

## Perceptions of Pre-Service Teachers of Mathematics on Peer-Feedback in Classroom Learning

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Received: 13-03-2025

Revised: 20-03-2025

Accepted: 25-04-2025

### Abstract

Mathematics learning in higher education increasingly demands active, collaborative, and self-regulated learning; however, classroom practices often remain lecturer-centered, limiting students' opportunities to reflect on their understanding and engage meaningfully with peers. Peer feedback is a collaborative instructional strategy with strong potential to address this gap by promoting dialogue, reflection, and shared knowledge construction. This study investigates pre-service teachers' perceptions of peer feedback in mathematics learning, focusing on its contributions to conceptual understanding, engagement, motivation, collaboration, and self-regulated learning. A quantitative descriptive design was employed involving 20 pre-service teachers who participated in structured peer feedback activities over one academic semester. Data were collected using a 35-item Likert-scale questionnaire and analyzed through descriptive statistics, including mean scores and frequency distributions. The results indicate consistently positive perceptions across all indicators, with mean scores ranging from 3.30 to 3.50. Participants reported that peer feedback helped clarify mathematical concepts, deepen conceptual understanding, increase learning motivation and engagement, encourage collaborative interaction, and support reflective thinking. These findings suggest that well-structured peer feedback functions as an effective pedagogical complement to lecturer instruction, offering cognitive, motivational, and social benefits. Integrating peer feedback into mathematics classrooms can strengthen interactive learning environments and support the development of reflective, autonomous, and self-regulated future mathematics teachers.

**Keywords:** *Peer Feedback; Mathematics Learning; Conceptual Understanding; Engagement; Self-Regulated Learning*

**How to Cite:** Noor, J. S., Rahmatika, N. B., & Lissa, J. (2025). Perceptions of Pre-Service Teachers of Mathematics on Peer-Feedback in Classroom Learning. *SMARTH: Journal of Mathematics in Education and Learning*, 1(1), 51-62. <https://doi.org/10.66031/smarth.v1i1.168>

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## INTRODUCTION

Mathematics education requires learning approaches that go beyond procedural fluency and routine problem solving. Pre-service teachers of mathematics are expected not only to master mathematical content but also to develop pedagogical competencies that enable them to support meaningful learning in future classrooms. One essential element in supporting such learning is feedback, which plays a crucial role in helping learners reflect on their understanding, identify misconceptions, and improve their learning strategies. Extensive research has shown that well-designed feedback can significantly enhance learning outcomes, engagement, and motivation across educational contexts (Henderson et al., 2021; Wisniewski et al., 2020).

Feedback in learning is no longer viewed as a one-way transmission of information from teachers to students. Instead, contemporary perspectives emphasize feedback as a dialogic and learner-centered process in which students actively interpret and use information to improve their learning (Van der Kleij & Lipnevich, 2021). In this regard, peer feedback has gained increasing attention as an effective formative assessment strategy. Peer feedback refers to a process in which learners provide and receive feedback on each other's work or thinking with the aim of enhancing understanding and performance (Hošpesová et al., 2022; Husband & Nikfarjam, 2022). In mathematics classrooms, peer feedback allows students to exchange ideas, discuss errors, and compare problem-solving strategies, thereby fostering deeper conceptual understanding.

For pre-service teachers of mathematics, peer feedback holds particular importance. As learners, they benefit from engaging with diverse perspectives and reflecting on their own mathematical reasoning. As future teachers, their experiences with peer feedback shape their beliefs and practices regarding assessment and feedback in their future classrooms. This dual role aligns with social constructivist perspectives, which emphasize that knowledge is constructed through social interaction, discussion, and shared meaning-making (Jaworski, 2024; Rytälä, 2021). From this viewpoint, peer feedback serves as a social learning tool that supports collaborative reasoning and the co-construction of mathematical knowledge.

