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MATHEMATICAL BELIEFS, ENGAGEMENT, AND PROBLEM-SOLVING SKILLS OF GRADE 9 STUDENTS

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ABSTRACT
The purpose of this quantitative study, which used descriptive and correlational designs, was to investigate the mediating effect of student engagement on the relationship between mathematical beliefs and problem-solving skills in Mathematics among students. One hundred thirty-eight Grade 9 students from four public secondary schools in Davao del Norte Division, School Year 2023-2024, were selected as respondents using stratified random sampling. This study used two adapted survey questionnaires to determine students' mathematical beliefs and engagement and a validated researcher-made test to assess their problem-solving skills in mathematics. Mean and Pearson-r were used to calculate numerical data. The results of this study revealed that the level of mathematical beliefs and engagement of the students is high. Additionally, the level of student's problem-solving skills in terms of test scores is average. Moreover, there is a significant relationship between mathematical beliefs and student engagement. However, results showed no significant relationship between mathematical beliefs and students' problem-solving skills. Further, mediation analysis was initially intended to be conducted as a part of the study; however, it was not executed since the conditions were not met. Additionally, future researchers may utilize the findings to analyze the study's variables and look into other variables or characteristics that mediate the relationship between mathematical beliefs and problem-solving abilities.

KEYWORDS: *problem-solving skills, mathematical beliefs, student engagement, grade 9 students, descriptive-correlational approach, Pearson-r, Kapalong, Davao del Norte, Philippines*

INTRODUCTION
Problem-solving is one of the most basic ways that humans think and learn. It is one of the 21st-century skills. It is a necessary mathematical ability that students studying mathematics should acquire. The capacity to answer problems is crucial as it teaches students how to use their mathematics understanding and skills to solve problems. However, students struggle in the test when it comes to word problem-solving problems, they find it difficult to understand the problems which makes them unable to complete math problems (Ali, 2019). Moreover, as Novriani and Surya (2017) mentioned, the student's problem-solving skills are so poor that they constitute a big issue in school. Most students struggle to answer mathematical issues at all educational levels, from basic to secondary to unexpectedly high schooling (Ziegler & Loos, 2017).

In the recent PISA result, 47% of students from participating countries could not solve mathematics problems that required more than direct inference and the use of representations from diverse data sources (OECD, 2019). PISA employs practical problems requiring quantitative thinking, spatial reasoning, and problem-solving abilities. Moreover, according to Andrade et al. (2020), most of the items in the mathematics subtest in PISA involve problem-solving, which means that students have poor performance in solving word problems. Additionally, in the study conducted in Indonesia by Emanuel et al. (2021), one of the findings shows that students cannot solve the problem because they have difficulty translating it from verbal problems to mathematical models.

Further, in the study conducted by Alvi and Nausheen (2019), observations show that grade 9 students in Pakistan are having difficulty understanding mathematical problems due to a lack of knowledge of mathematical concepts and the relevance of information, resulting to poor performance on items requiring complex cognitive abilities such as problem-solving in the national assessment.

In the Philippines, according to the TIMSS result, as cited by Ambasa et al. (2022), Filipino students had difficulties solving mathematics problems. According to the findings of a research done by Dela Cruz and Lapinid (2019), 40% of the respondents do not meet the required level of mathematical problem analysis owing to difficulties in understanding, interpreting, and evaluating. The PISA results revealed that students scored 353 points in Mathematics, which was classified as below Level 1 proficiency (Ciriaco, 2019). Further, in the 2018 result of the National Achievement Test in Region II, the Mean Percentage Score (MPS) in terms of problem-solving in mathematics of

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Grade 10 students is 39.95, which shows a very low result (Cariño, 2019).

Moreover, in a public secondary school in the Davao del Norte Division, most of the grade 9 students show low mathematical problem-solving skills. From the records of the Mathematics Coordinator on the student's level of proficiency in the school year 2020-2021, it has been found that the average proficiency of the students is 68.7% on problem-solving questions which is below the average. This prompted the mathematics teachers to do remediation for failing and low-performing students.

