations and interviews that have been conducted.

Table 5. Malaysian postgraduate students' level based on the Research Skill Design (RSD) framework

No	Student	Name	Average Level from Observer	RSD Level
1	KNBA	SH	5,2	5
		YL	5,2	
		AQ	5,1	
		AN	5,8	
		FZ	6,0	
2	KCL	SH	2,8	3
		YL	2,8	
		AQ	3,0	
		AN	3,0	
		FZ	3,0	
3	SHN	SH	4,8	5
		YL	5,8	
		AQ	4,8	
		AN	6,0	
		FZ	5,7	
4	NAB	SH	3,8	3
		YL	2,4	
		AQ	3,2	
		AN	2,1	
		FZ	1,7	

KNBA

For the RSD level, KNBA is at level 5, where KNBA determines research ideas guided by discipline or context. Objectives were chosen based on experience and expertise because KNBA is a teacher in one of the elementary schools. KNBA searches for information independently and determines the methodology suitable for the research being conducted. KNBA also evaluated the research results based on his teaching experience in elementary school. The research results are also self-organized based on the methodology and data collection process determined. The research proposed or presented is a development study that aims to analyze and create information/data to fill gaps identified by researchers or increase Knowledge. As stated by KNBA, similar research has been conducted before, but no one has incorporated videos that utilize music into the material being developed. Furthermore, KNBA has employed appropriate language and structure to expand the Knowledge of its target audience. Innovatively apply the developed Knowledge to different contexts, as the research conducted is utilized in the classroom learning process.

Ob: How did you conceive the idea for this research?

KNBA: I have been teaching in primary schools, and I have also made observations related to teachers' use of IT media. Most of what I found was that they did not utilize IT media. They teach traditionally using rote methods, so many students do not fully understand the material they learn. From here, I got the idea to create an IT-based learning medium called Math Drawing.

Ob: The research methodology you used was development research. How did you choose this research method?

KNBA: I got this research method from my supervisor. I chose this method after discussing it with my supervisor.

Ob: How do you ensure that the results of your research are correct?

KNBA: I conducted research with three schools with 76 students as respondents. The students have diverse backgrounds, including some from the city and others from outside the city. This media was then trialed at the school by teachers, along with the assessment. The teacher who conducted the trial also gave positive comments regarding the media that was trialled.

Ob: In the learning video included in the media, there is music. Is there any literature that supports the effect of using music in the learning process?

KNBA: For the use of music in learning videos, there is no separate literature.

Ob: How do you think it benefits others?

KNBA: Being a guide for teachers to change their views on the use of IT-based media and provide options for teachers to vary the use of learning media.

KCL

Based on the average level given by the reviewers, KCL is at level 3 for the RSD framework. KCL relied on ideas provided by peers and did not propose her ideas. KCL described and answered the questions based on an array of ideas that were already available; at the time of explaining KCL, it was still not very familiar with the proposed research idea. In describing the concept or recommended methodology, KCL sought help from colleagues to explain, as the proposed idea and methodology had been previously provided and investigated by peers in preparation for the research presentation. Organising information/data using the structure recommended by teammates and without hesitation in explaining the data information when presenting the research idea. When asked about data analysis, KCL also tended to synthesize information for the integration of components that were determined as a whole by teammates or peers, and also seemed to lack a clear understanding of the process of synthesizing information from the research presented. Using discipline-specific language and flow to demonstrate scientific Knowledge to a specific audience of teachers, as the title of the study relates to 'teacher morals in teaching science learning', the proposed research audience is science teachers.

P: How did you come up with this idea?
KCL: I got the idea from the issues in society.
P: To achieve this goal, a particular research method is needed, so how did you determine the method used?
KCL: Choosing from suitable papers.
P: When designing instruments and assessments, guidelines and theories are often employed.
KCL: .... (unable to answer)
P: How do you ensure the data you receive is valid?
KCL: Doing repetition
P: Who was involved in this research?
KCL: This research will be conducted in teams.
P: Then, what are the benefits of this research?
KCL: ..... (unable to answer)

SHN

For the RSD level, SHN is at level 5, where SHN in the interview can use appropriate language and flow to expand Knowledge. In determining the research idea, SHN is guided by the discipline or context. Objectives are set based on experience, expertise, and relevant literature. In planning the methodology, SHN develops it based on appropriate literature and applies existing methods with minor modifications. SHN conducts self-evaluation based on experience and validates with experts. SHN conducts research by organising information with the team and managing the process. Research is planned to analyze and create data to fill the gap identified by the researcher or to increase Knowledge of why things happen.