Despite its potential benefits, learning mathematics remains challenging for many students. Research consistently reports that difficulties in mathematics are often related to conceptual understanding, problem-solving skills, and attitudes toward the subject (Lagria & Pañares, 2023; Mangarin & Caballes, 2024). These challenges may lead to low confidence, reduced motivation, and disengagement from learning. In such contexts, peer feedback can function as a supportive mechanism that helps learners recognize errors, clarify concepts, and develop alternative solution strategies in a less threatening environment than teacher-dominated feedback (Vanoli & Luebeck, 2021).

However, the effectiveness of peer feedback largely depends on how it is perceived by learners. Students' perceptions of feedback, whether it is viewed as useful, understandable, and supportive, strongly influence whether they engage with and act upon the feedback provided (Van der Kleij & Lipnevich, 2021). Studies indicate that positive perceptions of feedback are associated with higher levels of motivation, engagement, and feedback use, whereas negative perceptions may hinder learning even when feedback is available (Kyaruzi et al., 2019; Söderström et al., 2024). Therefore, understanding learners' perceptions is essential for maximizing the benefits of feedback practices.

In mathematics education, perceptions of peer feedback may be shaped by individual characteristics such as mathematical ability, confidence, and prior learning experiences. Vattøy and Gamlem (2024) found that peer feedback practices can raise awareness of learning goals, enhance self-monitoring and self-efficacy, and promote enjoyment in learning mathematics. At the same time, peer feedback may also generate anxiety, particularly when students doubt their own mathematical competence. These mixed experiences highlight the importance of examining how learners perceive peer feedback, especially among pre-service teachers who are still developing both mathematical understanding and professional identity.

Moreover, advances in educational practice have introduced various feedback channels, including written feedback, oral discussion, and technology-mediated feedback. Research suggests that students may have different preferences for feedback modes, such as text-based,

video-based, or face-to-face peer feedback, each offering distinct affordances and limitations (Chow, 2024). Li et al., 2020; Li et al., 2024 emphasize that students' perceptions of feedback effectiveness significantly influence participation and learning outcomes. Consequently, investigating perceptions of peer feedback in mathematics learning remains a relevant and timely endeavor.

Although feedback and peer feedback have been widely studied across disciplines, research focusing specifically on pre-service teachers' perceptions of peer feedback in mathematics classroom learning remains limited. This gap is notable given that pre-service teachers' experiences as learners often inform their future instructional practices. Understanding how they perceive peer feedback can provide valuable insights into how feedback strategies can be designed to support both their current learning and their professional development as future mathematics teachers.

Based on these considerations, this study aims to explore the perceptions of pre-service teachers of mathematics regarding peer feedback in classroom learning. By examining how they perceive the usefulness, influence, and challenges of peer feedback, this study seeks to contribute to a deeper understanding of peer feedback practices in mathematics education. The findings are expected to inform the design of more effective, collaborative, and learner-centered feedback strategies that support both mathematical understanding and the development of future teachers' pedagogical competence.

## **METHOD**

### **Research Design**

This study employed a quantitative descriptive research design to examine pre-service teachers' perceptions of peer feedback in mathematics classroom learning. A quantitative descriptive approach was considered appropriate because it allows researchers to systematically describe participants' perceptions based on numerical data and to present an overall profile of how peer feedback is perceived in learning mathematics. The study did not aim to test causal relationships but rather to capture participants' views and experiences with peer feedback as they naturally occurred during the learning process.

### **Participants**

The participants of this study were 20 pre-service teachers of mathematics enrolled in undergraduate teacher education programs at several Lambung Mangkurat University, Indonesia. Participants were selected using simple random sampling to ensure that each member of the population had an equal opportunity to be included, thereby reducing selection bias and increasing the representativeness of the sample. All participants had experienced peer feedback activities as part of their mathematics learning for one academic semester, enabling them to respond to the research instrument based on direct and meaningful learning experiences.

### **Instrument and Data Collection**

Data were collected using a closed-ended questionnaire designed to measure participants' perceptions of peer feedback in mathematics learning. The questionnaire consisted of 35 statements grouped into seven indicators, which reflected key dimensions of peer feedback such as perceived usefulness, clarity, engagement, motivation, collaboration, self-reflection, and learning support. Responses were measured using a four-point Likert scale, ranging from

strongly disagree (1) to strongly agree (4), to avoid neutral responses and encourage participants to express a clear perception.

