International Journal of Multidisciplinary Research of Higher Education (IJMURHICA)
http://ijmurhica.ppj.unp.ac.id/index.php/ijmurhica

# Effect of Numbered Heads Together Model on Student Motivation in Mathematics

**Darwati[1], Fadly AS[1], Gilang Kurniawan[1], Laila Marhayati[2]**
[1]STAI Solok Nan Indah, Indonesia
[2]Universitas Putra Indonesia YPTK Padang, Indonesia
2502005@student.iain-ternate.ac.id *

**Article Information:**
Received November 10, 2025
Revised December 20, 2025
Accepted January 26, 2026

**Keywords:** *Numbered heads together, cooperative learning, mathematics education, student motivation*

**Abstract**

This study examines the effect of the Numbered Heads Together cooperative learning model on student motivation in mathematics. A quantitative approach with a quasi-experimental design was employed, involving 61 students divided into two groups: 33 in the experimental class taught using Numbered Heads Together and 28 in the control class taught with conventional methods. The sample was determined through cluster sampling. A mathematics learning motivation questionnaire served as the research instrument, tested for validity and reliability with Cronbach's alpha of 0.915. Questionnaire scores were converted into interval scales using the Method of Successive Interval. Prerequisite analysis confirmed no significant differences in population data, with the Kruskal–Wallis test yielding $p = 0.997$ ($> 0.05$). Hypothesis testing using the independent t-test revealed a significant difference in learning motivation between the two groups ($p = 0.002 < 0.05$). The findings demonstrate that students taught with the Numbered Heads Together model exhibited higher motivation in mathematics compared to those taught conventionally. The strength of this model lies in fostering individual responsibility while promoting positive peer interaction, which directly enhances student motivation in mathematics.

## INTRODUCTION

Mathematics is widely recognized as a fundamental discipline that contributes to the development of science, technology, and various problem-solving skills. Mathematics learning is expected to support students in developing logical, analytical, and systematic thinking, competencies that are increasingly required in both academic and everyday contexts (Manafe et al., 2022; Omer et al., 2025). Despite continuous efforts to improve mathematics education through curriculum reforms and instructional innovations, many students continue to experience difficulties in learning mathematics. Previous studies indicate that one contributing factor is the relatively low level of learning motivation, which is often associated with students' perceptions that mathematics is difficult, monotonous, or lacks relevance to their daily lives (Marsilawati, 2022; Priliyanti et al., 2021).

**How to cite:** Darwati, D., AS, F., Kurniawan, G., Marhayati, L. (2026). Effect of Numbered Heads Together Model on Student Motivation in Mathematics. *International Journal of Multidisciplinary Research of Higher Education (IJMURHICA)*, *9*(1), 299-308.

**E-ISSN:** 2622-741x
**Published by:** Islamic Studies and Development Center Universitas Negeri Padang

Learning motivation has consistently been identified as one of the psychological factors associated with students' engagement and learning outcomes. Puntaswari & Mukminan (2020) defines motivation as the internal driving force that initiates, sustains, and directs students' learning activities toward specific goals. Similarly, Alfiansyah (2018); Sartika et al (2022) describe learning motivation as arising from both internal and external sources that encourage individuals to engage in learning activities. According to Uno & Umar (2023), learning motivation can be reflected through several indicators, including the desire to achieve, learning needs, future aspirations, appreciation of learning, engaging learning activities, and a supportive learning environment. These indicators are frequently used to assess students' learning motivation.

Miller & Krajcik (2019); Rodríguez et al (2015) further distinguishes learning motivation into intrinsic and extrinsic dimensions. Intrinsic motivation originates from students' internal interests, curiosity, or personal satisfaction, whereas extrinsic motivation is influenced by external factors such as rewards, recognition, academic achievement, or classroom expectations. These two dimensions may interact in shaping students' participation and persistence during the learning process. Conversely, limited learning motivation has been associated with lower classroom engagement, reduced concentration, and less active participation in learning activities (Lubis, 2025), which may subsequently influence learning achievement (Ali et al., 2025).

