



MEASURING STUDENTS' SELF DETERMINATION IN MATHEMATICS LEARNING: AN INSTRUMENT VALIDATION STUDY

Iryana Muhammad¹, Al Jupri^{2*}, Kusnandi², Siti fatimah²

¹ Universitas Malikussaleh, Reuleut-Aceh Utara, Aceh, Indonesia

² Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No.229, Bandung, Indonesia

*Email: aljupri@upi.edu

Abstract

Self-determination is an important psychological aspect to measure. Instruments to measure this aspect are still limited. This study aims to develop and validate a questionnaire to measure self-determination in junior high school students' mathematics learning. This instrument is designed to measure four indicators of self-determination: autonomy, competence, relatedness, and willingness to engage in active learning. The research used a quantitative, descriptive approach, with expert validation and empirical testing. Content validity was evaluated by five validators from the fields of psychology, language, and mathematics education using the Q-Cochran test. The results of the empirical testing were analyzed for validity using Pearson Product-Moment correlation, and reliability was measured using Cronbach's Alpha. The Q-Cochran test results showed consistency in the experts' assessments. Of the 40 statements, 32 were declared valid and 8 invalid, with a high level of reliability. Thus, the developed instrument was deemed valid and reliable for measuring students' autonomy, competence, relatedness, and willingness to actively learn in mathematics.

Keywords: *instrument validation, mathematics learning, self-determination*

Abstrak

Determinasi diri merupakan salah satu aspek psikologis yang penting untuk diukur. Instrumen untuk mengukur aspek ini masih terbatas. Penelitian ini bertujuan mengembangkan dan memvalidasi instrumen angket determinasi diri siswa SMP dalam pembelajaran matematika. Instrumen ini dirancang untuk mengukur empat indikator determinasi diri, yaitu otonomi, kompetensi, keterkaitan, dan kemauan aktif belajar. Penelitian menggunakan pendekatan deskriptif kuantitatif melalui tahapan validasi ahli dan uji coba empiris. Validitas isi dievaluasi oleh lima validator dari bidang psikologi, bahasa, dan pendidikan matematika menggunakan uji *Q-Cochran*. Hasil uji coba empiris dianalisis validitasnya dengan korelasi *Pearson Product Moment* dan reliabilitas diukur menggunakan *Cronbach's Alpha*. Hasil uji *Q-Cochran* menunjukkan adanya keseragaman penilaian para ahli. Dari 40 pernyataan, 32 dinyatakan valid dan 8 tidak valid, dengan tingkat reliabilitas tinggi. Dengan demikian, instrumen yang dikembangkan dinyatakan valid dan reliabel untuk mengukur otonomi, kompetensi, keterkaitan, dan kemauan aktif belajar siswa dalam pembelajaran matematika.

Kata kunci: *determinasi diri, pembelajaran matematika, validasi instrumen*

How to Cite: Muhammad, I., Jupri, Al., Kusnandi, & Fatimah, S. (2025). Measuring Students' Self Determination in Mathematics Learning: An Instrument Validation Study. *ALGORITMA Journal of Mathematics Education*, 7 (2), 100-109.

Permalink/DOI: <http://dx.doi.org/10.15408/ajme.v7i2.48714>

Naskah Diterima: Nov 2025; Naskah Disetujui: Des 2025; Naskah Dipublikasikan: Des 2025

INTRODUCTION

Mathematics learning at the junior high school level plays a crucial role in developing students' logical, analytical, and systematic thinking skills. However, various studies have revealed that mathematics instruction in Indonesia remains predominantly procedural and outcome-oriented, rather than emphasizing conceptual understanding and students' learning motivation. This condition affects students' engagement and independence in learning mathematics, which reflects one of the key indicators of low self-determination among learners (Ferdianto & Hartinah, 2020; Widjaja et al., 2015).

Self-determination is one of the essential psychological constructs in education that explains the extent to which an individual engages in learning activities autonomously, feels competent, establishes positive relationships within the learning environment, and demonstrates an active willingness to learn (Ryan & Deci, 2000; Suprayogi et al., 2022). In the context of mathematics learning, self-determination plays a vital role in fostering students' intrinsic motivation, perseverance in facing challenges, and their ability to connect learning experiences with real-life situations. Intrinsic motivation, which arises from students' need to feel competent and autonomous, serves as a key driving force that encourages them to actively engage in the learning process (Rahman et al., 2020). Research has shown that students with higher levels of intrinsic motivation are more likely to engage in challenging learning activities, including those in mathematics learning (Purnamasari, 2024).

