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THE EFFECTIVENESS OF ETHNOMATEMATICS BASED LEARNING ON MATHEMATICS ABILITY OF ELEMENTARY SCHOOL STUDENTS: A META-ANALYIS STUDY

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ABSTRACT

The combination of culture and mathematics can provide more meaningful mathematics learning so that the abstraction of mathematical material can be more easily understood by students. However, previous research investigating the effectiveness of implementing ethnomathematics-based learning in elementary schools has shown mixed results. Therefore, the purpose of this study was to determine the effectiveness of ethnomathematics-based learning on the mathematical abilities of elementary school students. The method used in this study is meta-analysis. This study analyzed 13 effect sizes from 12 primary studies that met the inclusion criteria. The results of the study based on the moderator variable showed that the effectiveness of applying ethnomathematics-based learning to elementary students' mathematical abilities differed significantly based on the year of publication (Qb = 10.22; p = 0.00), but there was no significant difference based on the class level variable (Qb = 1.98; p = 0.16) and the sample size variable (Qb = 0.30; p = 0.58). These findings provide evidence that ethnomathematics-based learning can be effective in improving elementary school students' mathematical abilities. However, the varying results between studies could be due to other factors to consider. The results of this study can be a basis for policy makers and education practitioners to choose the right learning approach in improving the quality of learning mathematics in elementary schools. Further understanding of the factors that influence the effectiveness of ethnomathematics-based learning is also important for the development of a more optimal approach in this context.

Keywords: elementary school; effect size; ethnomathematics; mathematical ability; meta-analysis

INTRODUCTION

Mathematical abilities have an important role in the development of science and technology.[1,2,3] Mathematics has a prominent place because it is a driving force in the development of habits, positive attitudes and the capacity to formulate rational hypotheses

[1] Muhammad Daut Siagian, "Kemampuan Koneksi Matematik Dalam Pembelajaran Matematika," *MES: Journal of Mathematics Education and Science* 2, no. 1 (October 1, 2016): 58–67, https://doi.org/10.30743/mes.v2i1.117.

[2] Paul T. Cirino et al., "Cognitive Predictors of the Overlap of Reading and Math in Middle School," *Learning and Individual Differences* 109 (January 1, 2024): 102400, https://doi.org/10.1016/j.lindif.2023.102400.

[3] Richard Barwell, Mark Boylan, and Alf Coles, "Mathematics Education and The Living World: A Dialogic Response to a Global Crisis," *The Journal of Mathematical Behavior* 68 (December 1, 2022): 101013, https://doi.org/10.1016/j.jmathb.2022.101013.

and face challenges.[4,5,6] Good math ability early on can teach valuable skills for future math classes, other academic classes, and life in general. In fact, it is the strongest predictor of future academic success.[7,8,9] If students have good math skills at a young age, they will be more likely to succeed in school.[10,11,12] Learning mathematics in elementary schools is very important to improve students' ability to improve critical thinking

[4] Mojeed. K. Akinsola and F. B. Olowojaiye, "Teacher Instructional Methods and Student Attitudes towards Mathematics," *International Electronic Journal of Mathematics Education* 3, no. 1 (April 4, 2008): 60–73, https://doi.org/10.29333/iejme/218.

[5] Venera Gashaj et al., "Foundations for Future Math Achievement: Early Numeracy, Home Learning Environment, and The Absence of Math Anxiety," *Trends in Neuroscience and Education* 33 (December 1, 2023): 100217, https://doi.org/10.1016/j.tine.2023.100217.

[6] Fidelis Zai et al., "Mathematical Model and Dynamics Analysis of the Stingless Bee (Trigona Sp.) in a Colony," *Communication in Biomathematical Sciences* 5, no. 2 (January 19, 2023): 151–60, https://doi.org/10.5614/cbms.2022.5.2.4.

[7] J. D. Chesloff, "STEM Education Must Start in Early Childhood," *Education Week*, March 6, 2013, sec. Teaching & Learning, Early Childhood, 27–32, https://www.edweek.org/teaching-learning/opinion-stem-education-must-start-in-early-childhood/2013/03.

[8] Niken Wahyu Utami, Suminto A. Sayuti, and Jailani Jailani, "Indigenous Artifacts from Remote Areas, Used to Design a Lesson Plan for Preservice Math Teachers Regarding Sustainable Education," *Heliyon* 7, no. 3 (March 1, 2021): 1–9, https://doi.org/10.1016/j.heliyon.2021.e06417.

[9] Sarit Ashkenazi and Hagar Velner, "The Interplay Between Math Performances, Spatial Abilities, and Affective Factors: The Role of Task," *Trends in Neuroscience and Education* 33 (December 2023): 100211, https://doi.org/10.1016/j.tine.2023.100211.

[10] Barbara Harris and Dana Petersen, "Developing Math Skills in Early Childhood. Issue Brief," *Mathematica Policy Research, Inc.* (Mathematica Policy Research, February 2019), 1–6, https://eric.ed.gov/?id=ED594025.

[11] Ahmad Umar et al., "Does Opportunity to Learn Explain the Math Score Gap between Madrasah and Non-Madrasah Students in Indonesia?," *Jurnal Cakrawala Pendidikan* 41, no. 3 (September 30, 2022): 792–805, https://doi.org/10.21831/cp.v41i3.40169.

[12] L. Verschaffel, B. Greer, and E. De Corte, "Mathematics Learning," in *International Encyclopedia of Education (Third Edition)*, ed. Penelope Peterson, Eva Baker, and Barry McGaw (Oxford: Elsevier, 2010), 401–406, https://doi.org/10.1016/B978-0-08-044894-7.00517-0.

skills,[13,14] creative thinking,[15,16,17,18,19] and problem solving.[20,21] Therefore it is very important to strengthen mathematical abilities in students since they are in elementary school.

According to Piaget's theory of cognitive development, elementary school students enter the concrete operational level.[22] At this stage, it is easier for students to construct new knowledge through something that is real based on what they see.[23,24] However, the abstract characteristics of mathematics are often an obstacle.[25] This abstract nature is believed to be the cause of many students at the elementary level experiencing

[13] Anas Salahudin, Inne Marthyane Pratiwi, and Syaeful Hidayat, "Mathematical Critical Thinking Skill of Madrasah Ibtidaiyah Students on Cubes and Beam Volumes Material," *Al-Bidayah : Jurnal Pendidikan Dasar Islam* 12, no. 1 (June 30, 2020): 1–14, https://doi.org/10.14421/albidayah.v12i1.349.

