Effectiveness of Using Indigenous Games in Enhancing Mathematics Performance

Claire Balbawang
Graduate School
St. Louis College of Bulanao
Tabuk City, Kalinga, Philippines

Felicisimo Felix
Graduate School
St. Louis College of Bulanao
Tabuk City, Kalinga, Philippines

***Abstract*— This study was conducted to assess the effectiveness of indigenous games in improving performance in Mathematics. The study utilized a quantitative type of research employing quasi-experimental research through the use of pre-test and post-test and control and experimental group research, in which two different learning environments were compared. Grade 2 pupils of Kinama Elementary School, Rizal District, Division of Kalinga were considered in the study. They were grouped into two: the experimental group (14 participants) and the control group (13 participants). Participants in both groups were identified and matched based on their grade point average (GPA) in their 1st Grading Mathematics subject. Results of the pre-test that was administered before the conduct of the study were likewise considered in the selection. The use of indigenous games is effective in enhancing the performance of Grade 2 pupils in their mathematics subject, as manifested in the high increase in the scores of pupils in the experimental group and also in comparison to their scores with those in the control group.**

Keywords— ***Mathematics, Action Research, Indigenous Games, Kalinga, Elementary Pupils***

I. INTRODUCTION

In an ideal situation, schools could raise student academic achievement while still achieving their main aims of teaching and learning. Before entering secondary schools, students were expected to have a foundational understanding of literacy and math. Learning mathematics aids students in making sense of their surroundings. The ability to reason, connect ideas, analyze circumstances, and think logically equips students with crucial concepts and tools for making sense of challenging real-world situations (Goodyear et al., 2021; Maslihah et al., 2020; Hattie et al., 2016).

Studies generally demonstrate that math instruction involves a lot of talking and writing. This encourages a pessimistic outlook and subpar performance in the subject (McGee, 2019; Gill, 2018; Wilson, 2017). Additionally, research has revealed that students consistently exhibit a negative attitude toward learning mathematics (Mazana et al., 2019; Soni & Kumari et al., 2017). Particularly when mathematical symbols, signs, and formulae are not comprehended, students grow to fear and hate learning mathematics (Acharya, 2017). One subject that is regarded as a brain-tester is mathematics (Hill et al., 2016). Students also find the subject to be tedious, challenging, and depressing. They did not feel totally driven since they perceived it as being impractical in their daily lives (Hu et al., 2018). With a few notable exceptions, empirical classroom research over several decades reveals that mathematics instruction has typically been characterized by traditional, abstract formulation that only appears to be easily understood by a small percentage of students. Without providing enough opportunity for pupils to engage in problem-solving and experimenting, ideas are given in an overly theoretical and abstract manner. National and international assessments reveal that many students' mathematical knowledge and skills fall short of the desired standard after they have completed their basic education (Nang et al. 2015). Many students, even among those who have excellent evaluation scores, dislike mathematics and do not understand the need to devote so much class time to it. Some people find mathematics unsettling, which makes them avoid circumstances where they might need to apply mathematics. Additionally, the Trends in International Mathematics and Science Study (TIMSS) 2019 conducted by the International Association for the Evaluation of Educational Achievement found that the Philippines scored 297 in math and 249 in science (IEA) (Richardson et al., 2020). Only 1% of Filipino pupils met the high standard in math, which requires students to use conceptual understanding to solve problems. Six percent of Filipino students met the intermediate standard, demonstrating their ability to use fundamental mathematical concepts in straightforward circumstances. Only 19% of Filipino children, on the other hand, scored below the low thresholds, indicating that they have a rudimentary understanding of mathematics. In the Programme for International Student Assessment (PISA), Filipino students also came in last out of 79 countries in reading comprehension and second to the last in both mathematical and scientific literacy (Schleicher, 2019).

It is crucial that teachers reevaluate their pedagogy by incorporating responsive and 21st-century instructional practices to improve students' mathematics performance given the low performance of students (Heshmati et al., 2018). The use of games and even graphic organizers is one of the most widely used interventions. Games are competitive interactions between players whose objectives are predetermined.