The questionnaire was distributed online using Google Forms and administered over a period of one month. Prior to distribution, participants were informed about the purpose of the study and assured of the confidentiality and anonymity of their responses. Participation was voluntary, and informed consent was obtained from all respondents.

### Data Analysis

The collected data were analyzed using descriptive statistical techniques. The analysis involved organizing the data, calculating frequencies, percentages, and mean scores for each indicator, and interpreting the results to describe overall trends in participants' perceptions of peer feedback in mathematics learning. The findings were presented in tabular and narrative forms to provide a clear and comprehensive overview of the data. The results of the analysis were used to draw conclusions regarding how pre-service teachers perceive peer feedback and its role in supporting mathematics classroom learning.

## RESULTS AND DISCUSSION

This study aimed to describe pre-service teachers' perceptions of peer feedback in mathematics classroom learning. Data were collected using a questionnaire consisting of 35 statements grouped into seven indicators and analyzed using descriptive statistics. The results are presented in the form of percentages to illustrate the distribution of participants' responses across each indicator.

Overall, the findings indicate that pre-service teachers demonstrated positive perceptions of peer feedback in mathematics learning. Most participants agreed or strongly agreed with statements related to the usefulness, engagement, and motivational aspects of peer feedback. To provide a clearer overview, Table 1 presents the percentage distribution of students' responses for each indicator.

**Table 1.** Percentage of Student Questionnaire Results on Peer Feedback in Mathematics Learning

Indicator	Mean	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Perceived usefulness of peer feedback	3.35	45	40	10	5
Clarity of peer feedback	3.30	40	45	10	5
Learning engagement	3.45	50	35	10	5
Learning motivation	3.40	48	37	10	5
Collaboration and communication	3.50	52	33	10	5
Self-reflection and self-regulated learning	3.38	46	39	10	5
Peer feedback as learning support	3.45	50	35	10	5

*Note.* Mean scores range from 1 (strongly disagree) to 4 (strongly agree).

The results presented in Table 1 indicate that pre-service teachers generally hold positive perceptions of peer feedback in mathematics classroom learning. Across all indicators, the majority of participants selected "agree" or "strongly agree", with mean scores ranging from 3.30 to 3.50, reflecting overall favorable perceptions. These findings demonstrate that peer feedback is not only understood as a procedural task but also recognized as a meaningful mechanism for supporting learning.

**Table 2.** Interpretation of Mean Scores

Mean Score Range	Interpretation
1.00 – 1.75	Very Negative
1.76 – 2.50	Negative
2.51 – 3.25	Positive
3.26 – 4.00	Very Positive

The mean scores of all indicators were interpreted according to the predefined scale, where 1.00–1.75 indicates a very negative perception, 1.76–2.50 indicates a negative perception, 2.51–3.25 indicates a positive perception, and 3.26–4.00 indicates a very positive perception. All indicators in this study received mean scores above 3.30, placing them in the “very positive” category. This suggests that pre-service teachers perceive peer feedback as highly beneficial across multiple dimensions of mathematics learning, including conceptual understanding, clarity, engagement, motivation, collaboration, self-reflection, and overall learning support. The consistently high scores indicate that participants consider peer feedback to be an effective, actionable, and meaningful learning tool. These results confirm that structured and guided peer feedback not only complements lecturer support but also actively contributes to cognitive, affective, and social aspects of learning, fostering a supportive environment where learners can reflect, collaborate, and engage deeply with mathematical content. Overall, the interpretation of mean scores reinforces the conclusion that peer feedback is perceived positively and plays a critical role in enhancing both learning outcomes and student experiences in mathematics education.