Several studies have suggested that classroom instructional approaches may also influence students' learning motivation. Teacher-centered instruction, particularly when dominated by one-way lectures, may provide fewer opportunities for students to actively participate in discussion, collaboration, and knowledge construction. Such learning conditions have been reported to limit students' cognitive engagement as well as opportunities to develop social interaction during classroom activities (Engkizar et al., 2026; Syamsidah et al., 2018).

In response to these challenges, student-centered instructional approaches have received increasing attention as alternatives for promoting active learning (Baroud et al., 2025; Kassymova et al., 2025). One of the approaches frequently discussed in mathematics education is cooperative learning, which encourages students to work collaboratively in small groups while sharing responsibility for individual and group learning (Muhammad et al., 2023). Among various cooperative learning models, the Numbered Heads Together (NHT) model introduces individual accountability by requiring each group member to be prepared to represent the group when selected randomly by the teacher. This learning structure is expected to encourage broader participation and peer interaction during classroom activities (Alfiansyah, 2018).

Although previous studies have reported positive findings regarding the implementation of cooperative learning, evidence concerning the effectiveness of the NHT model in improving students' learning motivation remains inconsistent across educational contexts. Differences in student characteristics, classroom environments, and initial academic abilities suggest that the effectiveness of instructional models may vary and therefore requires further empirical examination. In addition, relatively limited studies have explored the interaction between cooperative learning models and students' prior academic ability in influencing learning motivation, particularly in mathematics classrooms.

Based on these considerations, this study investigates the effect of the

Numbered Heads Together (NHT) cooperative learning model on students' mathematics learning motivation compared with conventional instruction. Furthermore, the study examines whether students' prior academic ability interacts with the implementation of the NHT model in influencing mathematics learning motivation. By addressing these issues, the study seeks to provide additional empirical evidence regarding the implementation of cooperative learning in mathematics education.

## METHODS

This study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group design. This design was selected because random assignment of individual participants was not feasible; therefore, existing classes were used as the units of analysis (Arsal, 2015; Flannelly et al., 2018; Talaván & Rodríguez-Arancón, 2024). The study involved two groups: an experimental group that received instruction through the Numbered Heads Together (NHT) cooperative learning model and a control group that received conventional mathematics instruction (Engkizar et al., 2024; Kelley-Quon, 2018; Pureswaran et al., 2004; Roni et al., 2020).

The study was conducted at three public senior high schools in Indonesia, which are hereafter referred to as School A, School B, and School C to maintain institutional anonymity. The population consisted of all Grade XI Mathematics and Science (MIPA) students distributed across 17 classes, comprising seven classes from School A, four classes from School B, and six classes from School C. Throughout this paper, the participating classes are identified using the codes A1–A7, B1–B4, and C1–C6, respectively. Participants were selected using a cluster sampling technique, and the sampling procedure is illustrated in Figure 1.