According to Neslihan et al. (2017), a game is considered mathematical when the players may perceive or affect the game's outcome based on mathematical factors. An educational game is a planned activity with established rules for participation in which two or more students collaborate to accomplish clearly stated learning objectives (Mahmoudi et al., 2015). The ability of a game to offer practice and real-world application is its strength in mathematics teaching and learning. Games are utilized in a variety of ways in the classroom, including as ice breakers, to introduce new concepts, consolidate learning, break up repetition, and foster a good, upbeat environment (Drigas & Pappas, 2015).

Mathematical achievements in various areas, including problem-solving and algebraic skills, strategic and logical thinking, geometry skills, arithmetic, and critical thinking, are acknowledged as being promoted through educational games (Ishaq et al., 2019). These researches largely concentrated on the effects of game-based learning on knowledge-based mathematical accomplishments (Lowrie, 2015). However, other aspects of mathematics education are affective variables, such as students' motivation for studying mathematics and their attitudes toward it and its instruction, as these aspects can affect students' current mathematical abilities and future mathematical learning. The use of non-traditional interventions, like games, is an effective teaching strategy as backed by a sizable body of research. Games may engage students in the learning process and motivate them to participate by creating a more participatory environment, according to prior studies. Using games in the classroom promotes interaction, collaboration, and active learning. Games can also give teachers an engaging way to impart knowledge, especially helpful when teaching cause and effect. Lastly, as a teaching tool, games, can encourage interest among students, and the lessons they teach are more likely to stick with them (Monaghan et al., 2016). In addition, studies have shown that the use of indigenous games has a positive effect on teaching mathematics. Indigenous games play an important role in various communities (Tangkur et al., 2022; Mosimege, 2020). Despite research indicating that these games can be used to advance and create a connection between classroom activities and real-life contexts, the connection has not been explored adequately to make this a reality in many mathematics classrooms, especially in the Philippines. Some studies provide indications about the significance of indigenous games in learning school mathematics. Nkopodi and Mosimege (2009) claimed that indigenous games stimulate children’s mathematical imagination and logical thinking. In addition, the use of cultural contexts in teaching makes mathematics relevant, accessible, pleasurable, memorable, and meaningful for all students. In their view, the use of indigenous cultural games in mathematics classrooms provides an opportunity for pupils to relate their experiences outside the classroom to mathematical processes in the classroom (Hadebe-Ndlovu, 2022; Moloi, 2013; Tachie & Galawe, 2021; Fernandez-Oliveras et al., 2021). This tends to create awareness between mathematics and real-life and lessens the phobia toward the learning of mathematics. The use of indigenous games in the classroom builds a relationship between culturally specific activities and classroom activities (Dewah & Wyk, 2014).

Given the numerous advantages of gaming, it may not come as a surprise that instructional time allocated to game-related activities in the context of primary education is significant and growing. The goal of this study is to determine how well indigenous games can help students in grade 2 perform better in math.

II. METHODS

This study utilized a quantitative type of research employing quasi-experimental research through the use of pre-test and post-test and control and experimental group research, in which two different learning environments will be compared. This is designed to assess the effectiveness of indigenous games in improving the academic performance of pupils in mathematics.

Group	Pre-test	Approach	Post-test
E	O1	X_1	O2
C	O3	X_2	O4

where:
E = Experimental group
C = Control group
O1 = pretest of the experimental group
O2 = posttest of the experimental group
O3 = pretest of the control group
O4 = posttests of the control group
X_1 = Technology-based approach
X_2 = Traditional approach

Grade 2 pupils of Kinama Elementary School, Rizal District, Division of Kalinga were considered in the study. They were grouped into two: the experimental group (14 participants) and the control group (13 participants). Participants in both groups were identified and matched based on their grade point average (GPA) in their 1st Grading Mathematics subject. Results of the pre-test that was administered before the study was conducted were also considered in the selection. To ensure that the participants in both groups were of the same level of mental ability, the significant difference in the means of the pre-test was tested using t-test of independent samples.