It was all of these that prompted the researcher to study the mediating effect of engagement on the relationship between students' mathematical beliefs and their problem-solving skills. The results of this research will be crucial for students, particularly during the shift from modular instruction back to in-person sessions. The function of beliefs in mathematics and involvement is crucial in enhancing problem-solving abilities in the field of mathematics. Furthermore, educators may also use this research to develop novel approaches to tackle the obstacles of education in the 21st century.

OBJECTIVES

The objective of this research is to determine if student engagement has a significant impact in mediating the relationship between mathematical beliefs and problem-solving skills in mathematics among students in the division of Davao del Norte for the academic year 2023-2024. Specifically, this study aimed to answer the following questions:

1. What is the level of mathematical beliefs in terms of role and function of the teacher, significance and competence in mathematics, mathematics as a social activity, and mathematics as a domain of excellence?
2. What is the level of problem-solving skills of students in terms of understanding the problem, devising a plan, carrying out the plan, and looking back?
3. What is the level of student engagement in terms of cognitive engagement, emotional engagement, social engagement, and behavioral engagement?
4. Is there a significant relationship between (a) mathematical beliefs and problem-solving skills, (b) student engagement and problem-solving skills, and (c) mathematical beliefs and student engagement?
5. Does student engagement significantly mediate the relationship between mathematical beliefs and problem-solving skills of students?

METHODOLOGY

Research Design

This study employed quantitative research methods, namely descriptive and correlational approaches. This research used quantitative methods to collect numerical data and analyze it using mathematical techniques (Creswell, 2014). Additionally, according to Bhandari (2022), quantitative research is a methodical approach that is employed to identify patterns and averages., make predictions, assess cause-and-effect connections, and draw conclusions that may be applied to larger populations. Moreover, according to Fleetwood's (2023) definition, quantitative research refers to the methodical investigation of phenomena by the gathering of measurable data and the analysis of that data using statistical techniques.

Moreover, this study used a descriptive type of research. According to Bhat (2023), a descriptive study is one that defines the characteristics of the population or issue under investigation. Further, it is designed to explore one or more variables, which includes observing and measuring data (McCombes, 2022). Furthermore, according to Seyß (2022), the primary objective is to provide responses to inquiries pertaining to the manner in which the incident took place, the temporal and spatial dimensions of its occurrence, and the nature of the subject matter or occurrence.

Additionally, correlational research was utilized to determine relationships between two or more variables without any intervention (Bhandari, 2022). Further, Cherry (2023) added that it is designed to explore and characterize relationships and then make predictions. This type of research involves the examination of variables and the evaluation of their statistical correlation by the researcher (Chiang et al., 2018).

The researcher used a descriptive research design to describe the variables involved in this study, namely, student engagement, students' mathematics beliefs, and mathematical problem-solving skills. Also, to investigate and evaluate the associations between the variables in this study, the researcher employed a correlational research design. Furthermore, this study used mediating analysis to determine the linking effect of the mediating variable (student engagement) on the relationship between the independent variable (students' mathematical beliefs) and the dependent variable (students' mathematical problem-solving skills).

Sampling Design

To ascertain the appropriate sample size, this study employed stratified random sampling. When collecting data from a population that lacks homogeneity within its groups, it is appropriate to employ stratified sampling as a means of selecting a representative sample (Etikan & Bala, 2017). The respondents of the research consisted of Grade 9 students of four public schools within the Kapalong District of the Division of Davao del Norte in the academic year of 2023-2024. The total population of grade 9 students in the four selected schools is 213. Specifically, the student population of school A is 40, school B is 62, school C is 71, and school D is 40. Further, to determine the samples in each stratum, the researcher utilized simple random sampling. To choose the respondents, a random name generator is used. To get the sample size, the researcher utilized the Online Raosoft Sample Size Calculator, with a marginal error of 0.05 and a confidence level of 95%. From a total population of 213 students, the study used a sample size of 138 students across four selected schools. School A has a selection of 26 students, School B has 40 students, School C has 46 students, and School D has 26 students.

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Research Instrument

This study employed two modified research instruments and one test developed by the researcher. The instruments were selected purposefully based on the study's focus.

The Math and Science Engagement Scales (2016) was developed by Wang et al. (2016) to assess student engagement: cognitive engagement, emotional engagement, social engagement, and behavioral engagement.