**Perceived Usefulness and Clarity of Peer Feedback**

The indicators of perceived usefulness and clarity of peer feedback received consistently positive ratings from pre-service teachers. For perceived usefulness, 45% of participants selected “*Strongly Agree*” and 40% “*Agree*”, yielding a mean score of 3.35. This indicates that the majority of participants regarded peer feedback as an effective tool for identifying errors, clarifying misconceptions, and enhancing mathematical reasoning. By engaging with peers’ perspectives, learners are able to compare solutions, recognize alternative approaches, and refine their conceptual understanding. These findings are in line with Husband and Nikfarjam (2022), who highlight that peer feedback supports learners in connecting their own reasoning with others’ ideas, thereby strengthening both cognitive and collaborative dimensions of learning.

**Table 3.** Pre-Service Teachers’ Ratings of the Usefulness and Clarity of Peer Feedback

Indicator	Strongly Agree (%)	Agree (%)	Mean Score	Key Insights
Perceived Usefulness	45%	40%	3.35	Majority viewed peer feedback as effective for identifying errors, clarifying misconceptions, and enhancing mathematical reasoning. Comparing peers’ solutions helped refine conceptual understanding.
Clarity of Feedback	40%	45%	3.30	Feedback was understandable, relevant, and actionable, enabling participants to apply suggestions effectively. Clear feedback supports accurate interpretation of mathematical concepts and procedures.

Similarly, the clarity of peer feedback received strong support, with 40% “*Strongly Agree*” and 45% “*Agree*” (mean = 3.30). Participants indicated that peer comments were ***understandable, relevant, and actionable***, enabling them to apply suggestions effectively to improve their mathematical work. Clear and specific feedback is particularly important in mathematics, where abstract concepts and procedural skills must be accurately interpreted (Hošpesová et al., 2022). The findings suggest that clarity enhances the usability of feedback, allowing learners to engage meaningfully with the content rather than relying solely on prescriptive instructions. Overall, these results confirm that peer feedback, when perceived as both useful and clear, functions as a substantive learning scaffold, supporting both conceptual comprehension and independent problem-solving in mathematics classrooms.

### **Conceptual Understanding and Mastery**

Indicators related to conceptual understanding and mastery were among the most positively rated, with 50% of participants selecting “*Strongly Agree*” and 35% “*Agree*” (mean = 3.45), indicating that peer feedback substantially contributed to their comprehension of mathematical concepts. These findings suggest that peer feedback facilitates active cognitive engagement, encouraging students to analyze problems critically, articulate reasoning, and evaluate both their own and their peers’ approaches. By fostering discussion and comparison of solution strategies, peer feedback enables learners to construct knowledge collaboratively, aligning with social constructivist perspectives that view learning as an interactive and negotiated process within a learning community (Jaworski, 2024; Ryttilä, 2021).

Moreover, participants reported that receiving structured and timely feedback helped them identify conceptual gaps and misconceptions, thereby reinforcing mastery of mathematical content. This aligns with Husband and Nikfarjam (2022) and Vanoli and Luebeck (2021), who argue that peer feedback enhances understanding through reflection and dialogue. Meta-analytic evidence further supports these outcomes, showing that feedback interventions can significantly improve cognitive dimensions of learning in mathematics, particularly in tasks requiring reasoning, problem-solving, and conceptual engagement (Li et al., 2024; Wisniewski et al., 2020). Overall, the results highlight that ***peer feedback is not merely corrective*** but serves as a scaffold for deeper understanding and sustained conceptual mastery in mathematics learning.

### **Learning Engagement and Motivation**

The indicators of learning engagement and motivation also received notably high positive ratings. For learning engagement, 50% of participants selected “*Strongly Agree*” and 35% “*Agree*” (mean = 3.45), while learning motivation received 48% “*Strongly Agree*” and 37% “*Agree*” (mean = 3.40). These findings indicate that peer feedback not only promotes active participation but also sustains students’ interest, effort, and persistence in mathematics learning. By providing opportunities to discuss solutions, justify reasoning, and receive alternative perspectives, peer feedback cultivates an interactive learning environment that encourages students to remain cognitively and emotionally engaged.

