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An analysis of Generation Z prospective mathematics teachers' understanding of prime numbers in Ancient Greece

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AN ANALYSIS OF GENERATION Z PROSPECTIVE MATHEMATICS TEACHERS' UNDERSTANDING OF PRIME NUMBERS IN ANCIENT GREECE

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ABSTRACT

Generation Z prospective mathematics teachers do not have a deep understanding of the history of prime numbers in Ancient Greece. This is an obstacle to their understanding of the application of prime number concepts in learning. This research aims to present the biographies and works of mathematicians of the Ancient Greek era as well as the appreciation of generation Z students of prospective mathematics teachers towards the contribution of mathematicians of the Ancient Greek era in the development of mathematics. The methods used in this qualitative research are literature study and case study. The research subjects consisted of five students of generation Z prospective mathematics teacher who were purposively selected. The data analysis used was thematic analysis. The results showed that most of the subjects had a limited understanding of Ancient Greek mathematicians, but showed interest in learning more about Ancient Greek mathematicians. This study reveals two categories of understanding among the participants: those who *unknown about the Ancient Greek mathematicians who contributed to prime numbers and known about the Ancient Greek mathematicians who contributed to prime numbers.* Specifically, three participants did not recognize any Ancient Greek mathematicians related to prime numbers, while two participants were able to identify Euclid and Eratosthenes and explain their contributions.

Keywords: Prime Numbers, Generation Z, Ancient Greece, Teachers' Understanding.

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INTRODUCTION

Appreciating the history of mathematics is not merely about studying a series of numbers and names from the past, but rather an effort to understand the evolution of human thought in constructing logical structures. For prospective mathematics teachers, historical knowledge serves as a pedagogical bridge to explain "why" a concept emerged, not just "how" to calculate it. However, the reality on the ground shows that the history of mathematics is often viewed as supplementary material separate from the core. In fact, integrating a historical perspective into learning can help students overcome math anxiety by recognizing that mathematics is a dynamic and ever-evolving cultural product.

In this context, one of the most fundamental concepts to examine through a historical lens is the theory of prime numbers. A prime number is a positive integer number greater than 1 that is only divisible by 1 and itself. Prime numbers have been a major topic in number theory

since Ancient Greece. Early mathematicians such as Euclid and Eratosthenes proposed the basic concept of prime numbers (Farid, 2024). Euclid proved that the number of prime numbers is infinite (Akhsani et al., 2022). The set of all prime numbers is more than the number of prime numbers defined (Euclid, 2007). Eratosthenes invented a method known as the Sieve of Eratosthenes.

The discussion of prime numbers in the Ancient Greek era is important in the history of mathematics (Sembiring et al., 2024). With the research of prime numbers in the Ancient Greek era, the roots of the development of prime number theory can be known and measure the knowledge of generation Z students related to the discoveries of Euclid and Eratosthenes (Juari, 2006). By studying the methods used by Euclid and Eratosthenes in discovering the concept of prime numbers, it is expected to gain new inspiration in solving mathematical problems (Sari et al., 2017). In the modern era, prime numbers are used as keys in the process of message encryption and cryptography.

This research is expected to provide a deeper insight into the history of prime numbers in the Ancient Greek era to generation Z students who are prospective math teachers. Studying the early development of the concept of prime numbers, it is expected to gain a deeper understanding of how the roots of prime number development. From this deeper understanding, it is expected to find new inspiration to solve problems in everyday life. In addition, generation Z has a high awareness of global issues so that it can connect the concept of prime numbers with real applications in the modern world which aims to strengthen the relevance of learning.

The concept of prime numbers does not only play an important role in the field of mathematics, but has an important role in real life. Prime numbers are used in cryptography to secure data such as online financial transactions and personal data.Prime numbers are one of the bases for key generation of encryption algorithms such as RSA and cryptography. The concept of prime numbers developed by early mathematicians plays an important role in maintaining privacy in the digital era. This shows the relevance and continuity of the research of early mathematicians to modern times.

As part of Generation Z growing up in the era of digital disruption, prospective teacher students are required to possess broad information literacy, including the ability to contextualize scientific knowledge. A deep understanding of the biographies and intellectual struggles of figures such as Euclid and Eratosthenes enables prospective teachers to present more humanistic and inspiring material in future classrooms. Without a strong appreciation for historical aspects, mathematics instruction risks becoming trapped in the dry mechanization of formulas, thereby severing the relevance of the philosophical values inherent in the theory of prime numbers itself.