[14] Robin S. Codding et al., "Meta-Analysis of Skill-Based and Therapeutic Interventions to Address Math Anxiety," *Journal of School Psychology* 100 (October 1, 2023): 101229, https://doi.org/10.1016/j.jsp.2023.101229.

[15] Salahudin, Pratiwi, and Hidayat, "Mathematical Critical Thinking Skill of Madrasah Ibtidaiyah Students on Cubes and Beam Volumes Material."

[16] Igor Verner, Khayriah Massarwe, and Daoud Bshouty, "Constructs of Engagement Emerging in an Ethnomathematically-Based Teacher Education Course," *The Journal of Mathematical Behavior* 32, no. 3 (September 1, 2013): 494–507, https://doi.org/10.1016/j.jmathb.2013.06.002.

[17] Abdur Asari, Ali Mahmudi, and Elah Nurlaelah, "Our Prospective Mathematic Teachers Are Not Critical Thinkers Yet," *Journal on Mathematics Education* 8 (February 6, 2017), https://doi.org/10.22342/jme.8.2.3961.145-156.

[18] Wisanti Wisanti, Novita Kartika Indah, and Eva Kristinawati Putri, "Scientific Digital Poster Assignments: Strengthen Concepts, Train Creativity, and Communication Skills," *International Journal of Evaluation and Research in Education (IJERE)* 13, no. 2 (April 1, 2024): 1035–44, https://doi.org/10.11591/ijere.v13i2.25909.

[19] Suherman Suherman and Tibor Vidákovich, "Assessment of Mathematical Creative Thinking: A Systematic Review," *Thinking Skills and Creativity* 44, no. 4 (March 1, 2022): 101019, https://doi.org/10.1016/j.tsc.2022.101019.

[20] Mohamad Agung Rokhimawan, "Pengembangan LKM Berbasis Keterampilan Proses Sains Pada Mata Kuliah Pembelajaran IPA MI 1," *Al-Bidayah : Jurnal Pendidikan Dasar Islam* 8, no. 1 (2016): 1, https://doi.org/10.14421/albidayah.v8i1.88.

[21] Sutama wJ et al., "Collaborative Mathematics Learning Management: Critical Thinking Skills In Problem Solving," *International Journal of Evaluation and Research in Education (IJERE)* 11, no. 3 (September 1, 2022): 1015, https://doi.org/10.11591/ijere.v11i3.22193.

[22] Enose M W Simatwa, "Piaget's Theory of Intellectual Development And Its Implication for Instructional Management at Pre- Secondary School Level," *Educational Research and Reviews* 5, no. 7 (2010): 366–71.

[23] Anatri Desstya et al., "Refleksi Pendidikan IPA Sekolah Dasar di Indonesia (Relevansi Model Pendidikan Paulo Freire dengan Pendidikan IPA di Sekolah Dasar)," *Profesi Pendidikan Dasar* 4, no. 1 (June 13, 2017): 1–11, https://doi.org/10.23917/ppd.v1i1.2745.

[24] Yvette d'Entremont, "Linking Mathematics, Culture and Community," *Procedia - Social and Behavioral Sciences*, International Conference on New Horizons in Education, INTE 2014, 25-27 June 2014, Paris, France, 174 (February 12, 2015): 2818–24, https://doi.org/10.1016/j.sbspro.2015.01.973.

[25] Igor Verner, Khayriah Massarwe, and Daoud Bshouty, "Development of Competencies for Teaching Geometry through an Ethnomathematical Approach," *The Journal of Mathematical Behavior* 56 (December 1, 2019): 100708, https://doi.org/10.1016/j.jmathb.2019.05.002.

difficulties in understanding mathematical concepts.[26,27] In addition, teacher delivery strategies are still monotonous and formal in nature.[28,29]

The teacher conveys mathematical material theoretically without connecting it with things that are close to students' lives. This causes students to have an assessment that the mathematics they learn is very different from everyday life.[30] This is in accordance with Rosa's statement in Andriyani and Kuntarto which states that there are differences between the mathematical knowledge that students acquire academically and informally.[31] These factors make it difficult for students to understand the concept of learning mathematics presented.[32,33]

Teachers need to package learning mathematics into interesting learning and provide meaningful learning experiences for students, one of which is based on student

[26] Nur Umar and Wildan Wiguna, "Gamifikasi Media Pembelajaran Matematika Berbasis Mobile Di Sekolah Dasar Negeri Sindangmulya II," *eProsiding Sistem Informasi (POTENSI)* 1, no. 1 (2020): 231–41.

[27] Jitu Halomoan Lumbantoruan and Risma Uly Manalu, "Effectiveness of Learning Mathematics Derivative Materials Using Modules Equipped with Cooperative Models in High Schools," *International Journal of Evaluation and Research in Education (IJERE)* 13, no. 1 (February 1, 2024): 523–33, https://doi.org/10.11591/ijere.v13i1.25354.

[28] Rizky Amelia Farah and Budiyono, "Pembelajaran Matematika Materi Geometri Di SD Al Hikmah Surabaya," *Jurnal Penelitian Pendidikan Guru Sekolah Dasar* 6, no. 3 (n.d.): 2018.

[29] Irma Ayuwanti, Marsigit Marsigit, and Dwi Siswoyo, "Teacher-Student Interaction in Mathematics Learning," *International Journal of Evaluation and Research in Education (IJERE)* 10, no. 2 (June 1, 2021): 660–67, https://doi.org/10.11591/ijere.v10i2.21184.

[30] Eva Thanheiser, "What Is the Mathematics in Mathematics Education?," *The Journal of Mathematical Behavior* 70 (June 1, 2023): 1–13, https://doi.org/10.1016/j.jmathb.2023.101033.

[31] Adam Arya Nugraha, "Media Pembelajaran Interaktif Menggunakan GeoGebra Bernuansa Etnomatematika untuk Meningkatkan Kemampuan Representasi Matematis Peserta Didik," in *Prosiding Seminar Nasional Pendidikan Matematika dan Matematika*, vol. 5 (Seminar Nasional Pendidikan matematika dan Matematika, Yogyakarta: Fakultas Matematika dan ilmu Pengetahuan Alam Universitas Negeri Yogyakarta, 2022), https://doi.org/10.21831/pspmm.v5i1.221.