This study utilized pre-test/post-test, in which a teacher-made test composed of 25-item multiple choice was used to assess students’ performance in mathematics. The topic was aligned with the current topic for the second grading, which is subtraction. Prior to the administration of the pre-test, the said test underwent content and expert validation, in which three (3) experts in assessment and evaluation, mathematics education, and research and statistics were invited to review the contents of the test. The two groups received the same amount of contact hours, which is four (4) hours a week for the duration of six (6) weeks. The control group was taught using the traditional approach of teaching mathematics, which is the lecture method. In contrast, the experimental group was taught the same lessons using indigenous and Filipino games such as *tumbang preso, sack race, dangan-dangan, step paldam,* and *kadang-kadang*. Before implementing the game-based approach, the experimental group was oriented about the mechanics of the game. The experimental group learned through exploration and multiple representations of various concepts. The teacher served only as a facilitator in the group. After the experimentation, post-test was administered to both groups.

Data Analysis

The data gathered were analyzed using the following statistical tools:

Frequency and percentage were used to describe the profile of the participants along gender, birth order, academic performance in mathematics for the 1st grading period, availability of educational learning resources at home, and availability of gadget/s used in learning.

Mean score was used to determine the pre-test and post-test performances of the participants in both groups, which were interpreted using the following scale:

Scores	Descriptive Value
21-25	Excellent
16-20	Very Satisfactory
11-15	Satisfactory
06-10	Fair
00-05	Poor

The t-test for Independent Samples was used to compare the pre-test and post-test performances of the two groups.

The t-test for Paired Samples was employed to compare the performance and attitude of the experimental group before and after the experimentation.

III. RESULTS

Table 1. Profile of the Participants

Profile Variables	Experimental Group		Control Group	
	n	%	n	%
Gender				
Male	6	42.90.	8	61.50
Female	8	57.10	5	38.50
Birth Order				
First	5	35.70	6	46.20
Second	4	28.60	4	30.80
Third	4	28.60	2	15.40
Fourth	1	7.10	1	7.70
Academic Performance in Mathematics last 1st Grading				
90 – 100	0	0.00	0	0.00
85 – 89	0	0.00	0	0.00
80 – 84	6	42.90	10	76.90
75 – 79	8	57.10	3	23.10
Below 75	0	0.00	0	0.00
Availability of Educational Learning resources at Home				
Printed materials	9	64.30	4	30.80
Electronic materials	0	0.00	0	0.00
Internet	0	0.00	0	0.00
none	5	35.70	9	69.20
Availability of Gadgets				
Cellular phone	13	92.90	8	61.50
Laptop computer	0	0.00	0	0.00
Tablet	0	0.00	0	0.00
Computer desktop	1	7.10	0	0.00
None	0	0.00	5	38.50

Table 1 presents the profile of the participants in the experimental and control groups. It can be shown from the results that in the experimental group, there are more female than male participants. In addition, in terms of their birth order, many of them are eldest among siblings. It is important to note that many of the participants also obtained 75-79 academic performance in their mathematics subject last first grading of SY 2022-2023. In addition, many of the participants in the said group have printed educational materials available at their homes. Finally, almost all of them have cellular phones.

Meanwhile, in terms of the profile of the participants in the control group, there are more male participants than female. In addition, same with those in the experimental group, many of the participants are eldest in terms of their birth order. It can also be gleaned from the table that majority of the participants obtained 80-84 academic performance in mathematics. It is important to note that most of them do not have available learning resources at home. Finally, most of them also own cellular phones.

Table 2. Pre-test Results of the Participants in the Control and Experimental Groups

Score Range	Experimental Group		Control Group	
	n	%	n	%
21 – 25	0	0.00	0	0.00
16 – 20	0	0.00	0	0.00
11 – 15	0	0.00	1	7.70
06 – 10	14	100.00	12	92.30
00 – 05	0	0.00	0	0.00
Mean Score	7.85	Fair	8.00	Fair

Table 2 presents the pre-test results of the participants in the control and experimental groups. It can be shown from the table that all the 14 participants in the experimental group obtained a fair performance in their pre-test. Also, almost all the participants in the control obtained a fair performance in their pre-test. Only one participant got a score from 11-15. Generally, participants from the experimental and control groups obtained a fair performance in their pre-test.