Several previous studies have developed instruments to measure learning motivation or attitudes toward mathematics (Rahmawati & Nugraha, 2021; Utami & Rosyidi, 2019). However, most of these instruments have not specifically measured self-determination within the framework of Self-Determination Theory (SDT), which encompasses the basic psychological needs of autonomy, competence, and relatedness, let alone incorporate the aspect of active learning motivation, which is particularly relevant in the Indonesian mathematics learning context. The development of instructional instruments and the measurement of learning motivation within local contexts have, however, become a growing focus in Indonesian educational research. For instance, several studies have explored the effectiveness of the Realistic Mathematics Education (RME) approach in enhancing students' algebraic thinking skills (Musyrifah et al., 2023) dan validasi instrumen berbasis konteks lokal untuk memastikan kesesuaian budaya dan bahasa siswa SMP (Asmarani, 2024).

Building upon these findings, this study seeks to extend previous research by developing and validating a self-determination instrument that is relevant to the context of mathematics learning at the junior high school level. The validation process was carried out in three stages: content validity by experts and empirical validity through pilot testing with eighth-grade students.

Data were analyzed using the Q-Cochran test to examine the uniformity of expert judgments for content validity, the Pearson Product-Moment correlation to assess empirical validity, and Cronbach's Alpha to measure the reliability of the instrument. Theoretically, this study is grounded in the Self-Determination Theory (SDT), which emphasizes the fulfillment of basic psychological needs as the foundation for autonomous and meaningful learning motivation (Deci & Ryan, 2000). which emphasizes that human motivation develops optimally when the basic psychological needs for autonomy, competence, and relatedness are fulfilled. This study extends the theoretical framework by introducing a fourth dimension, active learning motivation, as a form of motivational actualization reflected in students' learning behavior in mathematics.

The novelty of this study lies in the development of a self-determination instrument encompassing four key indicators, autonomy, competence, relatedness, and active learning motivation, which are contextually designed for mathematics learning among junior high school students in Lhokseumawe City. The instrument was empirically validated and adapted to local cultural characteristics, making it a reliable tool for assessing students' levels of self-determination while contributing to further research in mathematics education and educational psychology. Based on this rationale, the present study aims to validate a self-determination instrument in mathematics learning through content, face, and empirical validity tests, in order to produce a comprehensive and contextually relevant instrument for measuring the self-determination levels of junior high school students.

METHOD

This study employed a descriptive quantitative approach with an instrument validation design. The purpose of the study was to develop and examine the validity and reliability of a self-determination questionnaire for junior high school students in mathematics learning. The validation process was carried out in two stages: content and face validity by experts, and empirical testing with students. The content validity was conducted by five experts from different fields, consisting of one psychology expert, one Indonesian language expert, one mathematics education lecturer, and two junior high school mathematics teachers. The involvement of multidisciplinary experts was intended to ensure that the instrument met substantive, linguistic, and pedagogical standards. Meanwhile, the empirical test was conducted at one public junior high school in Lhokseumawe City, Aceh, involving 26 eighth-grade students selected through purposive sampling. The participants were chosen based on their availability and willingness to complete the questionnaire thoroughly and honestly.

The self-determination questionnaire was developed to measure students' levels of willingness, independence, and intrinsic motivation in facing challenges and completing

mathematical tasks. The structure of the questionnaire consists of four main parts: the respondent identity section, which includes basic information such as name, gender, and class; the response instructions, which guide students to answer each statement honestly; the rating scale, which uses a four-point Likert scale, Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), designed asymmetrically without a neutral option to encourage respondents to take a clear position on each statement (Koo, 2025; Kusmaryono et al., 2022; Mason, 2025; Ramezani et al., 2025; Safitri, 2024) as well as the questionnaire statements, which were constructed based on four main indicators of self-determination: autonomy, competence, relatedness, and active learning motivation.