[32] Julie Goulet et al., "Supporting Academic Achievement Of Children in Out-of-Home Care Through Effective Interventions: Results of A Systematic Review And Meta-Analyses," *Children and Youth Services Review* 156 (January 1, 2024): 107388, https://doi.org/10.1016/j.childyouth.2023.107388.

[33] O. Arda Cimen, "Discussing Ethnomathematics: Is Mathematics Culturally Dependent?," *Procedia - Social and Behavioral Sciences*, ERPA International Congress on Education, ERPA Congress 2014, 6-8 June 2014, Istanbul, Turkey, 152 (October 7, 2014): 523–28, https://doi.org/10.1016/j.sbspro.2014.09.215.

culture.[34,35,36,37,38] Astutiningtyas et al,[39] stated that culture-based mathematics learning is an exciting and fun approach to learning mathematics. Humans are essentially cultured beings, culture is deeply rooted in human life, while humans use mathematics to solve problems in their daily lives.[40,41] Therefore, learning mathematics that is rooted in culture can be an alternative solution in learning mathematics, so that learning mathematics becomes meaningful because it is close to their daily activities. One approach to learning mathematics that is rooted in culture is ethnomathematics.[42]

Ethnomatematics-based learning is an approach to learning mathematics that seeks to relate mathematics to students' local cultural practices.[43] This learning approach seeks to foster meaningfulness from learning mathematics.[44] By bringing students' cultural practices into learning mathematics, it is hoped that students will feel that

[34] Emmanuel E Achor, Benjamin I Imoko, and Emmanuel S Uloko, "Effect of Ethnomathematics Teaching Approach on Senior Secondary Students' Achievement and Retention in Locus," *Educational Research and Review* 4, no. 8 (2009): 385–90.

[35] Suherman Suherman and Tibor Vidákovich, "Relationship Between Ethnic Identity, Attitude, and Mathematical Creative Thinking Among Secondary School Students," *Thinking Skills and Creativity* 51 (March 1, 2024): 1–13, https://doi.org/10.1016/j.tsc.2023.101448.

[36] Yan Gan and Juan Peng, "Effects Of Teacher Support on Math Engagement Among Chinese College Students: A Mediated Moderation Model of Math Self-Efficacy and Intrinsic Value," *Children and Youth Services Review* 156 (January 1, 2024): 107369, https://doi.org/10.1016/j.childyouth.2023.107369.

[37] Gladys Sunzuma et al., "A Comparison of the Effectiveness of Ethnomathematics and Traditional Lecture Approaches in Teaching Consumer Arithmetic: Learners' Achievement and Teachers' Views," *Pedagogical Research* 6, no. 4 (September 8, 2021): 1–8, https://doi.org/10.29333/pr/11215.

[38] Peter Appelbaum, "The Rise of STEM Education: Mathematics Learning for STEM," in *International Encyclopedia of Education (Fourth Edition)*, ed. Robert J Tierney, Fazal Rizvi, and Kadriye Ercikan (Oxford: Elsevier, 2023), 28–35, https://doi.org/10.1016/B978-0-12-818630-5.13036-2.

[39] Erika Laras Astuningtyas, Andhika Ayu Wulandari, and Isna Farahsanti, "Etnomatematika Dan Pemecahan Masalah Kombinatorik," *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah di Bidang Pendidikan Matematika* 3, no. 2 (November 30, 2017): 111–18, https://doi.org/10.29407/jmen.v3i2.907.

[40] Ubiratan D'Ambrosio and Milton Rosa, "Ethnomathematics and Its Pedagogical Action in Mathematics Education," in *Ethnomathematics and Its Diverse Approaches for Mathematics Education*, ed. Milton Rosa et al., ICME-13 Monographs (Cham: Springer International Publishing, 2017), 285–305, https://doi.org/10.1007/978-3-319-59220-6_12.

[41] Aigul Syzdykbayeva et al., "Training of Future Teachers for The Implementation of Continuity of Pre-School and Primary Mathematical Education," *Jurnal Cakrawala Pendidikan* 41, no. 2 (May 30, 2022): 531–40, https://doi.org/10.21831/cp.v41i2.43641.

[42] Noor Aishikin Adam, "Mutual Interrogation: A Methodological Process in Ethnomathematical Research," *Procedia - Social and Behavioral Sciences*, International Conference on Mathematics Education Research 2010 (ICMER 2010), 8 (January 1, 2010): 700–707, https://doi.org/10.1016/j.sbspro.2010.12.097.

[43] Marcia Ascher, *Ethnomathematics: A Multicultural View of Mathematical Ideas* (New York: Routledge, 2017), https://doi.org/10.1201/9780203756522.

[44] Andi Saparuddin Nur et al., "Contextual Learning With Ethnomathematics In Enhancing The Problem Solving Based On Thinking Levels," *JRAMathEdu (Journal of Research and Advances in Mathematics Education)* 5, no. 3 (September 30, 2020): 331–44, https://doi.org/10.23917/jramathedu.v5i3.11679.

mathematics is very close to their lives, so that they no longer perceive mathematics as a frightening and useless science. Students can think about the role and benefits of mathematics in their lives. Therefore, cultural phenomena in the student's local environment are aspects that must be integrated and cannot be separated from learning mathematics.[45] Ethnomatematics can be used to help students understand abstract mathematical concepts,[46,47] improve problem solving,[4849] and creativity.[50]

Many studies have confirmed that ethnomathematics-based learning can improve elementary school students' mathematical abilities, for example research conducted by.[51,52,53,54,55] However, their findings show relatively different results. Therefore it is

[45] I. Grattan-Guinness, "The Mathematics of The Past: Distinguishing Its History from Our Heritage," *Historia Mathematica* 31, no. 2 (May 1, 2004): 163–85, https://doi.org/10.1016/S0315-0860(03)00032-6.

[46] Dewi Herawaty et al., "The Improvement of The Understanding of Mathematical Concepts Through The Implementation of Realistic Mathematics Learning And Ethnomathematics," in *Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2018)* (International Conference on Educational Sciences and Teacher Profession (ICETeP 2018), Atlantis Press, 2019), 21–25, https://doi.org/10.2991/icetep-18.2019.6.