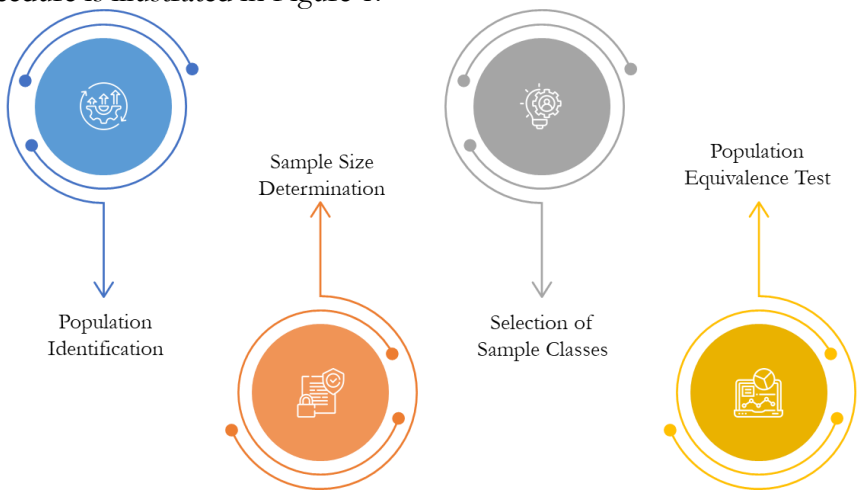


**Fig 1. Sampling procedure**

Before the sampling process, students' mathematics final examination scores from the first semester were collected to examine the characteristics of the population. Assumption testing was conducted using SPSS version 16, including normality and homogeneity tests. The normality test indicated that three classes (A7, C1, and C3) had significance values below 0.05, suggesting that the population data were not entirely normally distributed. Consequently, the equivalence of the population was examined using the Kruskal–Wallis test. The analysis yielded a significance value of 0.997 ($p > 0.05$), indicating no statistically significant differences in the average mathematics achievement among the participating classes. Based on these findings, the sampling procedure was continued using cluster sampling. Following the lottery procedure, one class from School B ($n = 33$) was assigned as the experimental

group, whereas one class from School C (n = 28) served as the control group.

The intervention was implemented after the experimental and control groups had been established. Students in the experimental group received mathematics instruction using the Numbered Heads Together (NHT) cooperative learning model. The implementation followed four stages: students were organized into heterogeneous groups, each student was assigned an identification number, group members discussed the assigned mathematical problems collaboratively, and the teacher randomly selected one student's number to present the group's response. Students in the control group received conventional teacher-centered mathematics instruction. At the end of the intervention, all participants completed the learning motivation questionnaire (Lim, 2025; Mahida, 2012; Younus & Zaidan, 2022).

Students' learning motivation was measured using a closed-ended questionnaire developed on a four-point Likert scale consisting of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The questionnaire consisted of both positively and negatively worded statements representing five dimensions of learning motivation: learning persistence, perseverance in overcoming learning difficulties, interest in learning, independent learning, and problem-solving ability. Instrument development involved four stages: preparing the questionnaire blueprint, constructing the questionnaire items, conducting content validation by three mathematics education experts, and administering a pilot study involving 37 Grade XI students from a class outside the research sample (Rokeman, 2024).

Item validity was evaluated using SPSS version 16 by comparing the calculated correlation coefficient (r<sub>calculated</sub>) with the critical value (r<sub>table</sub>) at a significance level of 0.05 (df = N − 2). Questionnaire items with r<sub>calculated</sub> > r<sub>table</sub> were considered valid. The analysis indicated that 26 of the 30 questionnaire items satisfied the validity criterion (r<sub>calculated</sub> > 0.325). Two items were revised, whereas the remaining two items were excluded because they did not meet the required validity threshold (Adeniran & Onasanya, 2024; Almquist et al., 2019; Chapman, 2018; Collier, 2020).

Instrument reliability was subsequently assessed using Cronbach's Alpha. As presented in Table 1, the standardized Cronbach's Alpha coefficient was 0.915, indicating a high level of internal consistency.

**Table 1. Reliability Statistics of the Learning Motivation Questionnaire**

| Reliability Statistics | Value |
|---|---|
| Cronbach's Alpha | 0.907 |
| Cronbach's Alpha Based on Standardized Items | 0.915 |
| Number of Items | 30 |

Data were analyzed using SPSS version 16. Descriptive statistics were first used to summarize the characteristics of the data, followed by assumption testing, including normality and homogeneity tests. Hypothesis testing was then conducted to examine differences in students' learning motivation between the experimental and control groups as well as the interaction between the instructional model and students' prior ability at a significance level of $\alpha = 0.05$.

## RESULT AND DISCUSSION

### Normality Test

Prior to the main statistical analysis, the distribution of the population data was examined using the Kolmogorov–Smirnov and Shapiro–Wilk tests in SPSS version 16. The results are presented in Table 2.