The instrument consists of 40 statements, with each indicator containing ten items evenly divided into five positive and five negative statements. Each item was rated using a four-point Likert scale, ranging from 1 to 4. The construction of the items was guided by the principles of the Self-Determination Theory (SDT) (Deci & Ryan, 2002), which was adapted to the context of mathematics learning at the junior high school level. The validation procedure was carried out in several stages. First, an initial draft of the instrument was developed based on theoretical foundations and a review of relevant literature on self-determination and mathematics learning. Second, the instrument underwent content and face validation by five experts to assess the relevance, clarity of wording, and representativeness of the construct. Third, the results of the content validation were analyzed using the Q-Cochran statistical test to determine whether the experts provided consistent judgments across all aspects of the instrument. The hypotheses used in this test were as follows:

H₀: The experts provided consistent judgments

H₁: The experts provided different judgments

The testing criteria were established such that H₀ is accepted if the Asymp. Sig value ≥ 0.05 and rejected if the value is < 0.05 . A significance value of ≥ 0.05 indicates uniformity among expert judgments, signifying that the instrument possesses good content validity. After the results of the content and face validation were analyzed, the instrument was revised based on the experts' feedback. Subsequently, an empirical test was conducted with 26 eighth-grade junior high school students to obtain data for empirical validity and reliability analysis.

The empirical validity was tested using the item–total correlation with the Pearson Product-Moment technique to determine the relationship between each item and the total construct score. An item was considered valid if the calculated r-value was greater than the critical r-table value at a significance level of 0.05. Meanwhile, the instrument's reliability was measured using the Cronbach's Alpha coefficient, with the criterion that the instrument is considered reliable if $\alpha \geq 0.60$. The overall data analysis procedure is illustrated in Figure 1.

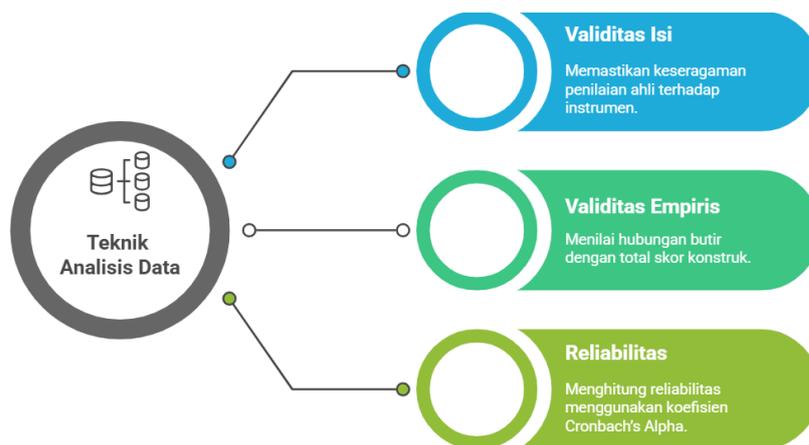


Figure 1. Data Analysis Technique

All statistical analyses were conducted using SPSS Statistics version 27. The results of the content, face, empirical validity, and reliability tests served as the basis for determining the feasibility and internal consistency of the self-determination instrument in mathematics learning. All components of the research method were systematically integrated, in which expert validation ensured theoretical and linguistic appropriateness, while the empirical testing provided a strong empirical foundation for the reliability and construct accuracy of the developed instrument.

RESULTS AND DISCUSSION

The results of this study present the process and findings from the content, face, and empirical validity tests of the self-determination questionnaire for students in mathematics learning. The analysis was conducted based on expert evaluations and empirical test data obtained from eighth-grade junior high school students. The findings are presented to illustrate the degree of consistency among expert judgments, the appropriateness of questionnaire items, and the internal consistency of the instrument in measuring students' autonomy, competence, relatedness, and active learning motivation. Detailed results and interpretations of the content validity test for the self-determination instrument are presented in Table 1, which shows the comparison of significance values for each validated aspect.

Table 1. Results of the Content Validity Assessment of the Self-Determination Questionnaire Test Statistics

N	7
Cochran's Q	4.000 ^a
df	4
Asymp. Sig.	.406
a. 1 is treated as a success.	

Table 1 shows that the Asymp. Sig value = 0.406, which is greater than the significance level of 0.05. Based on this result, H_0 is accepted, indicating that the experts provided consistent judgments regarding the content validity of the developed self-determination questionnaire items.