Ob: How do you find research ideas?
SHN: For me, it's based on experience, expertise, and articles. The information serves as a foundation for creating the idea.
Ob: For me, it's based on experience, expertise, and articles. The information serves as a foundation for creating the idea.
SHN: Analyze events in the surrounding environment and review relevant studies in support of the established idea.
Ob: How do you create your research methodology?
SHN: The methodology used is based on the literature obtained and modified in light of current developments.
Ob: Then, how do you ensure that the data you receive is accurate?
SHN: The methodology used is based on the literature obtained and modified in light of current developments.
Ob: Do you think research is typically conducted in groups or individually?
SHN: Joining a diverse team so that the ideas vary.
Ob: Do you think the conclusion of the research is enough to answer other people's research gaps? Or does it need to benefit others or a community?
SHN: I think the conclusion answers the gap first and explains why it happened, so that it can be used as a reference in further research.
Ob: Does that mean you don't want to explain further? It means it's more about filling the gap and explaining it.
SHN: yes
Ob: What do you think is the most crucial benefit of research results?
SHN: From my research, it is helpful to optimise further or maximise the use of ICT media for teachers and analyse teacher mastery.

NAB

NAB developed the idea independently, taking into account the lecturer's constraints and direction. Based on the structure of the concept, NAB determined the objectives using expertise from experience and literature. NAB posed a critical and researchable question by analyzing the existing data trends, which, at the time of explaining NAB, was still not very familiar with the proposed research idea. In collecting and recording data information, NAB looked for sources and used one of the existing methodologies. When asked about data analysis, NAB also tended to synthesize the information for the integration of the specified components as a whole, but did not fully understand the process of synthesizing information from the research. Using discipline-specific language and flow to demonstrate scientific understanding for a specific audience, namely teachers. Based on the average level given by reviewers, SHN is at level 3 for the RSD framework.

Ob: How did you get the idea?

NAB: The lecturer gave the idea direction.

Ob: To achieve this goal, a specific research method is required. How did you determine the process to be used?

NAB: Choose from suitable papers.

Ob: After reading this literature, do you have any ideas for future development?

NAB: Later, I will use it for my future research. I will use STEM education..

Ob: How did you choose your research method?

NAB: Quantitative research method

DISCUSSION

The analysis results reveal patterns and relationships between the problem-solving behaviors exhibited by students and the levels achieved, based on the RSD framework. Students who exhibit more sophisticated problem-solving behaviours tend to have higher levels in the RSD framework, while those with more basic or naive behaviours show lower levels. Harun et al.[8] Examined naïve, routine, and sophisticated students' behavioural gestures oriented towards mathematical problem solving and found that sophisticated students' gestures tended to show a deeper way of thinking, to behave in a more relaxed routine manner, and to show doubt and self-confidence occasionally. In contrast, naïve students tended not to show visible, thoughtful gestures. In addition, Mataniari et al.[27]. It was also revealed that the integration of the RSD framework into research-based activities provides an opportunity to assess students' reports in terms of critical thinking and writing skills, which are essential for problem-solving. This suggests that their level of research skills aligns with the RSD framework, where the levels of independence, critical thinking, and ability to address problems contribute to achieving a higher level of autonomy within the framework. This is also supported by Chang[28]. Research results state that problem-solving ability enables students to overcome various obstacles in various other areas of life. Individuals with experience in problem-solving tend to exhibit improved academic performance and are better equipped to face challenges.[10]

Problem-solving and research are closely connected activities in education. Problem solving is one of the key components of mathematical competence[29] and one of the skills required when conducting research.[30] There is a need for their integration in postgraduate education, and effective problem-solving is an essential component of research methods, as it enables students to formulate research questions, design experiments, and analyze data systematically.[11] The considered problem-solving process allows for the development of activity skills.

CONCLUSIONS

There is a significant relationship between the level of sophistication of problem-solving behaviours and the level of research skills achieved by postgraduate students. Postgraduate students who exhibit more sophisticated problem-solving behaviours, such as the ability to plan strategies, apply appropriate methods, and critically analyse data, tend to achieve higher levels in the RSD framework. Problem-solving behaviour in postgraduate students is one of the essential aspects for improving their research skills.

It is expected that future research can use a larger sample of students and be conducted at different levels. In addition, the study can involve other variables, such as educational background, previous experience, critical thinking ability, creative thinking ability, communication skills, or cultural context of skills. Future research can also investigate learning tools, particularly those based on research methodology that focuses on problem-solving behavior. The developed learning tools are expected to create varied learning strategies, including assessing and improving problem-solving behaviour in research.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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