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Developing and Validating the Research Skills Metacognitive Questionnaire: A Comprehensive Exploration of Instrument Design and Validation

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Abstract

The primary aim of the current paper is to illuminate the intricate process of developing the Research Skills Metacognitive Questionnaire (RSMQ), a specialized instrument crafted to assess students' metacognitive engagement in research skill development. The primary objective is to illuminate the pivotal steps undertaken in the initial validation of the RSMQ, leveraging statistical tests and employing the Rasch model. The culmination of this process yields a finalized survey instrument featuring 62 questionnaire items. Notably, the instrument demonstrates commendable item and person reliability, with 58 items fitting well within theRasch fit item criteria. This endeavour contributes to advancing assessment tools tailored to gauge metacognitive aspects in the dynamic context of research skill development among students.

Keywords: *metacognitive; research skills development; questionnaire development; Rasch.*

Introduction

The Research Skills Development (RSD) framework, proposed by Willison and Buisman-Pijlman (2016), is a comprehensive and versatile framework designed to enhance students' research skills across various educational levels (Dwiwansyah Musa & Hardianto, 2020; Faff, 2016; Mataniari et al., 2020; Sari et al., 2019; Tang, 2019). The framework emphasizes the development of students' abilities to engage in research processes effectively. It identifies six key facets of the research process that students need to develop: (1) Embark and Clarify, (2) Find and Generate, (3) Evaluate and Reflect, (4) Organise and Manage, (5) Analyse and Synthesis, (6) Communication and Apply the results with an awareness of associated ethical and social issues. Together, these six facets of the RSD framework provide a structured and holistic approach to cultivating research skills in students, ensuring their preparedness for engaging in meaningful and impactful research endeavours.

A notable study demonstrated that students who engaged in research skill development exhibited significantly more significant improvement in their abilities to generate testable hypotheses and design valid experiments (Maddens et al., 2022), scientific arguments

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(Engelmann et al., 2016), critical thinking (Mataniari et al., 2020), also readiness to work (Bandaranaike, 2018). Moreover, the literature emphasizes that the close and symbiotic link between the development of students' research skills plays a crucial role in improving the acquisition of students' metacognitive skills (Nunaki et al., 2019; Torres, 2018). In the realm of research activity, metacognitive scaffolding emerges as an invaluable support system for students. The importance of metacognitive skills becomes especially evident in real-life research scenarios characterized by open-ended or ill-structured tasks, such as solving complex design problems. Unlike well-defined problems with clear solutions, these research challenges often need more straightforward answers.

The dearth of assessment tools has been a notable gap in the expanding domain of the need for formative research within research activity (Willison et al., 2020). Particularly in the context of utilizing the Research Skills Development (RSD) framework, there is a discernible need for effective assessment instruments. Taking inspiration from the Engineering Design and Metacognitive Questionnaire (EDMQ) (Lawanto & Santoso, 2014), this article seeks to expound upon the construction of a questionnaire tailored to the unique facets of the RSD framework later called the Research Skills Metacognitive Questionnaire (RSMQ).

The development of the Research Skills Metacognitive Questionnaire (RSMQ) instrument shares a theoretical foundation with the Engineering Design and Metacognitive Questionnaire (EDMQ), drawing inspiration from Butler and Cartier's self-regulated learning (SRL) model. This model comprehensively explains the interplay between motivation, cognition, and metacognition within academic activities. In the RSMQ, the SRL columns encapsulate crucial SRL features, including task interpretation, planning strategies, cognitive actions, monitoring and fix-up strategies, and the criteria students associate with success. What sets RSMQ apart from EDMQ is the construction of a rubric matrix that combines Butler and Cartier's SRL features (2004) with the Six Facets of the Research Skills Development (RSD) framework (Willison & Buisman-Pijlman, 2016). This hybrid rubric integrates the well-established SRL model with the specific stages of the research process, encompassing the RSD framework's six key facets: embarking on research, finding and generating information, evaluating and reflecting on gathered data, organizing and managing research processes, analyzing and synthesizing findings, and finally, effectively communicating and applying the research outcomes. The unique amalgamation of these frameworks in the RSMQ instrument aims to comprehensively capture and assess metacognitive processes in research skill development, offering a versatile and robust tool for understanding and enhancing students' metacognitive engagement in research activities.