Table 3. Post-test Results of the Participants in the Control and Experimental Groups

Score Range	Experimental Group		Control Group	
	n	%	n	%
21 – 25	13	92.90	0	0.00
16 – 20	1	7.10	2	15.40
11 – 15	0	0.00	8	61.50
06 – 10	0	0.00	3	23.10
00 – 05	0	0.00	0	0.00
Mean Score	22.00	Excellent	12.85	Satisfactory

Table 3 presents the post-test results of the participants in the control and experimental groups. It can be gleaned from the results that almost all the participants in the experimental group obtained an excellent performance in their mathematics post-test. In addition, only one participant from the said group obtained a very satisfactory rating. Overall, participants in the experimental group achieved a mean score of 22 in their post-test, which means that they obtained an excellent rating after the conduct of the intervention.

Meanwhile, most participants in the control group obtained a satisfactory rating in their mathematics post-test. Some of them still got a fair rating, while only a few received a satisfactory rating in their post-test. In general, participants in the control group obtained a satisfactory rating after the conduct of the traditional lecture method in teaching mathematics.

Table 4. Significant Difference on the Pre-Test Scores of Participants in the Experimental and Control Groups

Groups	Pre-Test Score	df	t-value	p-value	Decision
Experimental Group	7.85	25	-.253	.802	Not Significant
Control Group	8.00				

**significant at .01*

Table 4 shows the significant difference on the pre-test scores of the participants in the experiment and control groups. It can be gleaned from the results that there is no significant difference on the pre-test scores of participants in the experiment and control groups. This is supported by the probability value of .802, which is higher than .01 level of significance. Hence, the null hypothesis is accepted. This means that the distribution of participants in the experimental and control groups is valid and reliable.

Table 5. Significant Difference on the Post-Test Scores of Participants in the Experimental and Control Groups

Groups	Post-Test Score	df	t-value	p-value	Decision
Experimental Group	22.00	25	10.820	.000	Significant
Control Group	12.85				

**significant at .01*

Table 5 presents the significant difference on the post-test scores of participants in the experimental and control groups. The results show that there is a significant difference on the post-test scores of participants in the experimental and control groups. This is supported by a probability value of .000 which is lower than .01 level of significance. Hence, the null hypothesis is rejected. The table shows a huge difference from the post-test scores of participants in the experimental and control groups. Specifically, results of the post-test show that participants from the experimental group obtained an excellent rating, while those in the control group obtained a satisfactory rating.

Table 6. Significant Difference on the Scores of Participants in the Experimental and Control Groups Before and After the Conduct of the Experimentation

Group	Test	Score	df	t-value	p-value	Decision
Experimental Group	Pre-Test	7.85	13	-21.370	.000	Significant
	Post-Test	22.00				
Control Group	Pre-Test	8.00	12	-4.677	.001	Significant
	Post-Test	12.85				

**significant at .01*

Table 6 presents the significant difference on the scores of the participants in the experimental and control groups before and after the conduct of the experimentation. It can be shown from the results that for participants in the experimental group, there is a significant difference on the scores of the participants in their pre-test and post-test. This is supported by the probability value of .000. Hence, the null hypothesis is rejected. This means that there is a huge increase in the scores of the participants after the implementation of the intervention on using indigenous games in learning mathematics.

Meanwhile, the table also shows a significant difference on the pre-test and post-test scores of the participants in the control group. This is supported by the probability of .001. Hence, the null hypothesis is rejected. However, the increase in the participants' scores in the control group is not that high compared to those in the experimental group.

IV. DISCUSSION

The goal of this study was to determine how well using indigenous games may improve pupils' mathematics performance. To ensure participant equality, the control and experimental groups' participant pairings were taken into consideration before the experiment. Thus, another technique employed in quasi-experimental design is matching individuals to experimental and control groups. Researchers begin by thinking about the factors that are essential to their study, especially those that may have an effect on the demographics or other characteristics of the dependent variable (Benedetto et al., 2018). The investigation showed that the participants in the experimental and control groups were appropriately matched.