**Table 2. Results of the Normality Test**

| Tests of Normality | | | | | | |
|---|---|---|---|---|---|---|
| Class | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
| | Statistic | Df | Sig. | Statistic | df | Sig. |
| A1 | ,152 | 29 | ,084 | ,963 | 29 | ,389 |
| A2 | ,151 | 28 | ,101 | ,950 | 28 | ,201 |
| A3 | ,097 | 27 | ,200* | ,954 | 27 | ,269 |
| A4 | ,120 | 36 | ,200* | ,974 | 36 | ,547 |
| A5 | ,098 | 37 | ,200* | ,958 | 37 | ,177 |
| A6 | ,106 | 37 | ,200* | ,979 | 37 | ,709 |
| A7 | ,169 | 37 | ,009 | ,952 | 37 | ,116 |
| B1 | ,136 | 22 | ,200* | ,942 | 22 | ,219 |
| B2 | ,138 | 34 | ,098 | ,939 | 34 | ,057 |
| B3 | ,134 | 34 | ,127 | ,958 | 34 | ,209 |
| B4 | ,137 | 34 | ,109 | ,938 | 34 | ,054 |
| C1 | ,163 | 30 | ,041 | ,960 | 30 | ,312 |
| C2 | ,141 | 29 | ,146 | ,962 | 29 | ,372 |
| C3 | ,160 | 30 | ,049 | ,929 | 30 | ,047 |
| C4 | ,080 | 29 | ,200* | ,972 | 29 | ,615 |
| C5 | ,140 | 30 | ,138 | ,959 | 30 | ,284 |
| C6 | ,143 | 28 | ,149 | ,947 | 28 | ,166 |

***Note.*** *Schools are anonymized as School A, School B, and School C.*

As shown in Table 2, three classes (A7, C1, and C3) had significance values below 0.05, indicating that the assumption of normality was not fully satisfied across the population. Therefore, the equivalence of the population was further examined using the Kruskal–Wallis test. The analysis produced a significance value of 0.997 ($p > 0.05$), suggesting no statistically significant differences in the average mathematics achievement among the participating classes. These findings indicate that the sampled classes were comparable prior to the intervention.

**Homogeneity of Variance**

Following the instructional intervention, the homogeneity of variance for students' learning motivation scores was examined using Levene's test. The results are presented in Table 3

**Table 3. Results of Levene's Test for Homogeneity of Variance**

| Variable | Levene Statistic | df1 | df2 | p |
|---|---|---|---|---|
| Learning Motivation | 5.561 | 1 | 59 | 0.022 |

The Levene test yielded a significance value of 0.022 ($p < 0.05$), indicating that the assumption of equal variances was not satisfied. Accordingly, subsequent comparisons between the two groups were conducted using the independent samples t-test with unequal variances assumed.

**Descriptive Statistics of Learning Motivation**

The descriptive statistics for students' learning motivation scores are presented in Table 4.

**Table 4. Descriptive Statistics of Students' Learning Motivation**

| Group | n | Mean | SD |
|---|---|---|---|
| Experimental (NHT) | 33 | 74.39 | 14.82 |
| Control | 28 | 64.23 | 10.16 |

The descriptive analysis indicates that students in the experimental group obtained a higher mean learning motivation score ($M = 74.39$) than those in the control group ($M = 64.23$). In addition, the experimental group exhibited greater variability in scores, as reflected by a larger standard deviation.

**Comparison of Learning Motivation Between Groups**

An independent samples *t*-test was performed to examine whether

students who learned through the Numbered Heads Together (NHT) model differed in learning motivation from those who received conventional instruction. Because the homogeneity assumption was not satisfied, the interpretation was based on the results for equal variances not assumed.

**Table 5. Independent Samples t-Test Results**

| Analysis | t | df | p | Mean Difference | 95% CI |
|---|---|---|---|---|---|
| Equal variances assumed | 3.019 | 59.000 | 0.004 | 10.17 | 3.43–16.91 |
| Equal variances not assumed | 3.111 | 56.732 | 0.003 | 10.17 | 3.62–16.72 |

The independent samples *t*-test showed a statistically significant difference in students' learning motivation between the two instructional groups ($t = 3.111$, $df = 56.732$, $p = 0.003$). Students in the experimental group obtained a higher mean motivation score ($M = 74.39$, $SD = 14.82$) than students in the control group ($M = 64.23$, $SD = 10.16$). The estimated mean difference between the groups was 10.17 points, with a 95% confidence interval ranging from 3.62 to 16.72.