The Mathematics-Related Beliefs Questionnaire (MRBQ) was developed by Eynde and De Corte (2018) to asses role and function of the teacher, significance and competence in mathematics, mathematics as a social activity, and mathematics as a domain of excellence.

The Researcher-made Test (RMT) was used to measure the level of students' problem-solving skills in Mathematics. Moreover, the test was a free-response type of test. The student's answers were evaluated using an analytic rubric adopted from the study of Salazar-Torres et al. (2021) measuring each indicator from 1-5. The questionnaire comprised five (5) word problems.

Statistical Design

The data was computed and the hypotheses were tested at the alpha 0.05 level of significance using the following statistical tools.

Mean. Also known as the arithmetic mean, a descriptive statistic, was used to measure the level of each variable. This was used to determine the level of student engagement, mathematical beliefs, and problem-solving skills. Specifically, this was used to answer research questions 1, 2, and 3.

Standard Deviation. A measure of variability that measures the extent to which data points in a collection deviate from the mean. This statistical instrument was implemented to ascertain the extent to which the data deviated from the mean.

Pearson Product Moment Correlation. Also referred to as the Pearson r, this metric is frequently employed to evaluate correlation. This was employed to ascertain whether there was a substantial correlation between mathematical beliefs and problem-solving skills, student engagement and problem-solving skills, and mathematical beliefs and student engagement. This was used to answer the research questions in item 4.

RESULTS

1. Out of the four indicators in determining the level of mathematical beliefs of students in Grade 9, the role and function of a teacher has the highest mean of 4.10, indicating that the mathematical beliefs of students are highly observed. The standard deviation (SD) is 0.85 and is considered high based on the parameter. Mathematics as a domain of excellence has a mean of 3.86 and an SD of 0.779, indicating that students' mathematical beliefs are highly observed. Mathematics as a social activity has a mean of 3.81 and an SD of 0.797, indicating that the mathematical beliefs of students are highly observed. The significance and competence in mathematics indicator had the lowest mean score of 3.79 and a standard deviation of 0.759, indicating that the mathematical beliefs of students are highly observed. The category mean of this variable is 3.86, indicating that mathematical beliefs among students are highly observed.
2. Out of the four variables used to measure student engagement, social engagement had the lowest average score of 3.86 and a standard deviation of 0.788, which is considered high based on the parameter. The highest mean was achieved in cognitive engagement, with a mean score of 4.01 and a standard deviation of 0.579, indicating a high level of engagement. This was followed by emotional engagement, which had a mean score of 3.94 and a standard deviation of 0.826, also indicating a high level of engagement. Behavioral engagement had a mean score of 3.90 and a standard deviation of 0.788, also indicating a high level of engagement. The category mean of this variable is 3.96, indicating that the level of student engagement is highly manifested.
3. Out of the four steps used to assess students' problem-solving skills, the highest mean score of 61.36, with a standard deviation of 29.311, was obtained for Devise a plan. This indicates a high level of proficiency. Understand the problem had a mean score of 59.67 and a standard deviation of 29.512. Carry out the plan had a mean score of 54.32 and a standard deviation of 24.414. Look back had the lowest mean score of 48.86, with a standard deviation of 25.050, indicating an average level of proficiency. The category mean of problem-solving skills of students in Mathematics is 56.05, with a standard deviation of 26.646. This indicates that problem-solving skills in Mathematics is moderate.
4. The results of this study indicate a weak positive association between mathematical beliefs and problem-solving skills (r-value of 0.124), as well as a connection between student engagement and problem-solving skills (r-value of 0.018). Nevertheless, the null hypothesis was not rejected in both instances due to the fact that the p-values (0.072 and 0.342) above the significance threshold of 0.05. The research revealed a significant relationship between mathematical beliefs and student engagement, with a correlation coefficient (r-value) of 0.652. Furthermore, the null hypothesis was rejected, as shown by a p-value of 0.000.
5. The relationship between mathematical beliefs and the problem-solving skills of students is not significantly mediated by student engagement.