Previous research by Farid (2024) discussed the life journey and discoveries of Euclid and Clairaut related to prime numbers. Furthermore, research by Harisman & Maharani (2024) discussed Sieve of Eratosthenes for junior high school students. While recent studies have begun to examine the history of mathematics from a Generation Z perspective (Azzuhri et al., 2024), there is still a significant gap in analyzing how this generation of prospective mathematics teachers understands and appreciates the foundational prime number theories of Ancient Greece. Thus, this study presents the biographies and discoveries of Euclid and Eratosthenes; knowledge and appreciation of generation Z students of prospective mathematics teachers at Padang State University.

This study aims to analyze the knowledge and appreciation of Generation Z prospective mathematics teachers regarding Ancient Greek mathematicians who contributed to prime number theory. This research will review the contributions of early mathematicians such as Euclid and Eratosthenes. Thus, this research will reveal the level of understanding and appreciation of generation Z students who are prospective mathematics teachers related to the biographies of Euclid and Eratosthenes and the discoveries in prime numbers.

METHOD

The method used in this research is a qualitative descriptive method that combines literature studies and case studies (Septiana & Khoiriyah, 2024). Literature study is a data collection method that involves analyzing and reviewing books, literature, and records relevant to the problem being investigated (Habsy et al., 2023). This literature study method was chosen because it provides a deeper understanding of the initial knowledge of prime number theory (Melati et al., 2023).The data used in this study were obtained from various sources such as books, journals, and scientific articles that discuss prime numbers in Ancient Greece (Putri et al., 2020). Case study is a research method that involves intensive data collection and in-depth analysis of a unique phenomenon in the context of a particular time and place. Research also uses open interviews that provide an opportunity for respondents to explain their views freely, so that more varied data can be obtained (Putri et al., 2024).

The samples studied in this research were five students of the mathematics education study program at Padang State University. The selection of five participants was based on the principle of data saturation in qualitative research, where the focus is not on statistical representation but on the depth and richness of the information obtained (Alordiah & Oji, 2024). These participants were selected through purposive sampling to allow for a profound and comprehensive qualitative analysis of their cognitive schemes and perceptions. They were identified as key informants because they had completed course Number Theory and the History of Mathematics. This academic background ensures they possess the necessary foundational knowledge to provide rich, nuanced data on how prospective teachers internalize historical values within their professional knowledge stucture.

Furthermore, the range of birth years of the research subjects, namely 2004-2006, places them in the Generation Z group (Gulo, 2023). Students of mathematics education study program were chosen as participants of this study with the consideration that they have the potential to understand the importance of mathematics history in the context of developing teacher professionalism (Tobondo, 2021). This information ensures that the data obtained can provide a sufficient picture of Gen Z's knowledge of the topics discussed.

An instrument is a tool that meets academic requirements so that it can be used as a tool to measure a measuring object or collect data about a variable (Sappaile, 2007).The instruments used in this study include semi-structured interview guides (Putria et al., 2020). Other instruments used in this study are mathematical books from the Ancient Greek era and academic journals (Arsyad & Sauri, 2024). The use of these sources will help identify the methods used by early mathematicians in finding prime numbers. The data analysis technique used in this research is thematic analysis which aims to identify, analyze and report patterns contained in the data (Sitasari, 2022). Research by Harisman et al. (2023) became a reference in the categorization of interview results.

Specifically, the interview guide was structured to explore three main dimensions of the subject's understanding. First, it assessed the subject's fundamental knowledge regarding specific historical figures who contributed to the development of prime numbers. This was followed by an inquiry into their grasp of prime numbers concepts as they were understood during the Ancient Greek era aiming to identify the depth of their historical matematical literacy. Finally, the instrument delved into the subject's perceptions regarding the significance of knowing these ancient Greek mathematicians, specifically in the context of their professional development as prospective mathematics teacher.

RESULT

Mathematicians who contributed to the Ancient Greek era were Euclid with his work Element, and Eratosthenes with the Sieve of Eratosthenes method (Khafifah et al., 2022). This research will specifically discuss Euclid and Eratosthenes to develop knowledge related to prime numbers. A prime number is an integer that is more than 1 and can only be divided by 1 and itself. The number one is not a prime number because prime numbers are a subcategory of numbers that have 2 factors, namely 1 and itself.

Biography and Discovery of Euclid

Euclid was a mathematician born around 300 BC in Alexandria (Akhsani et al., 2022; Nurhikmayati, 2024). Known for his noble character and intellectual rigor, he is often depicted as the foundational figure of classical geometry (Nurhikmayati, 2024). An artistic representation of Euclid is displayed in Figure 1.