[47] Kay Owens and Charly Muke, "Revising The History of Number: How Ethnomathematics Transforms Perspectives on Indigenous Cultures," *Revemop* 2 (March 4, 2020), https://doi.org/10.33532/revemop.e202007.

[48] Miriam Amit and Fouze Abu Qouder, "Weaving Culture and Mathematics in the Classroom: The Case of Bedouin Ethnomathematics," in *Ethnomathematics and Its Diverse Approaches for Mathematics Education*, ed. Milton Rosa et al. (New York: Springer International Publishing, 2017), 23–50, https://doi.org/10.1007/978-3-319-59220-6_2.

[49] Arif Hidayatul Khusna, Tatag Yuli Eko Siswono, and Pradnyo Wijayanti, "Research Trends In Critical Thinking Skills In Mathematics: A Bibliometric Study," *International Journal of Evaluation and Research in Education (IJERE)* 13, no. 1 (February 1, 2024): 18–30, https://doi.org/10.11591/ijere.v13i1.26013.

[50] R. Abiodun Ogunkunle and Nchelem R. George, "Integrating Ethnomathematics Into Secondary School Mathematics Curriculum for Effective Artisan Creative Skill Development," *European Scientific Journal, ESJ* 11, no. 3 (January 30, 2015), https://eujournal.org/index.php/esj/article/view/5013.

[51] Patrick Obere Abiam, Okechukwu S Abonyi, and J. O Ugama, "Effects of Ethnomathematics-Based Instructional Approach on Primary School Pupils' Achievement in Geometry," *Journal of Scientific Research & Reports* 9, no. 2 (2016): 1–15, https://doi.org/10.9734/JSRR/2016/19079.

[52] Suci Nooryanti, Sri Utaminingsih, and Henry Suryo Bintoro, "Pengaruh Pendekatan Pendidikan Matematika Realistik Berbasis Etnomatematika Terhadap Komunikasi Matematis Siswa Sekolah Dasar," *ANARGYA: Jurnal Ilmiah Pendidikan Matematika* 3, no. 1 (June 10, 2020): 30–34, https://doi.org/10.24176/anargya.v3i1.4739.

[53] Nur Atikah, V. Karjiyati, and Feri Noperman, "Pengaruh Model Realistic Mathematics Education Berbasis Etnomatematika Tabut Terhadap Kemampuan Komunikasi Matematika Siswa Kelas IV SDN Di Kota Bengkulu," *JURIDIKDAS: Jurnal Riset Pendidikan Dasar* 3, no. 1 (2020): 25–32, https://doi.org/10.33369/JURIDIKDAS.3.1.25-32.

[54] Putu Risma Radiana, I. Wayan Wiarta, and I. Komang Ngurah Wiyasa, "Pengaruh Model Pembelajaran Probing Prompting Berbasis Etnomatematika Terhadap Kompetensi Pengetahuan Matematika Kelas V," *Jurnal Adat Dan Budaya Indonesia* 2, no. 1 (September 30, 2020): 32–40, https://doi.org/10.23887/jabi.v2i1.28906.

[55] Tivani Sandra Witha, Victoria Karjiyati, and Pebrian Tarmizi, "Pengaruh Model RME Berbasis Etnomatematika Terhadap Kemampuan Literasi Matematika Siswa Kelas IV SD Gugus 17 Kota

necessary to carry out further research to provide more accurate and in-depth conclusions. One research approach that is suitable for this need is a meta-analysis study. Relatively different research findings on the same topic can make conclusions blurry and difficult to draw strong generalizations. Making policy decisions regarding the implementation of ethnomathematics-based learning in primary schools can be difficult, thus confusing stakeholders in determining whether they should apply this approach or not.

Meta-analysis is a statistical analysis technique that combines the results of previous studies on the same topic to find the combined effect of each study used.[56] Meta-analysis studies can be an appropriate approach to combine the results of different studies in one more comprehensive analysis.[57,58] Meta-analysis studies can be used to evaluate the results of previous research to reach in-depth and accurate conclusions.[59] This research approach produces more objective conclusions than other review methods because it focuses on the effect size of empirical findings.[60] In this regard, meta-analysis studies can be very useful tools for teachers in addressing differences in research findings. Through meta-analysis studies, relevant studies can be collected, data synthesis can be carried out, and statistical analysis can be used to identify general trends among different research findings.

In the context of ethnomathematics-based learning and improving the mathematics abilities of elementary school students, conducting a meta-analysis study can help identify general trends, clarify differences in the results of previous research, and draw more accurate conclusions about the impact of ethnomathematics-based learning in elementary schools. By having more objective conclusions through meta-analytic studies, teachers can make more informed and supportive decisions in designing

Bengkulu," *JURIDIKDAS: Jurnal Riset Pendidikan Dasar* 3, no. 2 (February 12, 2021): 136–43, https://doi.org/10.33369/juridikdas.3.2.136-143.

[56] Thomas M. Hunter, "Translation in a World of Diglossia," in *Translation in Asia* (Routledge, 2011), 157–83.

[57] Muslimin Muslimin et al., "Learning Integers With Realistic Mathematics Education Approach Based on Islamic Values," *Journal on Mathematics Education* 11, no. 3 (August 29, 2020): 363–84, https://doi.org/10.22342/jme.11.3.11721.363-384.

[58] Ahmad Syafii et al., "The Effects of Multiple Intelligences Theory on Learning Success: A Meta-Analysis in Social Science," *International Journal of Evaluation and Research in Education (IJERE)* 11, no. 2 (June 1, 2022): 736–43, https://doi.org/10.11591/ijere.v11i2.22223.

[59] Heri Retnawati et al., *Pengantar Analisis Meta* (Yogyakarta: Parama Publising, 2018).

[60] Michael Borenstein et al., eds., *Introduction to Meta-Analysis*, 2nd Edition (Chichester, U.K: John Wiley & Sons, 2021).

and implementing effective mathematics learning strategies. This helps improve the quality of learning in the classroom by building on existing evidence and research.[61]

In addition, when there are significant differences in research findings, meta-analysis studies can also help identify factors that might influence research results. By understanding these factors, teachers can consider the research context and take appropriate steps in adapting or applying research findings to their classroom situations.