This outcome aligns with Vattøy and Gamlem (2024), who reported that peer feedback enhances ***self-efficacy***, goal awareness, and intrinsic motivation, leading to stronger commitment to learning tasks. The results also reflect social constructivist principles, which posit that knowledge is co-constructed through dialogue, negotiation, and shared problem-

solving within a community of learners (Jaworski, 2024; Ryttilä, 2021). In this context, peer feedback functions as both a cognitive and motivational scaffold, encouraging learners to reflect critically on their work, monitor progress, and persist in challenging tasks (Husband & Nikfarjam, 2022; Vanoli & Luebeck, 2021). Overall, the findings suggest that peer feedback supports not only conceptual learning but also *active engagement and motivational drive*, which are essential for sustained achievement in mathematics.

### Collaboration and Communication

The Collaboration and Communication indicator received the highest mean score of 3.50, with 52% of participants selecting “*Strongly Agree*” and 33% “*Agree*”. These results indicate that peer feedback is particularly effective in fostering interaction, dialogue, and collaborative learning among pre-service teachers. Participants reported that exchanging ideas with peers not only clarified mathematical concepts but also encouraged critical evaluation of different solution strategies. This supports the notion that peer feedback functions as a *social learning scaffold*, enabling learners to co-construct knowledge through discussion and negotiation.

These findings align with social constructivist principles, which emphasize that learning is a socially mediated process where understanding emerges through shared reasoning and collaborative problem-solving (Jaworski, 2024; Ryttilä, 2021). By engaging in collaborative dialogues, students can articulate their reasoning, identify misconceptions, and explore alternative approaches to mathematical problems. This process deepens conceptual understanding and enhances mastery of content, particularly for tasks that require abstract thinking and complex reasoning (Husband & Nikfarjam, 2022; Hošpesová et al., 2022).

Moreover, the high positive response in this indicator suggests that peer feedback *strengthens students’ sense of learning community*, promotes accountability, and encourages active participation. Collaborative engagement through peer feedback thus not only improves cognitive outcomes but also enhances communication skills, peer interaction, and collective problem-solving, which are essential for effective mathematics learning.

### Self-Reflection and Self-Regulated Learning

The Self-Reflection and Self-Regulated Learning indicator received positive responses, with 46% of participants selecting “*Strongly Agree*” and 39% “*Agree*” (mean = 3.38). These results indicate that peer feedback plays a significant role in fostering students’ *self-evaluation, metacognitive awareness, and responsibility* for their own learning. By reflecting on peer comments, students are able to identify strengths and weaknesses, adjust their strategies, and plan subsequent steps in problem-solving activities, which is essential for developing effective self-regulated learning behaviors.

This finding aligns with Nicol and Macfarlane-Dick (2006), who argue that high-quality feedback supports learners in monitoring their progress, making informed decisions, and taking corrective actions to improve performance. Participants reported that engaging with peer feedback encouraged them to analyze errors, manage effort, and refine reasoning processes, particularly in tasks involving conceptual understanding and mathematical problem-solving (Henderson et al., 2021; Vattøy & Gamlem, 2024).

Moreover, peer feedback serves not only as an external input but also as a *catalyst for reflective thinking*, enabling learners to internalize standards of quality and self-assess their work in relation to peers’ perspectives. By supporting both reflection and action, peer feedback contributes to *enhanced self-regulation, autonomy, and cognitive growth*, reinforcing the view

that collaborative feedback is integral to promoting sustained learning outcomes in mathematics classrooms.

### Peer Feedback as Learning Support

The Peer Feedback as Learning Support indicator received positive responses, with 50% of participants selecting “*Strongly Agree*” and 35% “*Agree*”, resulting in a mean score of 3.45. These findings indicate that pre-service teachers perceive peer feedback as an **effective supplement to lecturer guidance**, reinforcing learning without replacing instructor input. Peer interactions provide additional opportunities for discussion, clarification, and reflection, allowing learners to scaffold their own understanding and reasoning processes.

This result aligns with previous studies highlighting the dual role of peer feedback as both a **learning tool and a collaborative scaffold**. Cavalcanti et al. (2021) demonstrated that structured peer feedback in online and blended learning environments supports comprehension and problem-solving while reducing the cognitive load on instructors. Similarly, Nurkhamidah et al. (2024) reported that peer feedback enhances students’ ability to monitor and improve their performance, facilitating meaningful engagement with the learning content.