Figure 1. An artistic representation of Euclid (Source: O'Connor & Robertson, 1999)

Euclid published a work entitled Elements which consisted of 13 volumes (Farid, 2024). Euclid's thoughts contained in his work caused Euclid to be considered the eternal mathematics teacher and the greatest Greek mathematician (Nurhikmayati, 2024). In Euclid's Elements book 9, the 20th proposition states that (the set of all) prime numbers is more than the number of prime numbers assigned (Euclid, 2007). In this proposition, it is well known that prime numbers are infinite (Farid, 2024). The historical publication of this work is shown in Figure 2.

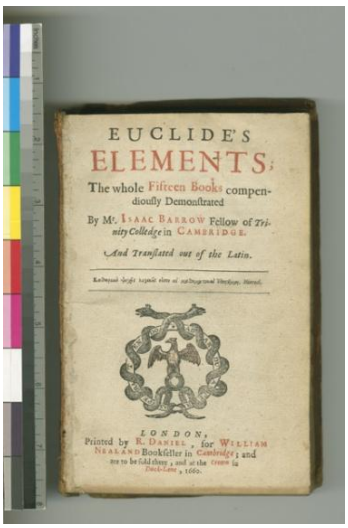

Figure 2. Euclid discovery (Source: Euclid, 1660)

Biography and Discovery of Eratosthenes

Eratosthenes was a mathematician born in Cyrene in 276 BC (Farid, 2024; Susilawati, 2017). Eratosthenes was a mathematician who mastered various sciences without being fixated on one particular field (Farid, 2024). Figure 3 shows an artistic representation of Eratosthenes.

Figure 3. Eratosthenes (Source: O'Connor & Robertson, 1999)

In 200 BC, Eratosthenes created an algorithm to calculate prime numbers known as the Sieve of Eratosthenes (Abdullah et al., 2018). In the Sieve of Eratosthenes, an easy method to find prime numbers in a small range from 1 to N was discovered (Lynch, 2023; O'neill, 2009). The Sieve of Eratosthenes is a method to find every prime integer within a certain range (Harisman & Maharani, 2024). Eratosthenes placed numbers in a box and crossed out various numbers that belonged to multiples and square roots so that the remaining numbers were prime (Farid, 2024).

Based on research by Abdullah et al. (2018), the identification of prime numbers using the Sieve of Eratosthenes technique begins by organizing the numbers 1 to N, with a limit of N=100. This procedure is carried out by eliminating the number 1, marking the number 2, and crossing out all its multiples. The same steps are applied to the numbers 3, 5, and 7 by eliminating each of their multiples. Using the Sieve of Eratosthenes method, the prime numbers produced include 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, and 97. In the following Figure 4 the Sieve of Eratosthenes is presented.

Researcher : "Do you know any mathematicians who contributed to prime numbers?"
Student 1 : "I don't know"
Researcher : "Do you know the concept of prime numbers in the Ancient Greek era?"
Student 1 : "I don't know"
Researcher : "How important do you think it is to know about mathematicians in the Ancient Greek era who discovered prime numbers?"
Student 1 : "considering prime numbers are one of the materials in mathematics that is important to know, then for me it is also important to know who the ancient Greek mathematician who discovered it"

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Figure 4. Sieve of Eratosthenes from 1-100 (Source: Abdullah et al., 2018)

Interview Results of Generation Z Prospective Mathematics Teachers

Based on the interviews, this research can describe the response of each research subject to the research questions, related to knowing the mathematicians of the Ancient Greek era who contributed to prime numbers, knowing the works of ancient Greek mathematicians who contributed to prime numbers, and knowing the level of appreciation of generation Z students who are prospective math teachers towards mathematicians of the Ancient Greek era who contributed to prime numbers.

Student 1 who was born in 2004 stated that she did not know about the mathematicians of the Ancient Greek era who discovered prime numbers. The following are the results of the interview with student 1.

Student 2 who was born in 2006 stated that he did not know about the ancient Greek mathematician who discovered prime numbers. The following are the results of the interview with student 2.

Researcher : "Do you know any mathematicians who contributed to prime numbers?"
Student 2 : "I don't know"
Researcher : "Do you know the concept of prime numbers in the Ancient Greek era?"
Student 2 : "no idea"
Researcher : "How important do you think it is to know about mathematicians in the Ancient Greek era who discovered prime numbers?"
Student 2 : "no idea"

Student 3 who was born in 2005 stated that she knew about the mathematicians of the Ancient Greek era who discovered prime numbers.
The following are the results of the interview with student 3.

Researcher : "Do you know any mathematicians who contributed to prime numbers?"
Student 3 : "I know, the figures are Euclid and Eratosthenes"
Researcher : "Do you know the concept of prime numbers in the Ancient Greek era?"
Student 3 : "I know"
Researcher : "How important do you think it is to know about mathematicians in the Ancient Greek era who discovered prime numbers?"
Student 3 : "It is important because by knowing figures like Euclid and Eratosthenes, we can appreciate the way they built the logic and mathematical structures that we use."