The primary aim of the current paper is to illuminate the intricate process involved in developing the Research Skills Metacognitive Questionnaire (RSMQ). This instrument is designed to evaluate and measure students' metacognitive engagement, specifically within the context of research skill development. The development process entails carefully considering and refining the questionnaire items to ensure their alignment with the targeted metacognitive processes associated with research activities. Moreover, the paper outlines the crucial steps involved in the initial validation of the RSMQ through a statistical test employing the Rasch model.

Literature Review

The extensive body of research has consistently demonstrated the profound influence of metacognition on the processes of scientific research and inquiry processes (Kavousi et al., 2020; Omarchevska et al., 2022; Pamungkas et al., 2018; Yurttaş Kumlu & Şahin, 2022). Metacognitive scaffolding facilitates students in understanding the multifaceted nature of research problems, encouraging them to reflect on their thinking processes, plan strategically, and monitor their progress related to learning information (Flavell, 1979;

Sijmkens et al., 2023). This reflective engagement allows students to adapt their research strategies dynamically, with the critical evaluation of cognitive outcomes in comparison to established internal or external standards ensuring they can effectively approach the inherent challenges of open-ended research tasks. Thus, in the dynamic and unpredictable research landscape, metacognitive support becomes essential, fostering effective problem-solving and the development of resilient and resourceful researchers (Bae & Kwon, 2021; Kavousi et al., 2020; Rahman et al., 2014).

Butler and Cartier's Self-Regulated Learning (SRL) (2004) model provides a comprehensive framework that delves into the intricate and interactive relationship between metacognitive and cognitive activities. According to this model, SRL is characterized as a multifaceted, dynamic, and contextually embedded learning process. The model identifies six central features that intricately interact with one another to shape the self-regulated learning experience: (1) Contextual Layer. The learning environment and its contextual elements play a pivotal role in shaping the learning process. (2) Individual Contributions. This encompasses the unique attributes and characteristics that individuals bring to the learning situation. (3) Mediating Variables. Various factors and influences mediate the learning experience, affecting the dynamic interaction between metacognitive and cognitive processes. (4) Task Interpretation and Personal Objectives. How individuals interpret tasks and set personal objectives significantly influences their approach to learning and problem-solving. (5) Self-Regulating Strategies. Students employ specific strategies to regulate their own learning process, adapting and modifying their approaches as needed. (6) Cognitive Strategies. These involve the actual cognitive activities and problem-solving techniques applied by learners to comprehend and tackle tasks (Butler & Cartier, 2004, 2005).

The Research Skills Development (RSD) framework is a versatile and adaptable conceptual structure designed to guide academics and researchers through the diverse landscape of research processes. It acknowledges the multifaceted nature of research by articulating six overarching facets: Embark and Clarify, Find and Generate, Evaluate and Reflect, Organise and Manage, Analyse and Synthesise, and Communicate and Apply. These facets represent high-level perspectives on the research journey rather than generic skills, allowing for flexibility and customization across different disciplines. The framework emphasizes the need for context-specific operationalization by academics, ensuring that it remains relevant and effective in various academic contexts. By providing a comprehensive and nuanced approach to research skills development, the RSD framework fosters a shared understanding of the fundamental processes that underpin scholarly inquiry, acknowledging both the commonalities and variations across disciplines (Based on Willison and O'Regan, 2006/2015, www.rsd.edu.au).

In the construction of the Research Skills and Metacognition Questionnaire (RSMQ), Lawanto's EDMQ (2014) rubric serves as a foundational model, incorporating elements of Self-Regulated Learning (SRL) features and the design phase. The RSMQ goes beyond traditional assessment tools by combining the six facets of the Research Skills Development (RSD) framework with the critical SRL components identified by Lawanto & Santoso (2014). Specifically, the SRL columns within the RSMQ meticulously capture essential SRL features: task interpretation, planning strategies, cognitive actions, monitoring, and fix-up strategies, along with the criteria students associate with success. These SRL features offer a nuanced understanding of how learners interpret, plan, execute cognitive actions, monitor their progress, and employ strategies to overcome challenges, providing valuable insights into the metacognitive dimensions of their research skills development. The amalgamation of SRL and RSD in the RSMQ thus creates a comprehensive assessment tool that not only evaluates technical proficiency but also delves into the strategic and reflective aspects of the research process, enriching the overall understanding of students' research capabilities. This integration aligns with contemporary educational paradigms that recognize the interconnected nature of

metacognitive skills and effective research practices, fostering a holistic approach to research skills development.