SUGGESTIONS

Teachers are encouraged to design lesson plans implementing creative strategies such as technology integration, project-based learning, and gamification that integrate problem-solving skills that require students to apply problem-solving skills in real-world scenarios. Teachers are suggested to cultivate positive mathematical beliefs among students by creating a supportive and encouraging learning environment. Additionally, teachers can offer constructive feedback and support to help students build confidence in their mathematical abilities. Teachers are advised to promote positive teacher-student relationships by focusing on building trust, encouraging communication, and creating a positive learning environment. Parents are also motivated to be involved in the education of students by promoting a growth mindset, providing support and resources at home, and fostering

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positive engagement with math can help improve their child's mathematical beliefs and set them up for success in their mathematical journey. Future researchers may use the results of this study to investigate other factors. Additional studies should investigate other factors or qualities that may mediate the relationship between mathematical beliefs and problem-solving skills.

CONCLUSION

The level of mathematical belief of grade 9 students is high. The level of student's problem-solving skills in terms of test scores is average. The level of student engagement of grade 9 students is high. There is no significant relationship between mathematical beliefs and the problem-solving skills of students. Also, there is no significant relationship between student engagement and problem-solving skills. Lastly, there is a significant relationship between mathematical beliefs and student engagement. Student engagement does not significantly mediate the relationship between mathematical beliefs and the problem-solving skills of students.

FIGURES

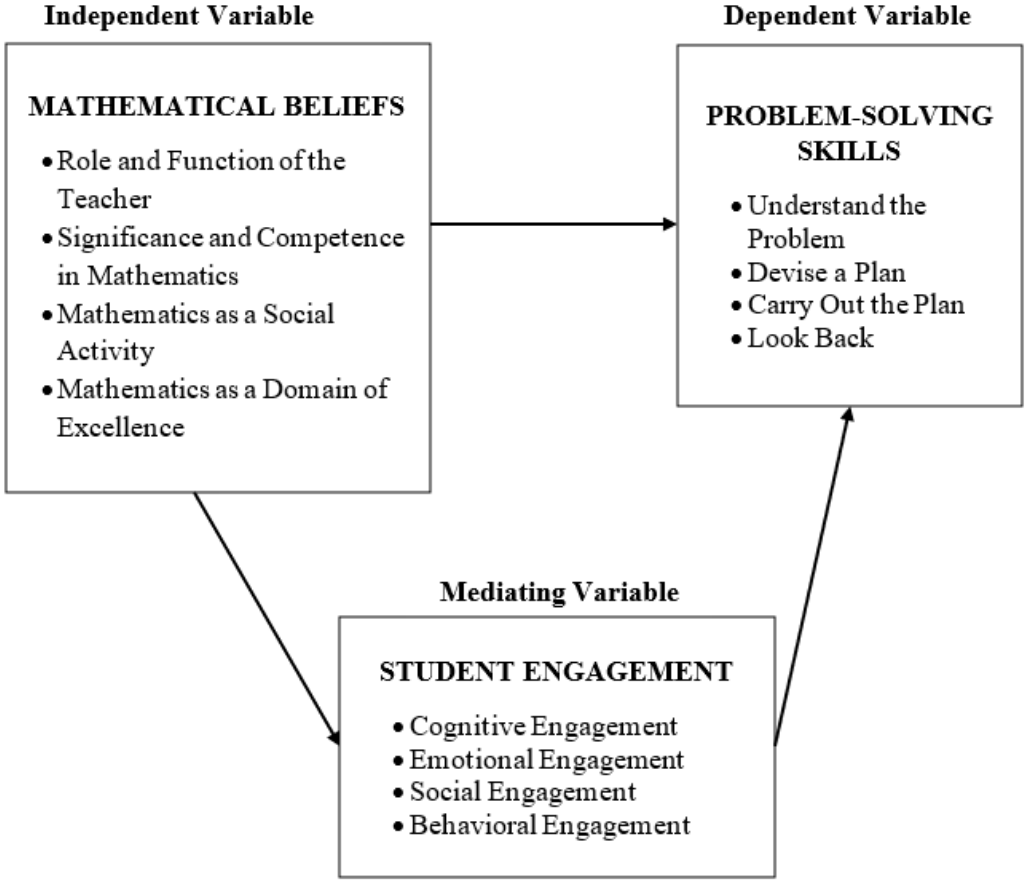

Figure 1. Conceptual Framework of the Study

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Source: https://www.google.com/maps/