Pre-test findings showed that both individuals in the experimental and control groups scored fairly on their mathematics exam. This indicates that individuals from both groups had a limited understanding of and familiarity with the mathematical concept of subtraction. Teachers have had issues because of students' poor mathematics proficiency (Nelson & Powell, 2018). The result of the study is supported by findings of previous research claiming the low and fair performance of elementary pupils in mathematics (Bonesronning et al., 2022; Cai et al., 2022; Mutlu, 2019). Additionally, the scores of thre participants in the experimental and control groups have increased, according to the results. The experimental group, however, experienced a significant increase, whereas the scores of the participants in the control group just slightly increased. It should be emphasized that participants in the experimental group received the intervention, which consisted of integrating native games. In contrast, participants in the control group received the standard lecture approach of instruction. According to the findings, the lecture technique is still a successful teaching method for mathematics. According to Strohmaier et al. (2020), the lecture method of education improves students' test scores by making concepts simpler to understand. The lecture format enables one-on-one instruction and lets the learner move at his own pace. Sometimes, it is advantageous to have group discussions in class. However, due to the various natures of today's learners, the efficiency of the lecture technique is too constrained. Lectures are comparable to other modalities when it comes to imparting fundamental knowledge, but they are not more efficient. The lecture method may be used to address the roles that teachers and students are expected to play. Additionally, Gupta and Kappor (2020) emphasized that teaching mathematics through lectures is ineffective. The teaching of physical skills, the development of attitudes or values, or the teaching of higher-order thinking skills like application, analysis, synthesis, or evaluation cannot be accomplished through lectures. For the instruction of challenging, abstract subjects, lectures are inadequate. Thus, educators must utilize additional cutting-edge teaching techniques that are responsive to the needs of their students, like the use of indigenous games.

In this study, it was discovered that using indigenous games effectively improves students' mathematical proficiency. The fact that post-test results of students in the experimental group were much higher than those of students in the control group supports this. The great score that students in the experimental group received on the post-test is another indicator of the efficiency of the aforementioned technique. As a result, game-based math instruction improves students' capacity to think, comprehend underlying ideas, and solve challenging mathematical problems (Leonard, 2018). While having fun, educational games encourage students to develop original ideas and push them to learn more quickly. More specifically, because elementary school students learn via play, adding native games into the teaching and learning of mathematics is essential (Bose & Seetso, 2016). Additionally, this increases the students' drive and interest in learning mathematics. These games were played in multicultural settings and were not just loved by members of one particular cultural group. The study demonstrates how geography, linguistic diversity, and culture influence the development of mathematics.

V. CONCLUSION AND RECOMMENDATIONS

The study concludes that the use of indigenous games is effective in enhancing the performance of Grade 2 pupils of Kinama Elementary School, Rizal District, Division of Kalinga in their mathematics subject, as manifested in the high increase of pupils' scores in the experimental group and also in comparison to their scores with those in the control group.

Other subject teachers may also start incorporating indigenous games into their subjects after thorough assessing the method's efficacy in raising students' academic achievement. Mathematics teachers may also utilize 21st-century instructional strategies and techniques to further improve the academic performance of pupils in mathematics. Furthermore, future researchers may also conduct school-wide collaborative research looking into the effectiveness of other strategies in enhancing pupils' academic performance in mathematics.

REFERENCES

Acharya, B. R. (2017). Factors affecting difficulties in learning mathematics by mathematics learners. *International Journal of Elementary Education*, *6*(2), 8-15.

Aikenhead, G. S. (2017). Enhancing school mathematics culturally: A path of reconciliation. *Canadian Journal of Science, Mathematics and Technology Education*, *17*(2), 73-140.

Barbieri, G. G., Barbieri, R., & Capone, R. (2021). Serious games in high school mathematics lessons: An embedded case study in Europe. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(5), em1963.

Barbin, E., Guillemette, D., & Tzanakis, C. (2020). History of mathematics and education. *Encyclopedia of mathematics education*, 333-342.

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences*, *2*(1), 4-12.

Benedetto, U., Head, S. J., Angelini, G. D., & Blackstone, E. H. (2018). Statistical primer: propensity score matching and its alternatives. *European Journal of Cardio-Thoracic Surgery*, *53*(6), 1112-1117.

Bonesrønning, H., Finseraas, H., Hardoy, I., Iversen, J. M. V., Nyhus, O. H., Opheim, V., ... & Schøne, P. (2022). Small-group instruction to improve student performance in mathematics in early grades: Results from a randomized field experiment. *Journal of Public Economics*, *216*, 104765.

Bose, K., & Seetso, G. (2016). Science and mathematics teaching through local games in preschools of Botswana. *South African Journal of Childhood Education*, *6*(2), 1-9.