Method

The development of the Research Skills Metacognitive Questionnaire (RSMQ) is anchored in Butler and Cartier's self-regulated learning (SRL) model (Butler and Cartier, 2004), a theoretical framework that intricately delineates the interplay among motivation, cognition, and metacognition within academic pursuits. The RSMQ leverages a rubric matrix amalgamating Butler and Cartier's SRL features with the six facets of the Research Skills Development (RSD) framework. The development of RSMQ alignment with EDMQ steps development (Lawanto & Santoso, 2014).

The RSD framework provides a comprehensive structure, encompassing six key facets that span the entire research process: embarking on research, finding and generating information, evaluating and reflecting on gathered data, organizing and managing research processes, analyzing and synthesizing findings, and effectively communicating and applying research outcomes. This incorporation allows the RSMQ to holistically assess students' metacognitive engagement at each stage of the research process, providing a nuanced understanding of their self-regulated learning practices in a research context (see Table 1).

The survey instrument, designed based on this integrated framework, comprises six subsections corresponding to the facets of the RSD framework. Each subsection is tailored to capture students' perceptions of essential SRL features, including task interpretation, planning strategies, strategic actions, monitoring and fix-up strategies, and criteria associated with success (see Table 1). The measurement scales for both instruments, RSMQ and EDMQ, are standardized, ranging from 1 to 4 (1 = rarely, 2 = sometimes, 3 = often, 4 = almost always), ensuring consistency in responses.

Table 1. Combination of SRL feature and RSD facets in RSMQ

SRL Feature	Research Skills development Facets						Total
	Embark and clarify	Find and generate	Evaluate and reflect	Organise and manage	Analysis and synthesis	Communication and apply	
Task Interpretation	3	3	2	1	2	2	13
Planning strategy	2	3	2	2	1	2	12
Cognitive actions	2	2	2	2	1	2	11
Monitoring and fix up strategies	2	2	2	1	1	1	9
Success criteria	5	3	2	2	2	3	17
Total	14	13	10	8	7	10	

The questionnaire validation process in this paper is a thorough examination encompassing face and content validity. To initiate the validity assessment, two experts in

self-regulated learning (SRL) were invited to review the questionnaire critically. Their role was pivotal in providing insights and comments on using SRL constructs within each questionnaire item. This process unfolded iteratively, allowing for a meticulous evaluation of the wording of each item to ensure the accurate identification of specific SRL features being assessed. After this expert review, revisions were implemented based on the constructive feedback received.

To delve deeper into the feedback received, interview sessions were conducted to seek additional insights and clarifications from students and teachers. This interactive process ensured a thorough exploration of their perspectives, allowing for a more nuanced understanding of the questionnaire's strengths and potential areas for improvement. Subsequently, revisions were made based on this valuable feedback, and the refined questionnaire was circulated once again to the same cohort of students and teachers for their final comments.

The field-testing phase of the RSMQ involved the compilation, pilot testing, and subsequent questionnaire preparation on a larger scale. A cohort of 74 high school students taking part in P5 ,Projek Penguatan Profil Pelajar Pancasila) actively participated in the study, providing valuable data for the exploration of the psychometric properties and underlying dimensionality of the questionnaire using the RASCH model. Employing WINSTEP version 5.6.2.0, item analysis was conducted to assess critical aspects, including local unidimensionality and independence, item fit, and reliability, by established Rasch model prerequisite tests. The criteria for a valid test, examined from various perspectives, were systematically outlined in Table 2, ensuring a comprehensive evaluation of the RSMQ's robustness and effectiveness.

Table 2. The value range for the validity and reliability test based on Rasch analysis (Boone et al., 2014; Sumintono & Widhiarso, 2013).

The validity aspect of the item	Criteria	
Item Fit Test	0,5 < MNSQ < 1,5.	
	-2,0 < ZSTD < +2,0.	
	0,4 < Pt. Measure Corr < 0,85.	
Reliability Value (Person/Item)	> 0.94	Special
	0.91-0.94	Very good
	0.81-0.90	Good
	0.67-0.80	Enough
	< 0.67	Weak
Value Cronbach Alpha	> 0.8	Very Good
	0.7 < < 0.8	Good
	0.6 < < 0.7	Enough
	0.5 < < 0.6	Poor
	< 0.5	Very Poor

Results and Discussion

The finalized survey instrument comprises 62 questionnaire items meticulously designed to assess five critical self-regulated learning (SRL) features. These features include task interpretation (13 items), planning strategies (12 items), cognitive actions (11 items), monitoring and fix-up strategies (9 items), and criteria of success (17 items). The

comprehensive nature of the instrument allows for collecting data related to these SRL features at each stage of the research process. The questionnaire items are distributed across various facets of research skill development, ensuring a nuanced evaluation of students' metacognitive engagement. For specific examples of the questionnaire items, refer to Tables 3-7, providing insights into the wording and content that students will encounter during the survey.