Figure 2. Local Map of Davao del Norte

TABLES

Table 1. Summary of the Level of Mathematical Belief

Indicators	Mean	SD	Description
Role and Function of a Teacher	4.10	0.85	High
Significance and Competence in Mathematics	3.79	0.76	High
Mathematics as a Social Activity	3.81	0.80	High
Mathematics as a Domain of Excellence	3.86	0.78	High
Category Mean	3.86	0.72	High

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Table 2. Level of Problem-solving Skills of Students

Indicator	Mean	SD	Description
Understand the Problem	59.67	29.51	Moderate
Devise a Plan	61.36	29.31	High
Carry Out the Plan	54.32	24.41	Moderate
Look Back	48.86	25.05	Moderate
Category Mean	56.05	26.65	Average

Table 3. Summary of the Level of Student Engagement

Indicators	Mean	SD	Description
Cognitive Engagement	4.01	0.58	High
Emotional Engagement	3.94	0.83	High
Social Engagement	3.86	0.79	High
Behavioral Engagement	3.90	0.84	High
Category Mean	3.96	0.74	High

Table 4. Significance of the Relationship Between Variables

Variables Correlated	r	p-value	Decision on H_0	Decision on Relationship
Mathematical Beliefs & Problem-Solving Skills	0.124	.072	Not Rejected	Not Significant
Student Engagement & Problem-Solving Skills	0.018	.342	Not Rejected	Not Significant
Mathematical Beliefs & Student Engagement	0.652	.000	Reject	Significant

REFERENCES

1. *Ali, A. (2019). Why students find difficulty in math's problem solving. Medium. https://medium.com/@iranaahsanali/why-students-find-difficulty-in-maths-problem-solving-69ef827807d10*
2. *Alvi, E., & Nausheen, M. (2019). Examining Grade 9 Students' Engagement in Mathematical Problem-Solving (MPS) When Working as Individuals and in a Small Group Settings. Bulletin of Education and Research, 41(1), 163–184. http://files.eric.ed.gov/fulltext/EJ1217919.pdf*
3. *Ambasa, R., & Tan, D. A. (2022). Student Mathematics Performance and Problem-Solving Skills in an Experiential Learning Environment. ResearchGate.https://www.researchgate.net/publication/360148973_Student_Mathematics_Performance_and_Problem-Solving_Skills_in_an_Experiential_Learning_Environment*
4. *Andrade, R. R., Fortes, E. C., & Mabilangan, R. A. (2020). Problem Solving Heuristics and Mathematical Abilities of Heterogeneous Learners. Universal Journal of Educational Research, 8(11), 5114–5126. https://doi.org/10.13189/ujer.2020.081112*
5. *Bakar, S. A., Ayub, A. F. M., Gopal, K., & Salim, N. R. (2019b). The Influence of Students' Beliefs on Mathematical Problem Solving towards Mathematics Achievement among Malaysian Matriculation Students. Universal Journal of Educational Research, 7(10), 2243–2247. https://doi.org/10.13189/ujer.2019.071026*
6. *Bhandari, P. (2023, June 22). Correlational Research | When & How to Use. Scribbr. https://www.scribbr.com/methodology/correlational-research/*
7. *Bhat, A. (2023). Descriptive Research: Definition, Characteristics, Methods + Examples. Question Pro. https://www.questionpro.com/blog/descriptive-research/*
8. *Cambaya, E. J. D., & Tan, D. A. (2022). Enhancing Students' Problem-Solving Skills and Engagement in Mathematics Learning Through Contextualized Instruction. In Sci. Int.(Lahore) (Vol. 34, Issue 2, pp. 101–109). https://N/A*
9. *Cariño. (2019). 2018 National Achievement Test (NAT) 6, 10, & 12 Results and Analysis. https://region2.deped.gov.ph/wp-content/uploads/2019/05/2018-NATIONAL-ACHIEVEMENT-TEST-NAT-610-12-RESULTS-AND-ANALYSIS-.pdf.*
10. *Cherry, K. (2023). Correlation Studies in Psychology Research. Verywell Mind. https://www.verywellmind.com/correlational-research-2795774*
11. *Chiang, I. C. A., Jhangiani, R. S., & Price, P. C. (2015, October 13). Correlational Research. Pressbooks. https://opentextbc.ca/researchmethods/chapter/correlational-research/*
12. *Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches. SAGE Publications, Inc. https://www.ucg.ac.me/skladiste/blog_609332/objava_105202/fajlovi/Creswell.pdf*
13. *Dela Cruz, J. K. B., & Lapinid, M. R. C. (2014). Students' Difficulties in Translating Worded Problems into Mathematical Symbols. In DLSU Research Congress 2014.*