Subsequently, the empirical validity test was conducted using data obtained from a pilot test involving 29 eighth-grade students from a school with characteristics similar to the main research subjects. Data were analyzed using the Pearson Product Moment correlation, which examines the relationship between each item score and the total questionnaire score. The analysis results revealed that eight items did not meet the validity criteria because their correlation coefficients ($r_{\text{calculated}} < r_{\text{table}}$). With 29 respondents, the critical r_{table} value ($n = 29$) was 0.367. The complete results of the empirical validity analysis of the self-determination instrument using SPSS Statistics 27 are presented in Table 2.

Table 2. Results of the Validity Test of the Self-Determination Questionnaire

Indicator	Type	Statement	r_{value}	Sig.	Description
Autonomy	(+)	P1	0.493	0.007	Valid
	(+)	P2	0.529	0.003	Valid
	(+)	P3	0.215	0.262	Invalid
	(+)	P4	0.838	0.041	Valid
	(+)	P5	0.033	0.864	Invalid
	(-)	P6	0.573	0.001	Valid
	(-)	P7	0.561	0.002	Valid
	(-)	P8	0.347	0.065	Invalid
	(-)	P9	0.707	0.001	Valid
	(-)	P10	0.418	0.024	Valid
Competence	(+)	P11	0.536	0.003	Valid
	(+)	P12	0.492	0.007	Valid
	(+)	P13	0.547	0.002	Valid
	(+)	P14	0.439	0.017	Valid
	(+)	P15	0.555	0.002	Valid
	(-)	P16	0.312	0.099	Invalid
	(-)	P17	0.398	0.033	Valid
	(-)	P18	0.433	0.019	Valid
	(-)	P19	0.162	0.401	Invalid
	(-)	P20	0.390	0.037	Valid
Relatedness	(+)	P21	0.556	0.002	Valid
	(+)	P22	0.116	0.548	Invalid
	(+)	P23	0.510	0.005	Valid
	(+)	P24	0.421	0.023	Valid
	(+)	P25	0.464	0.011	Valid
	(-)	P26	0.347	0.065	Invalid
	(-)	P27	0.589	0.001	Valid
	(-)	P28	0.457	0.013	Valid
	(-)	P29	0.543	0.002	Valid
	(-)	P30	0.426	0.021	Valid
Active Learning Motivation	(+)	P31	0.646	0.001	Valid
	(+)	P32	0.491	0.007	Valid
	(+)	P33	0.489	0.007	Valid
	(+)	P34	0.564	0.001	Valid
	(+)	P35	0.564	0.001	Valid
	(-)	P36	0.394	0.034	Valid
	(-)	P37	0.33	0.081	Invalid
	(-)	P38	0.586	0.001	Valid
	(-)	P39	0.464	0.011	Valid
	(-)	P40	0.574	0.001	Valid

Based on the validity test results presented in Table 2, it can be clearly identified which items were declared valid and which were not. An item was considered valid if it met the criteria of $r_{\text{calculated}} > r_{\text{table}}$ or had a significance value of $\text{Sig.} < 0.05$. From the analysis, eight statements did not meet the validity criteria and were therefore considered invalid.

The reliability test of the self-determination questionnaire was conducted using the Cronbach's Alpha formula, with the criterion that the instrument is considered reliable if the Cronbach's Alpha value is > 0.60 . The results of the reliability calculation using SPSS Statistics 27 are presented in Table 3.

Table 3. Reliability of the Self-Determination Questionnaire Statements

Reliability Statistics	
Cronbach's Alpha	N of Items
.899	40

As shown in Table 3, the reliability test results indicate that the Cronbach's Alpha coefficient for the 40 questionnaire items was 0.899. This value demonstrates that Cronbach's Alpha > 0.6 (Arikunto, 2013; Azwar, 2012; Sugiyono, 2019), confirming that the instrument has good internal consistency for measuring students' levels of self-determination. This study aimed to validate a self-determination questionnaire instrument for junior high school students in mathematics learning based on four indicators, namely autonomy, competence, relatedness, and active learning willingness. Unlike most previously developed self-determination instruments, which typically focus on the three basic psychological needs proposed in Self-Determination Theory (SDT), autonomy, competence, and relatedness, this study explicitly introduces active learning willingness as an additional indicator. The inclusion of this indicator responds to the contextual demands of mathematics learning, which requires students' active engagement in reasoning, problem solving, and mathematical communication.