Within the context of this study, these findings suggest that students who participated in mathematics learning through the Numbered Heads Together (NHT) cooperative learning model reported higher levels of learning motivation than students who received conventional instruction.

The findings of this study indicate that students who participated in mathematics learning through the Numbered Heads Together (NHT) cooperative learning model obtained higher learning motivation scores than those who received conventional instruction. These findings are consistent with previous studies suggesting that cooperative learning may provide learning environments that encourage student participation, interaction, and engagement during classroom activities (Johnson & Johnson, 2019; Muhammad et al., 2023). The descriptive and inferential analyses presented in this study suggest that the collaborative structure of NHT was associated with higher levels of learning motivation within the context of the participating classrooms.

One possible explanation for these findings relates to the characteristics of the NHT model, which combines individual accountability with collaborative problem-solving. During the learning process, each student was assigned an individual number and could be selected to represent the group's response (Alatise & Akinfolarin, 2025; Rambe et al., 2025). This learning structure may encourage students to participate more actively in group discussions because every member has a shared responsibility to understand the learning materials. Such interactions may also provide opportunities for students with stronger academic performance to assist their peers through peer-supported learning, a pattern that has also been reported in previous research (Saptono, 2024).

The descriptive results further showed that the experimental group achieved a higher average motivation score than the control group. Several indicators of the motivation questionnaire, including persistence in completing learning tasks, perseverance in facing learning difficulties, and interest in mathematics, showed higher scores among students in the experimental group. These findings may suggest that collaborative learning activities encouraged students to become more actively involved in solving mathematical problems, although the present study did not directly examine changes in intrinsic motivation (Anidar et al., 2026; Engkizar et al., 2026; Lubis, 2025).

Nevertheless, not all questionnaire indicators showed the same pattern. Some items related to preferences for working independently and boredom with

routine tasks did not demonstrate higher scores in the experimental group. This finding may indicate that students respond differently to collaborative learning environments depending on their individual learning preferences. Therefore, while NHT appeared to be associated with higher overall learning motivation in this study, its influence may vary across different dimensions of motivation.

From a theoretical perspective, these findings are broadly consistent with cooperative learning theory proposed by Jawad et al (2021); Khairanis (2025), as well as the social constructivist perspective introduced by Vygotsky (1978). These perspectives emphasize that learning occurs through social interaction, shared responsibility, and collaborative knowledge construction. The group discussions, peer interaction, and individual accountability incorporated into the NHT model may provide learning experiences that support both cognitive engagement and motivational development. Although the present study focused on learning motivation, the findings provide additional empirical evidence that structured cooperative learning can contribute to creating classroom environments that encourage active student participation.

## CONCLUSION

Based on the data analysis and discussion, this study found a statistically significant difference in mathematics learning motivation between students who learned through the Numbered Heads Together (NHT) cooperative learning model and those who received conventional instruction. Students in the NHT group obtained higher average motivation scores than those in the conventional learning group. These findings suggest that the use of the NHT learning model was associated with higher levels of mathematics learning motivation within the context of this study. Therefore, the NHT cooperative learning model may be considered as one alternative instructional approach for promoting students' learning motivation in mathematics classrooms. Future studies involving larger samples, different educational settings, and additional learning outcomes are recommended to provide broader evidence regarding the implementation of this learning model.