Based on a search of the literature that we have explored so far, we found that there have been several meta-analytic studies that examined the effectiveness of using an ethnomathematics approach at various levels of education.[62,63,64] However, we also note that there is no research that specifically focuses on the effect of using ethnomathematics-based learning at the elementary school level.

Therefore, the purpose of our study was to assess the effectiveness of applying ethnomathematics-based mathematics learning to elementary school students' mathematical abilities compared to traditional learning. We want to compare the learning outcomes of students who take ethnomathematics-based learning with those who take traditional learning at the elementary school level.

In addition, we also intend to examine what factors might influence the effectiveness of implementing ethnomathematics-based learning on the mathematical abilities of elementary school students. These factors may include student characteristics, teacher qualifications and experience, the curriculum used, and the support provided by the school and educational environment.

By conducting this research, we hope to provide more accurate and detailed results regarding the effect of ethnomathematics-based learning on the mathematics abilities of elementary school students. It is hoped that our findings can make a significant

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[61] Jo Boaler, "Mathematics from Another World: Traditional Communities and the Alienation of Learners," *The Journal of Mathematical Behavior* 18, no. 4 (June 1, 2000): 379–97, https://doi.org/10.1016/S0732-3123(00)00026-2.

[62] Muhammad Turmuzi, "Meta Analisis: Pengaruh Pembelajaran Berbasis Etnomatematika Terhadap Hasil Belajar Matematika Siswa," *JPMI (Jurnal Pembelajaran Matematika Inovatif)* 5, no. 5 (September 30, 2022): 1525–34, https://doi.org/10.22460/jpmi.v5i5.12305.

[63] Sri Apriatni et al., "The Influence of Ethnomathematics Based Learning on Mathematics Problem-Solving Ability: A Meta-Analysis," *Jurnal Pendidikan Matematika (JUPITEK)* 5, no. 1 (June 6, 2022): 23–33, https://doi.org/10.30598/jupitekvol5iss1pp23-33.

[64] Wahyu Ridlo Purwanto et al., "A Meta-Analysis On The Effect Of Ethnomathematics To Students' Ability In Geometry," in *Proceeding International Conference on Science, Education, and Technology*, vol. 8 (International Conference on Science, Education, and Technology, Semarang: Universitas Negeri Semarang, 2022), 114–22, https://proceeding.unnes.ac.id/ISET/article/view/1737.

contribution to the development of effective learning approaches in this field and also serve as a basis for policy making in order to improve the quality of learning mathematics in elementary schools.

RESEARCH METHODS

The research design used is meta-analysis. Meta-analysis is a type of study that aims to integrate the results of previous research in a particular field using quantitative statistical techniques.[65] The steps of meta-analysis generally include determining inclusion criteria, data collection, data extraction, and data analysis.

The population of this study is all research on the effectiveness of ethnomathematics-based learning on the mathematics abilities of elementary school students that have been published in national and international journals. The sampling technique in this meta-analysis study was to select studies that met the inclusion criteria set by the researchers. This will help obtain a representative sample of existing research and allow for more accurate and relevant analysis in this meta-analytic study.

The instrument used in this meta-analysis is a coding sheet that contains data extraction from primary studies used in the research. Coding is necessary to record research results that will be aggregated in the meta-analysis.[66] The coding sheet in this meta-analysis study contains information about statistical data to calculate effect size, namely sample size, mean, and standard deviation of the control and experimental groups.

The inclusion criteria aimed to determine which studies were eligible for inclusion in a systematic review by meta-analysis. The inclusion criteria in this meta-analysis include: Year of publication ranges from 2013 to 2022; 20 Research uses experimental research methods; there is at least 1 experimental group that applies ethnomathematics-based learning and a control group with traditional teaching; the study must report sufficient statistical data to calculate the effect size; and research published in national and international journals.

Relevant literature collection stage with inclusion criteria established using online databases such as Google Scholar, ERIC, DOAJ, Springer publishing, AIP Proceedings, IOP Sciences, and Elsevier. The keywords used in the literature search were

[65] Borenstein et al., *Introduction to Meta-Analysis.*
[66] Retnawati et al., *Pengantar Analisis Meta*.

"ethnomathematics", "ethnomatematics", "primary school", and "elementary school". The results of the search found 218 studies that were successfully collected regarding the effect of applying the ethnomathematics approach in elementary schools. Furthermore, the collected research was filtered based on the established inclusion criteria. The process resulted in 12 primary studies that met the eligibility criteria. However, some studies involved more than one control group resulting in 13 effect sizes being analyzed.

Data extraction is an activity to identify quantitative data in the literature and then input it into the meta-analysis database. Quantitative data input is the number of samples of the control and experimental groups, the mean of the control and experimental groups, and the standard deviation of the control and experimental groups. For more details, it can be seen in table 1 below.

Table 1
Results of Primary Study Data Extraction

No	Author	Nc	Xc	SDc	Ne	Xe	Sde
1	Abiam et al.[67]	202	43.22	9.78	202	54.56	11.99
2	Ariasih et al.[68]	22	12.23	2.67	20	24.25	2.52
3	Atikah et al.[69]	24	59.13	18.32	24	78.42	15.47
4	Darmawan et al.[70]	31	55.55	9.63	32	63.38	13.37
5	Maulana et al.[71]	26	67.95	7.09	23	77.61	7.83
6	Nooryanti et al.[72]	34	77.12	5.81	40	82.35	6.79

[67] Abiam, Abonyi, and Ugama, "Effects of Ethnomathematics-Based Instructional Approach on Primary School Pupils' Achievement in Geometry."

[68] Gusti Ayu Novi Ariasih, I. Made Suarjana, and Gede Wira Bayu, "Pengaruh Model Pembelajaran Inside Outside Circle Berorientasi Kearifan Lokal Terhadap Hasil Belajar Matematika Siswa Kelas V," *Jurnal Pendidikan Multikultural Indonesia* 1, no. 1 (2018): 28–39, https://doi.org/10.23887/jpmu.v1i1.20765.

[69] Atikah, Karjiyati, and Noperman, "Pengaruh Model Realistic Mathematics Education Berbasis Etnomatematika Tabut Terhadap Kemampuan Komunikasi Matematika Siswa Kelas IV SDN Di Kota Bengkulu."