Table 3. An Example of Task Interpretation Questionnaire Items in RSD facets

Task Interpretation	Questionnaire item example
Embark and clarify	When starting research, I must define the research statement clearly.
Find and generate	When looking for research information, I may involve surveys, interviews, observations, literature, or other sources.
Evaluate and reflect	When planning my research, I identify the potential errors in the research planning that need correction.
Organize and manage	When conducting research, I adhere to the planned time schedule.
Analysis and synthesis	When conducting data analysis, I should be able to interpret statistical data (such as averages and percentages) to support the arguments.
Communication and apply	When communicating the research, I focus on presenting information in accordance with the research problem formulation.

Table 4. An Example of Planning strategy Questionnaire Items in RSD facets

Planning strategy	Questionnaire item example
Embark and clarify	As I start research, I need to identify the research output.
Find and generate	I am searching for articles that have similar research aims to mine.
Evaluate and reflect	I discuss findings and provide feedback with my teammates.
Organize and manage	I create a task prioritization list based on research importance and deadlines.
Analysis and synthesis	I Plan how to organize collected data systematically by creating a structured framework for categorizing and storing information.
Communication and apply	I ensure that my communication is accessible by using clear and concise language.

Table 5. An Example of Cognitive actions Questionnaire Items in RSD facets

Cognitive actions	Questionnaire item example
Embark and clarify	I Establish specific and measurable objectives for the research project.
Find and generate	I Develop clear and testable hypotheses based on the research questions and objectives.
Evaluate and reflect	I Reflect the appropriateness and effectiveness of research methodologies employed.
Organize and manage	Create a detailed timeline outlining project milestones, tasks, and deadlines, facilitating a structured and organized workflow.
Analysis and synthesis	I Systematically comparing different data points or findings to identify similarities and differences.
Communication and apply	I comprehensively synthesize information to distill the key findings and insights from the research.

Table 6. An Example of Monitoring and fix up strategy Questionnaire Items

Monitoring and fix up strategy	Questionnaire item example
Embark and clarify	I Actively seeking and incorporating feedback from peers, mentors, or advisors to enhance the research direction
Find and generate	I Monitor the effectiveness of data collection methods and adjusting for improved results.
Evaluate and reflect	I encourage regular self-reflection to recognize and address personal biases and assumptions in research.
Organize and manage	I regularly review and update the project timeline to ensure adherence to deadlines.
Analysis and synthesis	I engage peers or experts in the field for constructive feedback on the analysis and synthesis process.
Communication and apply	I monitor the effectiveness of chosen communication media (e.g., reports, presentations, visuals) and make adjustments as needed.

Table 7. An Example of success criteria Questionnaire Items in RSD facets

Success criteria	Questionnaire item example
Embark and clarify	I know I have done a good job when I have clearly formulated and focused research questions that align with the objectives.
Find and generate	I know I have done a good job when I am able to identify and select information that is directly pertinent to the research objectives from a variety of sources, including academic journals, books, and reputable online databases.
Evaluate and reflect	I know I have done a good job when I ensure that information is directly relevant to the research objectives and questions.
Organize and manage	I know I have done a good job when a well-structured timeline with achievable milestones for different stages of the research is in place.
Analysis and synthesis	I know I have done a good job when I also ensure that the data analysis aligns with the overarching research objectives.
Communication and apply	I know I have done a good job when I am effective in presenting research findings in a clear and understandable manner for diverse audiences.

The Research Skills Metacognitive Questionnaire (RSMQ) underwent a rigorous empirical testing phase involving 74 high school students. The aim was to assess the validity and reliability of the questionnaire using the Rasch model. The findings of this empirical test are detailed in Table 6. In examining 62 statements within the questionnaire, it was identified that four statements did not meet the predefined criteria in the Rasch model. Specifically, these statements failed to fulfil the criteria of Outfit MNSq (mean square), Outfit ZSTD (standardized outfit Z-score), and Pt Measure Corr (point measure correlation). These criteria are crucial in ensuring that each statement aligns appropriately with the underlying construct being measured and contributes meaningfully to the overall reliability of the questionnaire.