Student 4 who was born in 2005 stated that she did not know about the Ancient Greek mathematicians who discovered prime numbers. The following are the results of the interview with student 4.

Researcher : "Do you know any mathematicians who contributed to prime numbers?"
Student 4 : "I don't know about mathematicians who contributed to prime numbers"
Researcher : "Do you know the concept of prime numbers in the Ancient Greek era?"
Student 4 : "no idea"
Researcher : "How important do you think it is to know about mathematicians in the Ancient Greek era who discovered prime numbers?"
Student 4 : "because I don't know the mathematician, I don't know how important it is to know about the mathematician in Ancient Greece who discovered prime numbers"

Student 5 who was born in 2005 stated that she knew about the mathematician in Ancient Greece who discovered prime numbers. The following are the results of the interview with student 5.

Researcher : "Do you know any mathematicians who contributed to prime numbers?"
Student 5 : "Yes, I know"
Researcher : "Do you know the concept of prime numbers in the Ancient Greek era?"
Student 5 : "Yes, I know"
Researcher : "How important do you think it is to know about the mathematician in Ancient Greece who discovered prime numbers?"
Student 5 : "It is very important because by knowing the mathematicians who discovered prime numbers, we will be motivated to study harder and it is also one of the ways we can appreciate their discoveries"

Based on the interview data, significant differences were found in historical understanding among the subjects, specifically between those who had effectively internalized the historical values from their prior coursework and those who had not. Students 1, 2, and 4 demonstrated a complete lack of knowledge, both regarding the identities of key mathematicians and their understanding of basic concepts concerning the development of prime numbers in Ancient Greece. This dominance of zero knowledge suggests that even after completing core courses, the "human side" of mathematics often fails to leave a lasting impression on students, who tend to view the subject purely as a functional tool or a dry mechanization of formulas. Interestingly, even those with no prior knowledge acknowledged the importance of these figures once prompted, indicating a latent curiosity within Generation Z that has not been fully activated by the current curriculum.

In contrast, Student 3 and Student 5 demonstrated better historical literacy, specifically being able to identify Euclid and Eratosthenes as key figures who made significant contributions to laying the foundations of number theory. Their responses indicate that historical knowledge directly impacts their appreciation of the subject; for instance, Student 3's emphasis on "appreciating logical structures" and Student 5's "motivation to study harder" prove that history acts as a pedagogical bridge that gives deeper meaning to abstract concepts. The diversity of response patterns, ranging from ignorance to deep appreciation, served as the basis for the researcher to classify prospective teacher students into two main categories based on their level of historical knowledge, as presented in Table 1.

Table 1. Knowledge Classification of Generation Z Student Prospective of Mathematics Teachers

No.	Classification	Description
1	*Unknown about the Ancient Greek mathematicians who contributed to prime numbers*	Generation Z students who are prospective math teachers do not know the mathematicians of the Ancient Greek era who contributed to prime numbers.
2	*Known about the Ancient Greek mathematicians who contributed to prime numbers*	Generation Z students who are prospective math teachers who know the mathematicians of the Ancient Greek era who contributed to prime numbers.

DISCUSSION

Unknown about the Ancient Greek mathematicians who contributed to prime numbers

The interview results indicated that three Generation Z prospective mathematics teachers, represented by Student 1, Student 2, and Student 4 were classified as Unknown about the Ancient Greek mathematicians who contributed to prime numbers. Insight into the history related to mathematicians is minimal among Generation Z students. Therefore, this generation needs to learn the history of mathematics to appreciate the contributions of mathematicians who have made significant contributions to knowledge. This phenomenon reflects Skemp's theory of instrumental understanding, where students master formulas but lack the relational understanding of their origins (Herheim, 2023).

This finding is consistent with Muris et al. (2023), who stated that Generation Z prefers entertainment over learning history. As a result, generation Z's interest in subjects such as history tends to decrease. From a constructivist perspective, learning is hindered when students cannot link new information to the origin of those ideas. This gap often stems from the perception that history is a boring subject and less relevant to their daily lives (Asmara, 2019).

The researcher found that Student 1 recognizes the fundamental importance of prime numbers as a core mathematical concept, yet this participant lacks knowledge regarding the historical figures behind their discovery. This gap is critical because understanding history can help the younger generation to appreciate mathematicians who have contributed to scientific progress (Lubis et al., 2024). Within the framework of Pedagogical Content Knowledge, a teacher's ability to explain the origins of a concept is vital for sustaining student attentiveness (Khaerani, 2024).