The results of the content validity analysis using Aiken's V coefficient indicated that all items met the established content validity criteria. This finding suggests that each item appropriately represents its corresponding indicator within the self-determination construct. These results are consistent with previous studies emphasizing the importance of content validity in the development of psychometric instruments, particularly those measuring motivational and affective constructs in educational contexts (Ryan & Deci, 2018). Furthermore, the Q-Cochran test showed no significant differences among expert judgments, indicating homogeneous evaluations of item appropriateness. This consistency among experts strengthens the evidence of content validity and suggests that the instrument was developed in alignment with a clear and coherent theoretical

framework. Similar approaches have been reported in earlier validation studies, where agreement among experts was used to support the robustness of instrument development processes.

Empirical testing demonstrated that most items were statistically valid, and the instrument exhibited high internal consistency, as reflected by the Cronbach's Alpha coefficient. These findings align with prior research reporting strong reliability for self-determination instruments grounded in SDT when indicators are clearly operationalized and contextually relevant (Hamzah, 2020; Shank et al., 2025). The primary contribution of this study lies in the addition of the active learning willingness indicator, which has not been explicitly incorporated into self-determination questionnaires in previous studies.

In the context of mathematics learning, active learning willingness reflects students' internal readiness and motivation to engage actively in learning activities, such as asking questions, expressing ideas, exploring multiple solution strategies, and reflecting on their mathematical thinking. This indicator complements the three basic psychological needs by emphasizing behavioral engagement, a dimension that is particularly crucial in mathematics classrooms. Previous studies have generally conceptualized student engagement as an outcome of self-determination rather than as an integral dimension measured within the construct itself (Jang et al., 2016). By positioning active learning willingness as a distinct indicator, the instrument developed in this study provides a more comprehensive and context-sensitive measurement of students' self-determination in mathematics learning. Consequently, this instrument offers both theoretical enrichment and practical utility for educators and researchers seeking to assess and foster students' motivational engagement in mathematics. Overall, the findings not only confirm earlier research regarding the validity and reliability of self-determination instruments but also extend the existing literature by integrating an indicator that captures students' active involvement in mathematical learning processes.

CONCLUSION

This study successfully developed and validated a self-determination questionnaire for mathematics learning, encompassing four key indicators: autonomy, competence, relatedness, and active learning motivation. The analysis showed homogeneous expert judgments regarding item relevance, while the empirical and reliability tests produced a valid and internally consistent instrument ($\alpha = 0.899$). The novelty of this research lies in the inclusion of the active learning motivation dimension as an extension of the Self-Determination Theory (SDT), which is particularly relevant to the context of junior high school mathematics learning. The limitation of this study lies in the relatively small number of respondents, which has not yet represented the diversity of schools. Therefore, future research is recommended to revalidate this instrument with

a larger and more varied sample and to integrate it with other variables such as learning motivation and mathematics achievement.

ACKNOWLEDGMENTS

The author sincerely thanks the instrument validators, consisting of a psychology expert, a language expert, a mathematics education lecturer, and two mathematics teachers, for their valuable contributions during the content validation process. Appreciation is also extended to the eighth-grade students of SMP Negeri in Lhokseumawe City for their active participation, as well as to the teachers and school administrators for their support during data collection.