Table 8. Validity construct of RSMQ using RASCH model misfit order

No	Code	MNSq	ZSTD	Pt.Corr	Note	No	Code	MNSq	ZSTD	Pt.Corr	Note
1	T1	0,91	- 0,18	0,43	Fit	32	C7	0,42	-0,73	0,29	Fit
2	T2	1,00	0,09	0,45	Fit	33	C8	0,61	-0,74	0,35	Fit
3	T3	0,51	-0,76	0,32	Fit	34	C9	0,45	-1,13	0,37	Fit
4	T4	2,29	4,14	0,14	Mis-fit	35	C10	0,89	-0,29	0,49	Fit
5	T5	0,89	-0,29	0,49	Fit	36	C11	1,10	0,38	0,32	Fit
6	T6	1,24	0,47	0,22	Fit	37	M1	1,10	0,38	0,32	Fit
7	T7	1,97	3,45	0,21	Mis-fit	38	M2	0,58	-0,54	0,27	Fit
8	T8	0,84	0,00	0,22	Fit	39	M3	0,56	-0,97	0,40	Fit
9	T9	0,61	-0,74	0,35	Fit	40	M4	0,84	0,00	0,22	Fit
10	T10	0,45	-1,13	0,37	Fit	41	M5	0,49	-0,89	0,34	Fit
11	T11	0,61	-0,74	0,35	Fit	42	M6	Best Fit Order Not Shown			Fit
12	T12	2,09	3,70	0,20	Mis-fit	43	M7	0,56	-0,97	0,40	Fit
13	T13	0,57	-1,16	0,43	Fit	44	M8	Best Fit Order Not Shown			Fit
14	PS1	0,89	-0,29	0,49	Fit	45	M9	0,56	-0,97	0,40	Fit
15	PS2	1,10	0,37	0,30	Fit	46	SC1	1,04	0,23	0,38	Fit
16	PS3	0,89	-0,29	0,49	Fit	47	SC2	1,04	0,23	0,38	Fit
17	PS4	0,57	-1,16	0,43	Fit	48	SC3	0,41	-1,32	0,42	Fit
18	PS5	2,22	2,17	0,22	Mis-fit	49	SC4	0,58	-0,54	0,27	Fit
19	PS6	0,90	0,20	0,15	Fit	50	SC5	0,51	-0,76	0,32	Fit
20	PS7	0,56	-0,97	0,40	Fit	51	SC6	0,69	-0,63	0,38	Fit
21	PS8	0,42	-0,73	0,29	Fit	52	SC7	0,57	-1,16	0,43	Fit
22	PS9	0,89	-0,29	0,49	Fit	53	SC8	2,30	1,97	0,16	Fit
23	PS10	0,89	-0,29	0,49	Fit	54	SC9	0,49	-0,89	0,34	Fit
24	PS11	0,63	-0,81	0,37	Fit	55	SC10	1,10	0,40	0,13	Fit
25	PS12	0,56	-0,97	0,40	Fit	56	SC11	0,42	-0,73	0,29	Fit
26	C1	Best Fit Order Not Shown			Fit	57	SC12	0,61	-0,74	0,35	Fit
27	C2	0,51	-0,76	0,32	Fit	58	SC13	0,64	-0,80	0,37	Fit
28	C3	0,89	-0,29	0,49	Fit	59	SC14	0,45	-1,13	0.37	Fit
29	C4	1,10	0,38	0,32	Fit	60	SC15	0,45	-1,13	0,37	Fit
30	C5	0,64	-0,80	0,37	Fit	61	SC16	0,63	-0,81	0,37	Fit

31	C6	1,10	0,37	0,30	Fit	62	SC17	0,84	-0.28	0,34	Fit

Items T4, T7, T12, T14, PS5, PS8, PS12, C7, C8, C9, C10, C11, M6, M7, and M8 are identified as not meeting one or more of the specified item fit test criteria in Table 2. According to Boone's recommendation, if an item displays MNSQ and Pt. Measure Corr values that fall short of the criteria, but ZSTD values meet the criteria, the item is still considered fit, signifying its retention (Boone, 2016). Based on the analysis, four statements: T4, T7, T12, and PS5 are considered misfit and excluded from the questionnaire item set. Item and person reliability shown in table 9.