## REFERENCES

Adeniran, T. A., & Onasanya, S. A. (2024). Impact of E-Learning on College of Education Lecturers' Knowledge of Quantitative Data Analysis in SPSS. *Technology*, *4*(2), 121–128. https://doi.org/https://doi.org/10.17509/ijert.v4i2.60863

Alatise, T., & Akinfolarin, C. (2025). School Based Management Committee Roles and Facilities Maintenance as Correlates of Teachers' Effectiveness. *Multidisciplinary Journal of Thought and Research*, *1*(3), 80–96. https://doi.org/10.67055/cz5yfb48

Alfiansyah, I. (2018). Penerapan Model Pembelajaran Kooperatif Tipe Nht Untuk Meningkatkan Hasil Belajar Siswa Kelas Iii Sekolah Dasar. *JTIEE (Journal of Teaching in Elementary Education)*, *2*(1), 85. https://doi.org/10.30587/jtiee.v2i1.359

Ali, A., Dea Venica, S., Aini, W., & Faisal Hidayat, A. (2025). Efektivitas Media Pembelajaran Interaktif dalam Meningkatkan Minat dan Motivasi Belajar Siswa Sekolah Dasar. *Journal of Information System and Education Development*, *3*(1), 1–6. https://doi.org/10.62386/jised.v3i1.115

Almquist, Y. B., Kvart, S., & Brännström, L. (2019). A practical guide to quantitative methods with SPSS. *Research Reports in Public Health Sciences*, *2*(November), 1–347. https://doi.org/https://doi.org/10.17045/sthlmuni.10321829

Anidar, J., Nursyamsi, N., Diminurman, A., & Engkizar, E. (2026). Building religious character in students: a qualitative study of youth information and counseling centers. *Jurnal Konseling Dan Pendidikan*, *14*(1), 194–204. https://doi.org/10.29210/1158400

Arsal, Z. (2015). The effects of microteaching on the critical thinking dispositions of pre-service teachers. *Australian Journal of Teacher Education*, *40*(3), 140–153. https://doi.org/10.14221/ajte.2014v40n3.9

Baroud, N., Ardila, Y., Akmal, F., & Sabrina, R. (2025). Opportunities and Challenges for Islamic Education Teachers in Using Artificial Intelligence in Learning. *Muaddib: Journal of Islamic Teaching and Learning*, *1*(2), 1–11. https://doi.org/https://muaddib.intischolar.id/index.php/muaddib/article/view/6

Chapman, S. J. (2018). Review of Discovering Statistics Using IBM SPSS Statistics, 4th Edition. *Journal of Political Science Education*, *14*(1), 145–147. https://doi.org/10.1080/15512169.2017.1366328

Collier, J. E. (2020). Applied Structural Equation Modeling Using AMOS. In *Applied Structural Equation Modeling using AMOS: Basic to Advanced Techniques*. Routledge. https://doi.org/10.4324/9781003018414

Engkizar, E., Jaafar, A., Hamzah, M. I., Syafril, S., Ediz, M. H., Efendi, E., Ridha, A., Febriani, A., & Oktavia, G. (2026). Tartil Method as an Effective Pedagogical Approach for Enhancing Students' Interest in Quranic Learning. *International Journal of Multidisciplinary Research of Higher Education (IJMURHICA)*, *9*(1). https://doi.org/https://doi.org/10.24036/ijmurhica.v9i1.637

Engkizar, E., Jaafar, A., Hamzah, M. I., Syafril, S., Febriani, A., Oktavia, G., & Satrial, A. (2026). Quran Teachers' Skills as Pedagogical Foundations: Conceptual and Practical Insights into Nine Competencies. *Muaddib: Journal of Islamic Teaching and Learning*, *2*(1), 22–38.

Engkizar, E., Jaafar, A., Sarianto, D., Ayad, N., Rahman, A., Febriani, A., Oktavia, G., Guspita, R., & Rahman, I. (2024). Analysis of Quran Education Problems in Majority Muslim Countries. *International Journal of Islamic Studies Higher Education*, *3*(1), 65–80. https://doi.org/https://doi.org/10.24036/insight.v3i1.209

Flannelly, K. J., Flannelly, L. T., & Jankowski, K. R. B. (2018). Threats to the internal validity of experimental and quasi-experimental research in healthcare. *Journal of Health Care Chaplaincy*, *24*(3), 107–130. https://doi.org/10.1080/08854726.2017.1421019

Jawad, L. F., Raheem, M. K., & Majeed, B. H. (2021). The Effectiveness of Educational Pillars Based on Vygotsky's Theory in Achievement and Information Processing Among First Intermediate Class Students. *International Journal of Emerging Technologies in Learning*, *16*(12), 246–262. https://doi.org/10.3991/ijet.v16i12.23181