Bowers, A., & Reategui, E. (2018). Native American Games and Mathematics: Learning through Culture. Mathematics Teaching in the Middle School, 23(4), 226-231.

Byun, J., & Joung, E. (2018). Digital game‐based learning for K–12 mathematics education: A meta‐analysis. *School Science and Mathematics*, *118*(3-4), 113-126.

Cai, D., Zhao, J., Chen, Z., & Liu, D. (2022). Executive functions training for 7-to 10-year-old students with mathematics difficulty: Instant effects and 6-month sustained effects. *Journal of Learning Disabilities*, 00222194221117513.

Choi, J. H., Meisenheimer, J. M., McCart, A. B., & Sailor, W. (2017). Improving learning for all students through equity-based inclusive reform practices: Effectiveness of a fully integrated schoolwide model on student reading and math achievement. *Remedial and special education*, *38*(1), 28-41.

Cleary, T. J., Velardi, B., & Schnaidman, B. (2017). Effects of the Self-Regulation Empowerment Program (SREP) on middle school students' strategic skills, self-efficacy, and mathematics achievement. *Journal of school psychology*, *64*, 28-42.

Darragh, L. (2016). Identity research in mathematics education. *Educational Studies in Mathematics*, *93*(1), 19-33.

Di Martino, P., & Gregorio, F. (2019). The mathematical crisis in secondary–tertiary transition. *International Journal of Science and Mathematics Education*, *17*(4), 825-843.

Doabler, C. T., Baker, S. K., Kosty, D. B., Smolkowski, K., Clarke, B., Miller, S. J., & Fien, H. (2015). Examining the association between explicit mathematics instruction and student mathematics achievement. *The Elementary School Journal*, *115*(3), 303-333.

Drigas, A. S., & Pappas, M. A. (2015). On Line and Other Game-Based Learning for Mathematics. *International Journal of Online Engineering*, *11*(4).

Essien, A. A. (2018). The role of language in the teaching and learning of early grade mathematics: An 11-year account of research in Kenya, Malawi and South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, *22*(1), 48-59.

Faber, J. M., Luyten, H., & Visscher, A. J. (2017). The effects of a digital formative assessment tool on mathematics achievement and student motivation: Results of a randomized experiment. *Computers & education*, *106*, 83-96.

Garnica, A. V. M., & Vianna, C. R. (2019). Oral History in Mathematics Education: an overview. *Oral History and Mathematics Education*, 1-19.

Gill, G. K. (2018). Prevalence of Mathematics Anxiety in Preservice Teachers and Preservice Counselors.

Goodyear, P., Carvalho, L., & Yeoman, P. (2021). Activity-Centred Analysis and Design (ACAD): Core purposes, distinctive qualities and current developments. *Educational Technology Research and Development*, *69*(2), 445-464.

Gresham, G., & Burleigh, C. (2019). Exploring early childhood preservice teachers' mathematics anxiety and mathematics efficacy beliefs. *Teaching Education*, *30*(2), 217-241.

Grootenboer, P., Grootenboer, & Marshman, M. (2015). *Mathematics, affect and learning*. Springer Singapore.

Gupta, S. C., & Kapoor, V. K. (2020). *Fundamentals of mathematical statistics*. Sultan Chand & Sons.

Hattie, J., Fisher, D., Frey, N., Gojak, L. M., Moore, S. D., & Mellman, W. (2016). *Visible learning for mathematics, grades K-12: What works best to optimize student learning*. Corwin Press.

Heshmati, S., Kersting, N., & Sutton, T. (2018). Opportunities and challenges of implementing instructional games in mathematics classrooms: Examining the quality of teacher-student interactions during the cover-up and un-cover games. *International Journal of Science and Mathematics Education*, *16*(4), 777-796.

Hill, J. L., & Hill, S. L. (2013). Indigenous Games as a Tool for Teaching Mathematics: A Case Study of the Zulu Stick Game. Journal of Mathematics Education, 6(1), 7-22.

Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. *Learning and individual differences*, *48*, 45-53.

Hu, X., Gong, Y., Lai, C., & Leung, F. K. (2018). The relationship between ICT and student literacy in mathematics, reading, and science across 44 countries: A multilevel analysis. *Computers & Education*, *125*, 1-13.