[70] Made Darmawan, Sariyasa, and Made Gunamantha, "Implementasi Etnomatika Berbasis Permainan Tradisional Terhadap Berpikir Kritis Dengan Kovariabel Kemampuan Verbal Siswa Kelas II SD," *PENDASI: Jurnal Pendidikan Dasar Indonesia* 5 (March 18, 2021): 31–42, https://doi.org/10.23887/jurnal_pendas.v5i1.255.

[71] Ginanjar Maulana, Zaenuri Zaenuri, and Iwan Junaedi, "Pattern of Problem Solving Skill Reviewed Based on Student Cognitive Style After Experienced Problem Based Learning Model with Ethnomathematics Nuances," *Journal of Primary Education* 9, no. 2 (March 31, 2020): 209–19, https://doi.org/10.15294/jpe.v9i2.37507.

[72] Nooryanti, Utaminingsih, and Bintoro, "Pengaruh Pendekatan Pendidikan Matematika Realistik Berbasis Etnomatematika Terhadap Komunikasi Matematis Siswa Sekolah Dasar."

No	Author	Nc	Xc	SDc	Ne	Xe	Sde
7	Parwati et al.[73] studi a	35	60.63	4.82	42	72.10	3.59
8	Parwati et al.[74] studi b	34	74.91	3.40	41	84.10	4.16
9	Prameswari & Anggraini[75]	19	64.21	12.16	19	79.47	10.79
10	Radiana et al.[76]	33	17.8	1.56	32	23.09	1.79
11	Satriari et al.[77]	27	65.00	12.08	31	89.44	14.31
12	Sukadariah et al., (2020)[78]	17	48.88	5.28	17	61.00	7.25
13	Witha et al., (2020)[79]	25	61.14	20.61	25	79.42	17.14

Source : Personal Documents
Note:
Nc : Sample size of control class
Xc : Average control class
SDc : Standard deviation of control class
Ne : Sample size of the experimental class
Xe : The average of the experimental class
SDe : Standard deviation of the experimental class

Statistical analysis in this meta-analysis study included Computing effect sizes for each study, performing heterogeneity tests, calculating summary effect/combined effect sizes, analyzing moderator variables, and evaluating publication bias.[80]

Calculating the effect size aims to provide more detailed, objective, and measurable information about the impact or differences observed in the context of ethnomathematics-based learning on the mathematics abilities of elementary school students. Heterogeneity test is needed to choose the right estimation model and see

[73] Radiana, Wiarta, and Wiyasa, "Pengaruh Model Pembelajaran Probing Prompting Berbasis Etnomatematika Terhadap Kompetensi Pengetahuan Matematika Kelas V."

[74] Ni Nyoman Parwati et al., "Local Wisdom-Oriented Problem Solving Learning Model to Improve Mathematical Problem Solving Ability," *Journal of Technology and Science Education* 8, no. 4 (June 22, 2018): 310, https://doi.org/10.3926/jotse.401.

[75] Noviardani Kartika Prameswari and Kurnia Anggraini, "Pengaruh Permainan Tradisional Terhadap Hasil Belajar Siswa Kelas I SDN Lidah Kulon IV," *Jurnal PGSD: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar* 15, no. 1 (May 31, 2022): 75–86, https://doi.org/10.33369/pgsd.15.1.75-86.

[76] Radiana, Wiarta, and Wiyasa, "Pengaruh Model Pembelajaran Probing Prompting Berbasis Etnomatematika Terhadap Kompetensi Pengetahuan Matematika Kelas V."

[77] I. Dw Ayu Md Satriari, I. Md Tegeh, and Ni Md.Setuti, "Pengaruh Model Pembelajaran Ikrar Berbasis Kearifan Lokal Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas IV Di Desa Sari Mekar," *MIMBAR PGSD Undiksha* 1, no. 1 (January 8, 2013), https://doi.org/10.23887/jjpgsd.v1i1.725.

[78] Ririn Fitri Sukadariyah, Atin Fatimah, and Kristiana Maryani, "Pengaruh Permainan Tradisional Engklek Terhadap Kemampuan Geometri Anak," *Yaa Bunayya : Jurnal Pendidikan Anak Usia Dini* 4, no. 1 (June 15, 2020): 57–63, https://doi.org/10.24853/yby.4.1.57-63.

[79] Witha, Karjiyati, and Tarmizi, "Pengaruh Model RME Berbasis Etnomatematika Terhadap Kemampuan Literasi Matematika Siswa Kelas IV SD Gugus 17 Kota Bengkulu."

[80] Borenstein et al., *Introduction to Meta-Analysis*.

whether there is potential for moderator variable analysis. In addition, moderator variable analysis was also carried out to explore factors that might influence the level of heterogeneity between studies. Furthermore, evaluating publication bias can help ensure the integrity and validity of the analysis results as well as provide a more accurate and comprehensive picture of the effects or differences observed in the existing literature.[81,82,83,84,85,86]

Statistical analysis in this study used the OpenMEE application. This application has quite complete features in conducting meta-analysis studies. OpenMEE is also efficient in analyzing subgroups (moderator variables). The meta-analysis focuses on effect sizes. The effect size classification of each study and the combined effect size in this meta-analysis refers to the classification shown in table 2 below.

Table 2
Categories of effect size (ES) groups using the Cohen interpretation

No	Classification	Interval
1	Weak	$ES \leq 0.20$
2	Moderate	$0.20 < ES \leq 0.50$
3	Strong	$0.50 < ES \leq 1.00$
4	Very Strong	$ES > 1.00$

Source :[87]

RESULT AND DISCUSSION

The results of the analysis of thirteen effect sizes (see Figure 2), found that the smallest effect size was 0.66 and the largest was 4.54. All scattered effect sizes have

[81] Retnawati et al., *Pengantar Analisis Meta*.

[82] Anton Agus Setiawan et al., "Blended Learning and Student Mathematics Ability in Indonesia: A Meta-Analysis Study," *International Journal of Instruction* 15, no. 2 (April 1, 2022): 905–16, https://doi.org/10.29333/iji.2022.15249a.

[83] Marwa Astriani Kamsurya et al., "The Effect of Self-Efficacy on Students Mathematical Abilities: A Meta-Analysis Study," *Jurnal Pendidikan Progresif* 12, no. 2 (April 23, 2022): 451–63, https://doi.org/10.23960/24040.