Johnson, D. W., & Johnson, R. T. (2019). Cooperative Learning: The Foundation for Active Learning. In *Active Learning - Beyond the Future*. IntechOpen. https://doi.org/10.5772/intechopen.81086

Kassymova, G. K., Engkizar, E., Hebebci, M. T., & Talgatov, Y. K. (2025). Interreligious Coexistence in Islam: Implications for Islamic Education and the Achievement of SDGs. *Muaddib: Journal of Islamic Teaching and Learning*, *1*(3), 79–92.

Kelley-Quon, L. I. (2018). Surveys: Merging qualitative and quantitative research methods. *Seminars in Pediatric Surgery*, *27*(6), 361–366. https://doi.org/10.1053/j.sempedsurg.2018.10.007

Khairanis, R. (2025). The Impact of Post-Potivism and Constructivism on

Public Policy: A review of Philosophy of Science in Indonesia. *Jurnal Cendekia Ilmiah*, *4*(2). https://doi.org/https://doi.org/10.56799/jceki.v4i2.7225

Lim, W. M. (2025). What Is Quantitative Research? An Overview and Guidelines. *Australasian Marketing Journal*, *33*(3), 325–348. https://doi.org/10.1177/14413582241264622

Lubis, Z. N. L. (2025). Hubungan Antara Motivasi Intrinsik Dan Motivasi Ekstrinsik Dengan Keaktifan Mahasiswa Fakultas Ekonomi Universitas Negeri Medan. *Jurnal Penelitian Ilmu Pendidikan Indonesia*, *4*(2), 577–583. https://doi.org/https://doi.org/10.31004/jpion.v4i2.413

Mahida, J. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. In *Educational Research* (Vol. 4). https://drive.google.com/file/d/1d5ZzlgJuCrwAyLpdBeK5dhKMZTpE2HNb/view

Manafe, M. H., Daniel, F., & Taneo, P. N. L. (2022). Prestasi Belajar Matematika Siswa pada Pembelajaran Model Kooperatif Tipe Numbered Heads Together (NHT). *Jurnal Basicedu*, *6*(3), 3279–3284. https://doi.org/10.31004/basicedu.v6i3.2544

Marsilawati, N. M. S. (2022). Penerapan Model Pembelajaran Inkuiri Untuk Meningkatkan Minat Belajar Dan Hasil Belajar Matematika Siswa Kelas Xi Ia2 Sma Negeri 4 Singaraja. *Jurnal Citra Pendidikan*, *2*(3), 613–625. https://doi.org/10.38048/jcp.v2i3.898

Miller, E. C., & Krajcik, J. S. (2019). Promoting deep learning through project-based learning: a design problem. *Disciplinary and Interdisciplinary Science Education Research*, *1*(1), 1–10. https://doi.org/10.1186/s43031-019-0009-6

Muhammad, I., Darmayanti, R., Sugianto, R., & Choirudin. (2023). Teori Vygotsky: Kajian bibliometrik penelitian cooperative learning di sekolah dasar (1987-2023). *Bulletin of Educational Management and Innovation*, *1*(2), 81–98. https://doi.org/10.56587/bemi.v1i2.78

Omer, S. M. S., Evers, K., Wang, C. Y., & Chen, S. (2025). Technology-enhanced mathematics learning: review of the interactions between technological attributes and aspects of mathematics education from 2013 to 2022. *Humanities and Social Sciences Communications*, *12*(1), 1–13. https://doi.org/10.1057/s41599-025-05475-7

Priliyanti, A., Muderawan, I. W., & Maryam, S. (2021). Analisis Kesulitan Belajar Siswa Dalam Mempelajari Kimia Kelas XI. *Jurnal Pendidikan Kimia Undiksha*, *5*(1), 11–18. https://doi.org/10.23887/jjpk.v5i1.32402