Hutchison, J. E., Lyons, I. M., & Ansari, D. (2019). More similar than different: Gender differences in children's basic numerical skills are the exception not the rule. *Child development*, *90*(1), e66-e79.

Ishaq, A. A., Latunde, T., Ogwumu, O. D., Mustapha, A. M., & Ajinuhi, J. O. (2019). Impacts of Simulation-Games on Teaching and Learning Mathematics. *ATBU Journal of Science, Technology and Education*, *7*(4), 129-134.

Itter, D., & Meyers, N. (2017). Fear, Loathing and Ambivalence toward Learning and Teaching Mathematics: Preservice Teachers' Perspectives. *Mathematics Teacher Education and Development*, *19*(2), 123-141.

Kiili, K., Devlin, K., Perttula, A., Tuomi, P., & Lindstedt, A. (2015). Using video games to combine learning and assessment in mathematics education. *International Journal of Serious Games*, *2*(4), 37-55.

Kilpatrick, J. (2020). History of research in mathematics education. *Encyclopedia of mathematics education*, 349-354.

Kokka, K. (2016). Urban teacher longevity: What keeps teachers of color in one under-resourced urban school?. *Teaching and Teacher Education*, *59*, 169-179.

Koushik, M. A. (2019). An Exploratory Study of the Use of Traditional Indigenous Games to Enhance Mathematical Thinking of Primary School Children. International Journal of Education in Mathematics, Science and Technology, 7(4), 303-311.

Leonard, J. (2018). *Culturally specific pedagogy in the mathematics classroom: Strategies for teachers and students*. Routledge.

Lowrie, T. (2015). Digital games and learning: what's new is already old?. In *Digital Games and Mathematics Learning* (pp. 1-9). Springer, Dordrecht.

Lowrie, T. (2015). Digital games and learning: what's new is already old?. In *Digital Games and Mathematics Learning* (pp. 1-9). Springer, Dordrecht.

Macdonald, K., Milne, N., Orr, R., & Pope, R. (2018). Relationships between motor proficiency and academic performance in mathematics and reading in school-aged children and adolescents: a systematic review. *International journal of environmental research and public health*, *15*(8), 1603.

Mahmoudi, H., Koushafar, M., Saribagloo, J. A., & Pashavi, G. (2015). The effect of computer games on speed, attention and consistency of learning mathematics among students. *Procedia-Social and Behavioral Sciences*, *176*, 419-424.

Malvasi, V., Gil-Quintana, J., & Bocciolesi, E. (2022). The projection of gamification and serious games in the learning of mathematics multi-case study of secondary schools in Italy. *Mathematics*, *10*(3), 336.

Martin, D. B., Price, P. G., & Moore, R. (2019). Refusing systemic violence against Black children: Toward a Black liberatory mathematics education. In *Critical race theory in mathematics education* (pp. 32-55). Routledge.

Maslihah, S., Waluya, S. B., & Suyitno, A. (2020, May). The Role Of Mathematical Literacy To Improve High Order Thinking Skills. In *Journal of Physics: Conference Series* (Vol. 1539, No. 1, p. 012085). IOP Publishing.

Mazana, Y. M., Suero Montero, C., & Olifage, C. R. (2019). Investigating students' attitude towards learning mathematics.

McClain, L. R. (2018). The Power of Indigenous Games: Supporting Mathematics Learning for Native American Students. Journal of American Indian Education, 57(2), 30-53.

McGee, J. D. (2019). *Effectiveness of Math Literacy Implementation on Eighth Grade Algebra Students* (Doctoral dissertation, Brenau University).

McLaren, B. M., Adams, D. M., Mayer, R. E., & Forlizzi, J. (2017). A computer-based game that promotes mathematics learning more than a conventional approach. *International Journal of Game-Based Learning (IJGBL)*, *7*(1), 36-56.

Mkhize, M. V. (2019). Mathematics anxiety among pre-service accounting teachers. *South African Journal of Education*, *39*(3), 1-14.

Monaghan, J., Trouche, L., & Borwein, J. M. (2016). *Tools and mathematics* (Vol. 110). Berlin: Springer International Publishing.

Mutlu, Y. (2019). Math Anxiety in Students with and without Math Learning Difficulties. *International Electronic Journal of Elementary Education*, *11*(5), 471-475.