[84] Ali Muhtadi et al., "Self-Efficacy and Students' Mathematics Learning Ability in Indonesia: A Meta Analysis Study," *International Journal of Instruction* 15, no. 3 (July 1, 2022), https://doi.org/10.29333/iji.2022.15360a.

[85] Nurul Aulia Martaputri et al., "The Correlation Between Emotional Intelligence and Academic Achievement A Meta Analysis Study," *Jurnal Pendidikan Progresif* 11, no. 3 (November 27, 2021): 511–23, https://doi.org/10.23960/22935.

[86] Ali Muhtadi et al., "A Meta-Analysis: Emotional Intelligence and Its Effect on Mathematics Achievement," *International Journal of Instruction* 15, no. 4 (October 1, 2022): 745–62, https://doi.org/10.29333/iji.2022.15440a.

[87] Monique Hennink, Inge Hutter, and Ajay Bailey, *Qualitative Research Methods* (London: SAGE, 2010).

positive effect sizes, which means that all studies report that the effect of using the ethnomathematics approach on the mathematics abilities of elementary school students is better than the control group. Referring to the classification of Cohen (1988), there are three effect sizes (n = 3 or 23.08%) which are classified as strong effects and ten effect sizes (n = 10 or 76.92%) which are classified as very strong effects. Based on random effect estimates, the combined effect size value is (g = 1.74; p < 0.01. This effect size is included in the large effect category. Thus, these results reveal that the use of the ethnomatematic approach has a very large effect strong on the math skills of elementary school students.

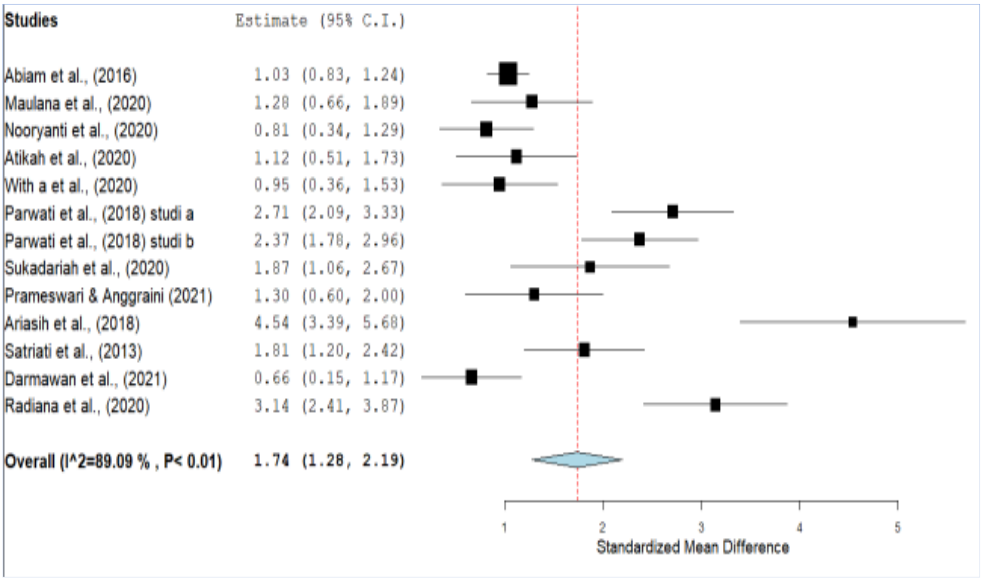

Figure 2
Forest Plot for Effect Sizes
Source: Personal Documents

The I^2 value found to be 89.09% reflects high heterogeneity.[88] Therefore, it is potential to carry out a moderator variable analysis to reveal what factors can influence the effect of using an ethnomathematics approach to the mathematical abilities of elementary school students. Table 2 presents a summary of the moderator variable analysis.

[88] Julian P. T. Higgins and Simon G. Thompson, "Quantifying Heterogeneity in a Meta-Analysis," *Statistics in Medicine* 21, no. 11 (June 15, 2002): 1539–58, https://doi.org/10.1002/sim.1186.

Table 2
Moderator Variable Analysis

Moderating Variable	N	g	P	Heterogeneity				
				Q	Df	Qw	Qb	P
Overall	13	1.74	< 0.01	110.01	12			
Grade Level								
High Grade (4-6)	10	1.89	< 0.01	101.39	1	108	1.98	0.16
Low Grade (1-3)	3	1.22	< 0.01	6.64				
Sample Size								
30 or less	6	1.73	< 0.01	33.47	1	110	0.30	0.58
31 or over	7	1.76	< 0.01	76.24				
Year of Publication								
2013-2017	2	1.37	< 0.01	5.51	1	99.79	10.22	0.00
2018-2022	11	1.82	< 0.01	94.28				

Source : Personal Documents
Note : n = number of studies; g = effect size; Qw = Q within; Qb = Q intermediate

The results of the analysis showed that the average effect size of each class-level category variable was not significantly different (Qb = 1.98; p = 0.16). This value indicates that class level variables have no effect on the effectiveness of using the ethnomathematics approach to the mathematics abilities of elementary school students compared to traditional learning approaches. Although the effect size in the high class group (g = 1.89; p < 0.01) was higher than the low class group (g = 1.22; p < 0.01), it was not significantly different.

The results of the analysis showed that the average effect size of each category of sample size variables was not significantly different (Qb = 0.30; p = 0.58). This value indicates that the sample size variable has no effect on the effectiveness of using the ethnomathematics approach to the mathematics abilities of elementary school students compared to traditional learning approaches. Although the effect size in the sample group ≤ 30 (g = 1.76; p < 0.01) is higher than the sample group > 30 (g = 1.73; p < 0.01), it is not significantly different.

The results of the analysis showed that the average effect size of each variable category in the year of study was found to be significantly different (Qb = 10.22; p = 0.22). This value indicates that the research year variable has no effect on the effectiveness of using the ethnomathematics approach to the mathematics abilities of

elementary school students compared to traditional learning approaches. The use of the ethnomathematics approach was more effective in studies published in 2018-2022 ($g = 1.82$; $p < 0.01$) when compared to studies published in 2013-2017 ($g = 1.37$; $p < 0.01$).

Furthermore, to prove that the meta-analysis carried out in this study was objective, an evaluation of publication bias was carried out. Table 3 presents a summary of the results of the publication bias test.