Table 9. Reliability measured results of RSMQ

Reliability component	value	criteria
Person reliability	0.84	Good
Item reliability	0.84	Good
Cronbach Alpha	0.91	Very Good

The person and item reliability values, both meeting the criteria for "Good", suggest that the questionnaire is consistent in measuring the intended construct for individuals and individual items. The excellent Cronbach Alpha further reinforces the internal consistency of the questionnaire, indicating a high degree of reliability (Boone et al., 2014; Sumintono & Widhiarso, 2013). These reliability indicators collectively support the credibility and stability of the questionnaire, affirming its suitability for assessing the targeted construct.

Conclusion

This paper meticulously detailed the development process and initial validation of the Research Skills Metacognitive Questionnaire (RSMQ) utilizing the Rasch model. Our approach integrated Butler and Cartier's self-regulated learning (SRL) features with the six facets of research skills development, forming a comprehensive rubric matrix. The outcome of this endeavour is a survey instrument that underwent rigorous measurement using the Rasch model, resulting in a refined set of 58 questionnaire items to assess five distinct SRL features.

The utility of the RSMQ lies in its ability to capture not only the cognitive dimensions of research skills but also the metacognitive aspects, providing researchers and educators with a valuable tool to gauge and enhance students' proficiency in research activities. By aligning with established frameworks for research skill development, the RSMQ contributes to the ongoing discourse on practical pedagogical approaches in cultivating research competencies. In conclusion, the RSMQ, refined through the Rasch model, is a robust and versatile instrument poised to contribute to understanding and advancing research skills and metacognition. Its potential applications in various educational and research contexts make it an asset for practitioners and scholars in research skill development.

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References

Bae, H., & Kwon, K. (2021). Developing metacognitive skills through class activities: what makes students use metacognitive skills? Educational Studies, 47(4), 456–471. https://doi.org/10.1080/03055698.2019.1707068

Bandaranaike, S. (2018). From research skill development to work skill development. Journal of University Teaching and Learning Practice, 15(4). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064042012&partnerID=40&md5=8763d2d1efc79b49be71e78b24eced57

Boone, W. J., Staver, J. R., & Yale, M. S. (2014). Rasch Analysis in the Human Sciences. Springer Netherlands. https://doi.org/10.1007/978-94-007-6857-4

Butler, D. L., & Cartier, S. C. (2004). Promoting Effective Task Interpretation as an Important Work Habit: A Key to Successful Teaching and Learning. Teachers College Record: The Voice of Scholarship in Education, 106(9), 1729–1758. https://doi.org/10.1111/j.1467-9620.2004.00403.x

Butler, D. L., & Cartier, S. C. (2005). Multiple Complementary Methods for Understanding Self-Regulated Learning as Situated in Context. American Meeting of the American Educational Research Association, 11–15. https://ecps.educ.ubc.ca/files/2013/11/Butler-Cartier-2005-AERA-Paper-Final.pdf

Dwiwansyah Musa, L. A., & Hardianto, H. (2020). IMPLEMENTASI PEMBELAJARAN BERBASIS RISET UNTUK MENINGKATKAN KETERAMPILAN MENELITI MAHASISWA. Tadrib, 6(1), 1–12. https://doi.org/10.19109/tadrib.v6i1.3786

Engelmann, K., Neuhaus, B. J., & Fischer, F. (2016). Fostering scientific reasoning in education – meta-analytic evidence from intervention studies. Educational Research and Evaluation, 22(5–6), 333–349. https://doi.org/10.1080/13803611.2016.1240089

Faff, R. W. (2016). Mapping "Pitching Research" Tasks into the RSD7 Framework: A Pedagogic Perspective. SSRN Electronic Journal, 1–55. https://doi.org/10.2139/ssrn.2724451

Farhan, M., Rafi, H., Rafiq, H., Siddiqui, F., Khan, R., & Anis, J. (2019). Study of Mental Illness in Rat Model of Sodium Azide Induced Oxidative Stress. J. Pharm. Nutr. Sci, 9, 213-221.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Kavousi, S., Miller, P. A., & Alexander, P. A. (2020). Modeling metacognition in design thinking and design making. International Journal of Technology and Design Education, 30(4), 709–735. https://doi.org/10.1007/s10798-019-09521-9