Myers, J. A., Hughes, E. M., Witzel, B. S., Anderson, R. D., & Owens, J. (2022). A Meta-Analysis of Mathematical Interventions for Increasing the Word Problem Solving Performance of Upper Elementary and Secondary Students with Mathematics Difficulties. *Journal of Research on Educational Effectiveness*, 1-35.

Nasution, M. K. M. (2018, December). The uncertainty: A history in mathematics. In *Journal of Physics: Conference Series* (Vol. 1116, No. 2, p. 022031). IOP Publishing.

Nelson, G., & Powell, S. R. (2018). A systematic review of longitudinal studies of mathematics difficulty. *Journal of Learning Disabilities*, *51*(6), 523-539.

Neslihan, U. S. T. A., IŞIK, A. D., Şahan, G., Süreyya, G. E. N. Ç., Fatih, T. A. Ş., Gülay, G., ... & KÜÇÜK, K. (2017). The opinions of pre-service teachers on the usage of games in mathematics teaching. *International Journal of Social Sciences and Education Research*, *3*(1), 328-344.

Papert, S. A. (2020). *Mindstorms: Children, computers, and powerful ideas*. Basic books.

Planas, N., Morgan, C., & Schütte, M. (2018). Mathematics education and language: Lessons and directions from two decades of research. *Developing research in mathematics education*, 196-210.

Richardson, M., Tina Isaacs, T., Barnes, I., Swensson, C., Wilkinson, D., & Golding, J. (2020). Trends in International Mathematics and Science Study (TIMSS) 2019: national report for england.

Rubie-Davies, C. M., Peterson, E. R., Sibley, C. G., & Rosenthal, R. (2015). A teacher expectation intervention: Modelling the practices of high expectation teachers. *Contemporary Educational Psychology*, *40*, 72-85.

Schleicher, A. (2019). PISA 2018: Insights and Interpretations. *oecd Publishing*.

Soni, A., & Kumari, S. (2017). The role of parental math anxiety and math attitude in their children's math achievement. *International Journal of Science and Mathematics Education*, *15*(2), 331-347.

Strohmaier, A. R., MacKay, K. J., Obersteiner, A., & Reiss, K. M. (2020). Eye-tracking methodology in mathematics education research: A systematic literature review. *Educational Studies in Mathematics*, *104*(2), 147-200.

Tanujaya, B., Mumu, J., & Margono, G. (2017). The Relationship between Higher Order Thinking Skills and Academic Performance of Student in Mathematics Instruction. *International Education Studies*, *10*(11), 78-85.

Tobin, P. C., & Weiss, V. (2016). Teaching Undergraduate Mathematics using CAS Technology: Issues and Prospects. *International Journal for Technology in Mathematics Education*, *23*(1).

Torbeyns, J., Schneider, M., Xin, Z., & Siegler, R. S. (2015). Bridging the gap: Fraction understanding is central to mathematics achievement in students from three different continents. *Learning and instruction*, *37*, 5-13.

Van de Weijer-Bergsma, E., & Van der Ven, S. H. (2021). Why and for whom does personalizing math problems enhance performance? Testing the mediation of enjoyment and cognitive load at different ability levels. *Learning and Individual Differences*, *87*, 101982.

Van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). Realistic mathematics education. *Encyclopedia of mathematics education*, 713-717.

Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., ... & Petrill, S. A. (2015). Is math anxiety always bad for math learning? The role of math motivation. *Psychological science*, *26*(12), 1863-1876.

Widjaja, W., Groves, S., & Ersozlu, Z. (2021). Designing and delivering an online lesson study unit in mathematics to pre-service primary teachers: opportunities and challenges. *International Journal for Lesson & Learning Studies*.

Williams, J., Roth, W. M., Swanson, D., Doig, B., Groves, S., Omuvwie, M., ... & Mousoulides, N. (2016). *Interdisciplinary mathematics education*. Springer Nature.

Wilsson, R. (2017). *Perceived effects of supplementary training: a phenomenographic study of math teachers' ongoing development* (Master's thesis).

Yong, S. T., Harrison, I., & Gates, P. (2016). Using digital games to learn mathematics-What students think. *International Journal of Serious Games*, *3*(2), 13-28.