Puntaswari, N. C., & Mukminan. (2020). Promoting Good Citizenship in the Social Studies Course at the Secondary School in Indonesia. *Proceedings of the 2nd International Conference on Social Science and Character Educations (ICoSSCE 2019)*, *22*, 1–8. https://doi.org/10.2991/assehr.k.200130.047

Pureswaran, D. S., Gries, R., & Borden, J. H. (2004). Quantitative variation in monoterpenes in four species of conifers. *Biochemical Systematics and Ecology*, *32*(12), 1109–1136. https://doi.org/10.1016/j.bse.2004.04.006

Rambe, F. S. P., Mawardi, M., Saengngern, A., Suryani, O., & Akmar, R. (2025). Discord-Enhanced Flipped Guided Inquiry Learning: A Modern Approach to Teaching Chemical Bonding to Improve Student Motivation. *Multidisciplinary Journal of Thought and Research*, *1*(3), 128–136. https://doi.org/10.67055/xsp83r33

Rodríguez, J., Laverón-Simavilla, A., Del Cura, J. M., Ezquerro, J. M., Lapuerta, V., & Cordero-Gracia, M. (2015). Project Based Learning experiences in the space engineering education at Technical University of Madrid.

*Advances in Space Research*, *56*(7), 1319–1330. https://doi.org/10.1016/j.asr.2015.07.003

Rokeman, N. R. M. (2024). Likert Measurement Scale in Education and Social Sciences: Explored and Explained. *EDUCATUM Journal of Social Sciences*, *10*(10), 77–88. https://doi.org/10.37134/ejoss.vol10.1.7.2024

Roni, S. M., Merga, M. K., & Morris, J. E. (2020). Conducting Quantitative Research in Education. In *Journal of Physics A: Mathematical and Theoretical* (Vol. 44, Issue 8). Springer Singapore. https://doi.org/10.1007/978-981-13-9132-3

Saptono, B. (2024). The Effectiveness of Numbered Head Together in Learning. *Jurnal Prima Edukasia*, *12*(2), 293–299. https://doi.org/10.21831/jpe.v12i2.74975

Sartika, R., Indrawati, J., & Marsidin, S. (2022). Berbagai Teori Motivasi Dalam Manajemen Pendidikan Islam. *Nidhomiyyah: Jurnal Manajemen Pendidikan Islam*, *3*(1), 12–42. https://doi.org/10.38073/nidhomiyyah.v3i1.839

Syamsidah, S., Suryani, H., Tawani, R., & Arfandi, A. (2018). Efektivitas Model Pembelajaran Berbasis Masalah dalam Pembelajaran Meningkatkan Keterampilan Berpikir Ilmiah Siswa. *Jurnal Internasional Pengembangan Dan Penelitian Ilmiah (IJSDR)*, *3*(10), 11–15. https://doi.org/https://doi.org/10.23887/jpepi.v13i2.2660

Talaván, N., & Rodríguez-Arancón, P. (2024). Subtitling short films to improve writing and translation skills. *Revista Española de Lingüística Aplicada/Spanish Journal of Applied Linguistics*, *37*(1), 57–82. https://doi.org/10.1075/resla.21032.tal

Uno, H. B., & Umar, M. K. (2023). Mengelola kecerdasan dalam pembelajaran: sebuah konsep pembelajaran berbasis kecerdasan. In *Bumi Aksara*. Bumi Aksara. https://books.google.com/books?hl=en%5C&lr=%5C&id=lmmoEAAAQBAJ%5C&oi=fnd%5C&pg=PP1%5C&dq=penggunaan+teknologi+kecerdasan+buatan+dalam+pengembangan+sistem+informasi+manajemen+pergudangan%5C&ots=2FZD_SVVPQ%5C&sig=D8rEg69Cs9eZM1k3tW7ZpjNyPpE

Younus, A. M., & Zaidan, M. N. (2022). the Influence of Quantitative Research in Business & Information Technology: an Appropriate Research Methodology Philosophical Reflection. *American Journal of Interdisciplinary Research and Development*, *4*(2771–8948), 61–76. https://doi.org/http://www.ajird.journalspark.org/index.php/ajird/article/view/54