Lawanto, O., & Santoso, H. (2014). Development and Validation of the Engineering Design Metacognitive Questionnaire. 2014 ASEE Annual Conference & Exposition Proceedings, 24.412.1-24.412.11. https://doi.org/10.18260/1-2--20303

Maddens, L., Depaepe, F., Raes, A., & Elen, J. (2022). Fostering students' motivation towards learning research skills: the role of autonomy, competence and relatedness support. Instructional Science. https://doi.org/10.1007/s11251-022-09606-4

Mataniari, R., Willison, J., Hasibuan, M. H. E., Sulistiyo, U., & Dewi, F. (2020). Portraying students' critical thinking skills through research skill development (RSD) framework: A case of a biology course in an Indonesian University. Journal of Turkish Science Education, 17(2), 302–314. https://doi.org/10.36681/tused.2020.28

Nunaki, J. H., Damopolii, I., Kandowangko, N. Y., & Nusantari, E. (2019). The Effectiveness of Inquiry-based Learning to Train the Students' Metacognitive Skills Based on Gender Differences. International Journal of Instruction, 12(2), 505–516. https://doi.org/10.29333/iji.2019.12232a

Omarchevska, Y., Lachner, A., Richter, J., & Scheiter, K. (2022). Do Video Modeling and Metacognitive Prompts Improve Self-Regulated Scientific Inquiry? Educational Psychology Review, 34(2), 1025–1061. https://doi.org/10.1007/s10648-021-09652-3

Pamungkas, Z. S., Aminah, N. S., & Nurosyid, F. (2018). Students Critical Thinking Skill in Solving Scientific Literacy using a Metacognitive Test Based on Scientific Literacy. Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 7(2), 161–169. https://doi.org/10.24042/jipfalbiruni.v7i2.2909

Rafi, H., Ahmad, F., Anis, J., Khan, R., Rafiq, H., & Farhan, M. (2020). Comparative effectiveness of agmatine and choline treatment in rats with cognitive impairment induced by AlCl3 and forced swim stress. Current Clinical Pharmacology, 15(3), 251-264.

Rahman, S., Yasin, R. M., Salamuddin, N., & Surat, S. (2014). The Use of Metacognitive Strategies to Develop Research Skills among Postgraduate Students. Asian Social Science, 10(19). https://doi.org/10.5539/ass.v10n19p271

Sari, D. P., Wulan, A. R., & Solihat, R. (2019). Developing 21st century student research skills through assessment matrix and edmodo in biology project (Saprudin, A. G. Abdullah, Sutarno, R. R. Agustin, I. Permana, & A. B. D. Nandiyanto (eds.); Vol. 1157, Issue 2). Institute of Physics Publishing. https://doi.org/10.1088/1742-6596/1157/2/022093

Sijmkens, E., De Cock, M., & De Laet, T. (2023). Scaffolding students' use of metacognitive activities using discipline- and topic-specific reflective prompts. Metacognition and Learning. https://doi.org/10.1007/s11409-023-09363-w

Sumintono, B., & Widhiarso, W. (2013). Aplikasi model Rasch untuk penelitian ilmu-ilmu sosial (Application of the Rasch model to social sciences research). Trim Komunikata. .

Tang, K. N. (2019). Innovate higher education to enhance graduate employability. Pertanika Journal of Social Sciences and Humanities, 27(3), 1727–1738. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85072240872&partnerID=40&md5=0e4c52fa86950c010caa68bc66943230

Torres, L. (2018). Research skills in the first-year biology practical - Are they there? Journal of University Teaching and Learning Practice, 15(4), 32–55. https://doi.org/10.53761/1.15.4.3

Willison, J., & Buisman-Pijlman, F. (2016). PhD prepared: research skill development across the undergraduate years. International Journal for Researcher Development, 7(1), 63–83. https://doi.org/10.1108/IJRD-07-2015-0018

Willison, J., Zhu, X., Xie, B., Yu, X., Chen, J., Zhang, D., Shashoug, I., & Sabir, F. (2020). Graduates' affective transfer of research skills and evidence based practice from university to employment in clinics. BMC Medical Education, 20(1). https://doi.org/10.1186/s12909-020-1988-x

Yurttaş Kumlu, G. D., & Şahin, F. (2022). Metacognitive Activities Performed by Pre-Service Science Teachers in Scientific Reasoning Skills Teaching with the POE Technique. Science Insights Education Frontiers, 13(1), 1789–1817. https://doi.org/10.15354/sief.22.or066