REFERENCES

- Arikunto, S. (2013). *Prosedur Penelitian: Suatu Pendekatan Praktik* (Edisi revisi). Jakarta: Rineka Cipta.
- Asmarani, D. (2024). Pengembangan Instrumen Validasi Pembelajaran Matematika Berbasis Konteks Lokal Siswa SMP. *ALGORITMA: Journal of Mathematics Education*, 6(1), 45–56. <https://journal2.uinjkt.ac.id/index.php/algorithm/article/view/42909>
- Azwar, S. (2012). *Reliabilitas dan Validitas*. Pustaka Pelajar.
- Deci, E. L., & Ryan, R. M. (2000). The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Deci, E. L., & Ryan, R. M. (2002). Handbook of Self-Determination Theory. In *Handbook of self-determination research*. Oxford University Press. <https://doi.org/https://doi.org/10.1093/oxfordhb/9780197600047.001.0001>
- Ferdianto, F., & Hartinah, S. (2020). *Analysis of the Difficulty of Students on Visualization Ability Mathematics Based on Learning Obstacles*. <https://doi.org/10.2991/assehr.k.200402.053>
- Hamzah, I. F. (2020). Aplikasi Self-Determination Theory pada Kebijakan Publik Era Industri 4.0. *Psisula: Prosiding Berkala Psikologi*, 1(September), 66–73. <https://doi.org/10.30659/psisula.v1i0.7691>
- Jang, H., Kim, E. J., & Reeve, J. (2016). Why students become more engaged or more disengaged during the semester: A self-determination theory dual-process model. *Learning and Instruction*, 43, 27–38. <https://doi.org/https://doi.org/10.1016/j.learninstruc.2016.01.002>
- Koo, M. (2025). Likert-Type Scale: A Review of Usage, Issues, and Best Practices. *MDPI Data*, 5(1), 18–30. <https://doi.org/10.3390/data5010018>
- Kusmaryono, I., Wijayanti, D., & Maharani, H. R. (2022). Number of Response Options, Reliability, Validity, and Potential Bias in the Use of the Likert Scale: Education and Social Science Research, a Literature Review. *International Journal of Evaluation and Research in Education*, 8(4), 625–637. <https://doi.org/10.12973/ijem.8.4.625>
- Mason, L. (2025). Cochran’s Q Test of Stimulus Overselectivity within the Autism Spectrum: A Demonstration of the Test’s Utility. *Behaviour Research*, 57(4), 587–601. <https://doi.org/10.1111/BR.13092>
- Musyrifah, E., Nurasiah, D., & Hafiz, M. (2023). Meningkatkan Kemampuan Berpikir Aljabar Siswa dengan Pendekatan Realistic Mathematics Education (RME). *ALGORITMA: Journal of Mathematics Education*, 5(1), 13–25. <https://doi.org/10.15408/ajme.v5i1.32581>
- Purnamasari, N. (2024). Analysis of students’ interest in learning mathematics. *Powermath Edu*, 3(3). <https://doi.org/https://doi.org/10.31980/pme.v3i3.2667>
- Rahman, F., Abdillah, hafizh Z., & Hidayah, N. (2020). Determinasi Diri Sebagai Prediktor School Well-Being Pada Siswa SMP. *Psikoislamedia Jurnal Psikologi*, 05(01), 94–103.
- Rahmawati, I., & Nugraha, E. (2021). Validasi Instrumen Sikap terhadap Matematika Siswa

- Sekolah Menengah. *Jurnal Kajian Pembelajaran Matematika*, 5(2), 101–113.
<https://doi.org/10.30998/jkpm.v5i2.8962>
- Ramezani, S. G., González, D. A., & Vega, C. (2025). Developing and Validating a Comprehensive Scale for Educational Contexts: A Multidimensional Instrument Validation Study. *Education and Information Technologies*, [online ahead of print].
<https://doi.org/10.1007/s10639-025-13587-5>
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, 25(1), 54–67.
<https://doi.org/10.1006/ceps.1999.1020>
- Ryan, R. M., & Deci, E. L. (2018). *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Publications.
<https://books.google.co.id/books?id=th5rDwAAQBAJ>
- Safitri, I. (2024). Should Likert Data Be Transformed Using Summated Rating Scale? Evidence from Undergraduate Students. *EduSci Journal*, 3(2), 45–56.
- Shank, E., Tang, H., & Morris, W. (2025). Motivation in online course design using self-determination theory: an action research study in a secondary mathematics course. *Educational Technology Research and Development*, 73(1), 415–441.
<https://doi.org/10.1007/s11423-024-10410-9>
- Sugiyono. (2019). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D* (Edisi ke-3). Alfabeta.
- Suprayogi, M. N., Al-Mahdaly, A., & Suryadi, D. (2022). The Role of Self-Determination in Mathematics Learning: Implications for Motivation and Engagement. *International Journal of Instruction*, 15(4), 567–582. <https://doi.org/10.29333/iji.2022.15432a>
- Utami, W., & Rosyidi, M. I. (2019). Pengembangan Instrumen Motivasi Belajar Matematika Siswa SMP. *Jurnal Pendidikan Matematika Dan Sains*, 7(1), 45–54.
<https://doi.org/10.21831/jpms.v7i1.27890>
- Widjaja, Wanty, Dolk, Maarten, Fauzan, & Ahmad. (2015). The Role of Contexts and Teacher's Questioning to Enhance Students' Thinking. *Journal of Science and Mathematics Education in Southeast Asia*, 33(2).