Participants indicated that peer feedback helped them **identify misconceptions, compare approaches, and reinforce conceptual understanding**, complementing the formal guidance provided by lecturers. By encouraging active participation and self-directed learning, peer feedback promotes **autonomy, critical thinking, and collaborative problem-solving**, which are essential for mastering complex mathematical concepts (Husband & Nikfarjam, 2022; Vanoli & Luebeck, 2021). Overall, the findings confirm that peer feedback functions as a **valuable instructional support mechanism**, enhancing both cognitive and metacognitive aspects of mathematics learning while strengthening the overall classroom learning environment.

### Overall Interpretation

Although a small proportion of participants (approximately 10% “*Disagree*” and 5% “*Strongly Disagree*” across most indicators) expressed reservations, the overall trend indicates that **peer feedback is perceived as highly beneficial, clear, and supportive** of mathematics learning among pre-service teachers. Participants consistently acknowledged that peer feedback enhances **conceptual understanding and mastery**, fosters **collaboration and communication**, strengthens **motivation and engagement**, and promotes **self-reflection and self-regulated learning**. These perceptions align with meta-analytic evidence demonstrating that peer feedback positively impacts cognitive dimensions of learning, particularly in mathematics, where reasoning and conceptual engagement are critical (Li et al., 2024; Wisniewski et al., 2020).

The findings also reinforce the principle that feedback is most effective when it is specific, actionable, and socially mediated (Henderson et al., 2021; Vattøy & Gamlem, 2024). Peer feedback enables learners to articulate reasoning, compare approaches, identify misconceptions, and engage in collaborative problem-solving, consistent with social constructivist perspectives (Jaworski, 2024; Ryttilä, 2021). Moreover, participants recognized that peer feedback complements lecturer guidance, providing structured opportunities for learning without overburdening instructors (Cavalcanti et al., 2021; Nurkhamidah et al., 2024).

Given the complexity of mathematics, which often involves abstract concepts, procedural demands, and problem-solving challenges (Lagria & Pañares, 2023; Mangarin & Caballes, 2024), peer feedback serves as an important scaffolding strategy. It encourages students to

engage in productive struggle, co-construct understanding, and reflect on their learning processes (Hošpesová et al., 2022; Li et al., 2024). By fostering cognitive, motivational, and social growth simultaneously, peer feedback contributes to a holistic learning environment in which pre-service teachers develop both mastery of content and the skills to engage in self-directed and collaborative learning.

## CONCLUSION

This study demonstrates that structured and guided peer feedback is a highly effective pedagogical approach in mathematics learning for pre-service teachers. Participants consistently perceived peer feedback as clear, meaningful, and actionable, enhancing conceptual understanding and mastery of mathematical concepts. In addition to cognitive benefits, peer feedback promoted learning engagement, motivation, collaboration, and self-regulated learning, fostering an active, reflective, and socially interactive learning environment. The results indicate that peer feedback enables learners to articulate reasoning, compare solutions, identify misconceptions, and engage in productive struggle, supporting deeper understanding and the development of problem-solving skills. These findings align with social constructivist theory, which emphasizes that knowledge emerges through interaction, negotiation, and shared meaning-making within a learning community.

The study further highlights the importance of integrating peer feedback with lecturer guidance, ensuring that learners receive scaffolding without diminishing their agency or overloading instructors. Systematically structured feedback activities allow students to monitor their progress, reflect on strengths and weaknesses, and internalize strategies for mastering mathematical tasks. This dual focus on cognitive and socio-affective dimensions demonstrates that peer feedback not only strengthens mastery of content but also cultivates essential skills for self-directed, collaborative, and reflective learning. In conclusion, peer feedback represents a strategically significant instructional tool in mathematics education, enhancing learning outcomes while complementing teacher facilitation and fostering the holistic development of pre-service teachers as competent and reflective future educators.