Table 3
File-Safe N (FSN)

	k	FSN	Target Significance	Observed Significance
Rosenthal	13	1973	0.05	< 0.01

Source: Personal Documents

From the results of the publication bias test (see Table 3), the FSN value is 1973. This value is greater than 5k+10 = 75. This indicates that this meta-analytic study does not have a publication bias problem. Thus the meta-analysis study conducted is valid and scientifically justified.

The results of the analysis showed that the combined effect size was ($d = 1.74$; $p < 0.01$). These results indicate that the use of the ethnomathematics approach has a very strong influence on the mathematics abilities of elementary school students compared to the traditional learning approach. The ethnomathematics approach is considered effective because mathematics subject matter is associated with real-life situations or students' experiences in everyday life, so that students more easily understand mathematical concepts.[89] Integrating culture into learning mathematics makes it easier for students to understand abstract material.[90,91,92] Ethno-mathematics-based learning makes students more interested in discussing and working on a given project, because the mathematical concepts used in the project are very close to their lives and they even encounter them

[89] Christopher A. Correa et al., "Connected and Culturally Embedded Beliefs: Chinese And US Teachers Talk About How Their Students Best Learn Mathematics," *Teaching and Teacher Education* 24, no. 1 (January 1, 2008): 140–153, https://doi.org/10.1016/j.tate.2006.11.004.

[90] D'Ambrosio and Rosa, "Ethnomathematics and Its Pedagogical Action in Mathematics Education."

[91] Owens and Muke, "Revising the History of Number."

[92] Herawaty et al., "The Improvement of The Understanding of Mathematical Concepts Through The Implementation of Realistic Mathematics Learning And Ethnomathematics."

every day.[93] The results of this study are in line with and strengthen the results of a meta-analysis study conducted by.[94,95,96] who also found that ethnomathematics-based learning was effective on students' mathematical abilities. However, these three studies did not focus on examining the effect of using ethnomathematics-based learning in elementary schools.

The results of the analysis based on moderator variables as a whole show that the year of publication affects the effectiveness of ethnomathematics-based learning on the mathematics abilities of elementary school students, but not the class level and sample size. Based on the grade level, it was found that the application of ethnomathematics-based learning had a very strong effect on the mathematics abilities of low and high grade students. Even though the effect size in the high class group was higher than the low class group, it was not significantly different. These results indicate that class level variables do not affect the effectiveness of applying ethnomathematics-based learning to the mathematical abilities of elementary school students.

Based on the sample size, it was found that the application of ethnomathematics-based learning had a very strong effect on the mathematics abilities of elementary school students at sample sizes ≤ 30 and > 30. Although the effect size for the sample group ≤ 30 was higher than that for the sample group > 30, this proved to be not significantly different. These results indicate that the sample size variable does not affect the effectiveness of applying ethnomathematics-based learning to the mathematical abilities of elementary school students. Apriatni et al. (2022) also reported that ethnomathematics-based learning was effective on problem solving abilities at sample sizes ≤ 30 and > 30, but had insignificant differences.[97] The consistency of these findings provides a more accurate conclusion.

Based on the year of research, it was found that the application of ethnomathematics-based learning had a very strong effect on the mathematical abilities

[93] I. Made Surat, "Peranan Model Pembelajaran Berbasis Etnomatematika Sebagai Inovasi Pembelajaran Dalam Meningkatkan Literasi Matematika," *Emasains : Jurnal Edukasi Matematika Dan Sains* 7, no. 2 (September 3, 2018): 143–54, https://doi.org/10.5281/zenodo.2548083.

[94] Turmuzi, "Meta Analisis."

[95] Apriatni et al., "The Influence Of Ethnomathematics Based Learning On Mathematics Problem-Solving Ability."

[96] Purwanto et al., "A Meta-Analysis On The Effect Of Ethnomathematics To Students' Ability In Geometry."

[97] Apriatni et al., "The Influence Of Ethnomathematics Based Learning On Mathematics Problem-Solving Ability."

of elementary school students in studies that were reported in 2013-2017 and 2018-2022. The resulting effect sizes in the two groups were found to be significantly different. These results indicate that the research year variable affects the effectiveness of applying ethnomathematics-based learning to the mathematical abilities of elementary school students. This finding is also consistent with the research of Apriatni et al. (2022) who found that the application of ethnomathematics-based learning was reported to be most effective in 2021-2022 compared to 2015-2016, 2017-2018, and 2019-2020.[98] In addition, a meta-analysis study by Purnomo et al.[99] and Samritin et al.[100] also found that the variable year of publication affects the effect size. The consistency of these findings provides a more accurate conclusion.

CONCLUSION

Based on a meta-analysis of thirteen effect sizes from twelve primary studies that examined the effectiveness of applying ethnomathematics-based learning to elementary school students' mathematical abilities, it can be concluded that the application of ethnomathematics-based learning has a very strong influence on elementary school students' mathematical abilities. In addition, based on the analysis of moderator variables, it was found that the year of publication affected the effectiveness of ethnomathematics-based learning on the mathematics abilities of elementary school students, but not the class level and sample size.

This meta-analysis study only examines research sourced from journals, so that the number of studies involved is only 12 primary studies. Therefore, further research can expand the number of studies by involving other sources such as master's theses and doctoral dissertations. In addition, the moderator variables analyzed were limited to three variables, namely class level, number of samples and year of study. Future research can examine further by involving other moderator variables, such as sampling techniques, sample size, publication sources, length of experiment, and type of subject matter, so that

[98] Apriatni et al.

[99] Bagus Purnomo et al., "The Effect of Flipped Classroom Model on Mathematical Ability: A Meta Analysis Study," *Jurnal Pendidikan Progresif* 12, no. 3 (June 21, 2022): 1201–17, https://doi.org/10.23960/jpp.v12.i3.202216.

[100] Samritin Samritin et al., "A Meta-Analysis Study of The Effect of The Blended Learning Model on Students' Mathematics Learning Achievement," *Jurnal Elemen* 9, no. 1 (January 2, 2023): 15–30, https://doi.org/10.29408/jel.v9i1.6141.

the results of the analysis become broader. Expanding the number of studies from multiple sources and considering a wider range of moderator variables will strengthen the findings and allow for broader generalizations.

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DECLARATION OF CONFLICTING INTERESTS

We hereby declare that the researcher has no potential conflict of interest with the research, authorship and/or publication of this article.

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