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 7| July 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

14. *Emanuel, E. P. L., Kirana, A., & Chamidah, A. (2021). Enhancing students' ability to solve word problems in Mathematics. Journal of Physics. Conference Series, 1832(1), 012056. https://doi.org/10.1088/1742-6596/1832/1/012056*
15. *Fleetwood, D. (2023). Quantitative Research: What It Is, Practices & Methods. Question Pro. https://www.questionpro.com/blog/quantitative-research/*
16. *McCombes, S. (2022).Descriptive Research | Definition, Types, Methods & Examples. Scribbr. https://www.scribbr.com/methodology/descriptive-research/*
17. *National Council of Teachers of Mathematics (2014). Principles To Actions: Ensuring Mathematical Success for All. NCTM*
18. *Ng, C., Bartlett, B., & Elliott, S. N. (2018). Empowering Engagement. In Springer eBooks. https://doi.org/10.1007/978-3-319-94652-8*
19. *Novriani, Milda Rizky and Surya, Edy (2017) Analysis of Student Difficulties in Mathematics Problem Solving Ability.MTS Swasta Ira Medan. International Journal of Sciences : Basic and Applied Research (IJSBAR), 33 (03). pp. 63-75. ISSN 2307-4531*
20. *OECD (2019) ,PISA 2018 Results (Volume I). (2019). In Programme for international student assessment/InternationaleSchulleistungsstudie. https://doi.org/10.1787/5f07c754-en*
21. *Op't Eynde, P., & De Corte, E. (2003). Students' Mathematics-Related Belief Systems: Design and Analysis of a Questionnaire. https://eric.ed.gov/?id=ED475708*
22. *Salazar-Torres, J., Leal, O. R., & Ortega, M. V. (2021). The rubric as an assessment tool for solving problem situations in the physics and mathematics teaching context. Journal of Physics. Conference Series, 1981(1), 012018. https://doi.org/10.1088/1742-6596/1981/1/012018*
23. *Seyß, P. (2022, August 31). Descriptive Research - Definition & Methods. Bachelor Print. https://www.bachelorprint.eu/methodology/descriptive-research/*
24. *Sturm, N., & Bohndick, C. (2021). The Influence of Attitudes and Beliefs on Problem-Solving Performance. Frontiers in Education, 6. https://doi.org/10.3389/feduc.2021.525923*
25. *Wang, M. T., Fredricks, J. A., Ye, F., Hofkens, T. L., & Linn, J. S. (2016). The Math and Science Engagement Scales: Scale development, validation, and psychometric properties. Learning and Instruction, 43, 16–26. https://doi.org/10.1016/j.learninstruc.2016.01.008*
26. *Yuanita, P., Zulnaidi, H., & Zakaria, E. (2018). The effectiveness of Realistic Mathematics Education approach: The role of mathematical representation as mediator between mathematical belief and problem solving. PloS One, 13(9), e0204847. https://doi.org/10.1371/journal.pone.0204847*
27. *Zhao, Y., Lin, S., Liu, J., Zhang, J., & Yu, Q. (2021). Learning contextual factors, student engagement, and problem-solving skills: A Chinese perspective. Social Behavior and Personality, 49(2), 1–18. https://doi.org/10.2224/sbp.9796*
28. *Ziegler, G. M., & Loos, A. (2017). "What is Mathematics?" and why we should ask, where one should experience and learn that, and how to teach it. In ICME-13 monographs (pp. 63–77). https://doi.org/10.1007/978-3-319-62597-3_5*