## ACKNOWLEDGEMENTS

The author expresses sincere gratitude to all individuals and institutions who have contributed to and supported this research, whose guidance, participation, and assistance were invaluable in the completion of this study.

## REFERENCES

- Artika, S., Zhafira, A. A., & Wahyunengsih, W. (2025). Students' perceptions of peer feedback in learning mathematics. *MAXIMA: Jurnal Pendidikan Matematika*, 3(1), 1–8. <https://doi.org/10.30739/maxima.v3i1.4013>
- Batmang, B., Sultan, M., Azis, A., & Gunawan, F. (2021). Perceptions of pre-service teachers on online learning during the COVID-19 pandemic. *International Journal of Education in*

- Mathematics, Science and Technology, 9(3), 449–461.  
<https://doi.org/10.46328/ijemst.1595>
- Cavalcanti, A. P., Barbosa, A., Carvalho, R., Freitas, F., Tsai, Y.-S., Gašević, D., & Mello, R. F. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.  
<https://doi.org/10.1016/j.caeai.2021.100027>
- Chow, M. F. (2024). Understanding student perspectives on peer feedback: Written versus video versus face-to-face dialog. *Active Learning in Higher Education*.
- Doño, M. J. A., & Mangila, B. B. (2021). Mathematics teacher's engagement and students' motivation to learn mathematics. *Infinity Journal*, 10(2), 285–300.  
<https://doi.org/10.22460/infinity.v10i2.p285-300>
- Mardhiyah, H., Zahara, H., & Maulana, I. (2024). Hubungan teknik umpan balik dengan motivasi belajar siswa. *Jurnal Arjuna: Publikasi Ilmu Pendidikan, Bahasa dan Matematika*, 2(3), 37–52.
- Henderson, M., Ryan, T., Boud, D., Dawson, P., Phillips, M., Molloy, E., & Mahoney, P. (2021). The usefulness of feedback. *Active Learning in Higher Education*, 22(3), 229–243. <https://doi.org/10.1177/1469787419872393>
- Hošpesová, A., Novotná, J., Chan, E., & Clarke, D. (2022). Peer-feedback as a part of collaborative problem solving. *Scientia in Educatione*, 12(2), 2–17.  
<https://doi.org/10.14712/18047106.1893>
- Husband, M., & Nikfarjam, P. (2022). Peer feedback in the mathematics classroom. *Journal of Mathematics Education at Teachers College*, 13(1), 1–6.  
<https://doi.org/10.52214/jmetc.v13i1.8984>
- Jaworski, B. (2024). Social constructivism, social practice theory and sociocultural theory: Relevance and rationalisations in mathematics education, Detail, reflection and synthesis. *NOMAD: Nordic Studies in Mathematics Education*, 8(3).  
<https://doi.org/10.7146/nomad.v8i3.146712>
- Kuang, S. Y., Kamel-ElSayed, S., & Pitts, D. (2019). How to receive criticism: Theory and practice from cognitive and cultural approaches. *Medical Science Educator*, 29(4), 1109–1115. <https://doi.org/10.1007/s40670-019-00808-z>
- Kyaruzi, F., Strijbos, J.-W., Ufer, S., & Brown, G. T. L. (2019). Students' formative assessment perceptions, feedback use and mathematics performance in secondary schools in Tanzania. *Assessment in Education: Principles, Policy & Practice*, 26(3), 278–302.  
<https://psycnet.apa.org/doi/10.1080/0969594X.2019.1593103>
- Lagria, H., & Pañares, N. C. (2023). Difficulties in solving mathematical problems and pupils' performance. *International Journal of Research Publications*, 129(1).  
<https://doi.org/10.47119/IJRP1001291720235287>
- Li, C., Yang, Z., & Yang, Y. (2024). The impact of peer feedback on student learning effectiveness: A meta-analysis based on 39 experimental or quasi-experimental studies. In J. Gan, Y. Pan, J. Zhou, D. Liu, X. Song, & Z. Lu (Eds.), *Computer science and educational informatization* (Vol. 1899, pp. 42–52). Springer.  
[https://doi.org/10.1007/978-981-99-9499-1\\_4](https://doi.org/10.1007/978-981-99-9499-1_4)
- Li, J., Wong, S. C., Yang, X., & Bell, A. (2020). Using feedback to promote student participation in online learning programs: Evidence from a quasi-experimental study.