Furthermore, this minimal knowledge of history inhibits students in understanding the logic of proof, which is the essence of Greek mathematics. For student 4, the total lack of knowledge made it impossible to evaluate the importance of these historical figures. Historical insight should serve as a bridge to change the perception of mathematics from mere memorization to dynamic thinking (Lumbantobing et al., 2026). Without knowing the background, the logical construction of prime number theories remains a mystery to these prospective educators.

By understanding the background of the discovery of concepts, prospective teachers can instill more meaningful philosophical values and logical reasoning in students (Quraisy et al., 2025). This effort is important so that mathematics learning is no longer considered rigid or mechanical process by the next generation. The lack of knowledge shown by Student 1, 2, and 4 highlights a pedagogical challenge in modern teacher training programs. Addressing this

gap is necessary to ensure that mathematics is taught as a relevant and interesting intellectual journey rather than a chore.

Known about the Ancient Greek mathematicians who contributed to prime numbers

In contrast, the researcher found that Student 3 and Student 5 were identified as Known about the Ancient Greek mathematicians who contributed to prime numbers. Student 3 succesfully identified Euclid and Eratosthenes. Student 5 further emphasized that knowning these figures serves as a powerful motivator to study harder and appreciate scientific discoveries. These students demonstrated high literacy factors, enabling them to recognize the figures responsible for these mathematical foundations. Their appreciation aligns with Ausubel's meaningful learning, where historical context serves as an anchor for complex mathematical concepts (Bryce & Blown, 2024).

This finding is consistent with Andriyani et al. (2024), suggesting that students who have strong interest in the history of mathematics tend to participate more actively in class discussions and ask more in-depth questions. Within the Social Constructivism framework, the ability to articulate the importance of historical "logical structures" shows a deep internalization of mathematical culture. Spurring interest in learning the history of mathematics is important (Sirait, 2016). This shows that interest not only increases motivation to learn, but also the quality of learning (Prastika, 2021).

In addition, Hidayati (2024), study found that students who studied the history of mathematics had a better understanding of abstract mathematical concepts, such as limits and derivatives. According to Realistic Mathematic Education theory, understanding the historical "real-world" problem-solving process helps clarify abstract concepts like the Sieve of Eratosthenes. By understanding the origins of these concepts, students can more easily relate these concepts to real-world contexts (Frisnoiry et al., 2024). Student 5's motivation stems from seeing ancient mathematicians as relatable role models who used logic to solve complex mysteries.

This finding emphasizes that the history of mathematics serves as a tool for prospective teachers to transform abstract material into meaningful knowledge (Hasan, 2019). Exploring the evolution of concepts helps students dissect the logical construction behind theorems, rather than simply memorizing algorithms. This depth of understanding is a core component of Technological Pedagogical Content Knowledge, where history provides the essential pedagogical "why." Understanding the origins of these ideas makes it easier for them to communicate mathematical principles in a more coherent manner.

As a result, integrating history strengthens a more comprehensive and deeper conceptual understanding. This readiness indicates that "Known" students are better prepared to address complex philosophical questions regarding the nature of prime numbers in their future classrooms. The ability shown by Student 3 and 5 highlights the effectiveness of integrating historical literacy into the professional knowledge structure of prospective teachers. Therefore, promoting this historical insight is a vital step to ensure that future mathematics teachers can bridge ancient logic with modern pedagogical needs effectively.

CONCLUSION AND SUGGESTIONS

This study concludes that there is a significant gap in historical literacy among Generation Z prospective mathematics teachers regarding the origins of prime number theory. While the contributions of Euclid and Eratosthenes are fundamental, the majority of research subjects fall into the "Unknown" category, possessing only an instrumental understanding of formulas without knowing their historical context. This finding implies that even after completing core courses, prospective teachers often fail to internalize the philosophical values of mathematics. Consequently, without a strong historical foundation, they risk presenting

mathematics as a rigid and mechanical subject, which may hinder their ability to foster meaningful learning and reduce math anxiety in their future students.

Based on these findings, it is suggested that mathematics education programs should more effectively integrate historical perspectives into their core curriculum to strengthen students' Pedagogical Content Knowledge (PCK). History should not be treated as a separate, supplementary topic but as a pedagogical tool to explain the logic and evolution of mathematical concepts. For future research, it is recommended to develop and test history-based learning modules specifically designed for Gen Z's digital learning styles. This approach is essential to ensure that future educators can transform abstract theories into an engaging intellectual journey, making mathematics feel more humanistic and relevant to the modern world.

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