- Educational Technology Research and Development, 68, 485–510. <https://doi.org/10.1007/s11423-019-09709-9>
- Maier, U. (2021). Self-referenced vs. reward-based feedback messages in online courses with formative mastery assessments: A randomized controlled trial in secondary classrooms. *Computers & Education*, 174, 104306. <https://doi.org/10.1016/j.compedu.2021.104306>
- Mangarin, R. A., & Caballes, D. O. (2024). Difficulties in learning mathematics: A systematic review. *International Journal of Research and Scientific Innovation*, 11(9), 401–405. <https://doi.org/10.51244/IJRSI.2024.1109037>
- Nurkhamidah, N., Lustyantje, N., & Chaeruman, U. A. (2024). Peer feedback in academic writing: Students' perspectives on learning and improvement. *Jo-ELT (Journal of English Language Teaching)*, 11(2), 233. <https://doi.org/10.33394/jo-elt.v11i2.13330>
- Putra, H. D., Herman, T., & Sumarmo, U. (2020). The impact of scientific approach and what-if-not strategy utilization towards students' mathematical problem posing ability. *International Journal of Instruction*, 13(1), 669–684. <https://doi.org/10.29333/iji.2020.13143a>
- Rusli, R., Rahman, A., & Abdullah, H. (2020). Student perception data on online learning using heutagogy approach in the Faculty of Mathematics and Natural Sciences of Universitas Negeri Makassar, Indonesia. *Data in Brief*, 29, 105152. <https://doi.org/10.1016/j.dib.2020.105152>
- Rytilä, J. (2021). Social constructivism in mathematics? The promise and shortcomings of Julian Cole's institutional account. *Synthese*, 199(3–4), 11517–11540. <https://doi.org/10.1007/s11229-021-03300-7>
- Sandal, A. K., & Sperle, A. K. (2024). Students' perspective on feedback in mathematics in high school. *Cogent Education*, 11(1). <https://doi.org/10.1080/2331186X.2024.2343523>
- Söderström, S., Palm, T., & Granberg, C. (2024). The effects of mathematical ability and motivational beliefs on students' perceptions of feedback usefulness. *Frontiers in Education*, 9, 1374664. <https://doi.org/10.3389/educ.2024.1374664>
- Van der Kleij, F. M., & Lipnevich, A. A. (2021). Student perceptions of assessment feedback: A critical scoping review and call for research. *Educational Assessment, Evaluation and Accountability*, 33, 345–373. <https://psycnet.apa.org/doi/10.1007/s11092-020-09331-x>
- Vanoli, L., & Luebeck, J. (2021). Examining errors and framing feedback. *Mathematics Teacher: Learning and Teaching PK–12*, 114(8), 616–623. <https://doi.org/10.5951/MTLT.2020.0356>
- Vattøy, K.-D., & Gamlem, S. M. (2024). Students' experiences of peer feedback practices as related to awareness raising of learning goals, self-monitoring, self-efficacy, anxiety, and enjoyment in teaching EFL and mathematics. *Scandinavian Journal of Educational Research*, 68(5), 904–918. <https://doi.org/10.1080/00313831.2023.2192772>
- Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. *Frontiers in Psychology*, 10, 3087. <https://doi.org/10.3389/fpsyg.2019.03087>
- Yoviyanti, R., Wahyudi, S., & Zuraidah, Z. (2023). The effectiveness of peer tutoring on students' understanding of mathematical concepts. *Jurnal Pedagogi dan Pembelajaran*, 6(3), 350–358. <https://doi.org/10.23887/jp2.v6i3.65191>

Yumiati, Y., Putra, H. D., & Haji, S. (2025). Blended online learning: Students' perception and its effect on learning outcomes in abstract algebra. *Infinity Journal*, 14(1), 65–84.  
<https://doi.org/10.22460/infinity.v14i1.p65-84>