

Digital literacy awareness to enhance the learning of mathematics

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Abstract

This study seeks to investigate the correlation between digital literacy and the frequency of usage of mathematics across diverse demographics, with the focus on 181 people within the age range of 18- 50 years. Utilizing a multi-method approach, including correlation analysis, regression modeling, and Analysis of Variance (ANOVA), we analyzed survey data to quantify the relationship between familiarity with terminologies such as machine learning, artificial intelligence (AI), data science and usage of basic mathematical principles to solve real-life problems. Results demonstrate a significant positive correlation between digital awareness and enhanced mathematical literacy, with notable variations observed across age groups, educational backgrounds, and professional domains. These findings underscore the critical role of technology in fostering mathematical proficiency and the need for pedagogical approaches that integrate digital tools and real-world applications.

Keywords: African mathematical literacy; technological advancement; digital tools integration; educational technology; digital awareness

1. Introduction

Computational mathematics literacy is a crucial skill in the contemporary technology-oriented world, where digital tools and breakthroughs in artificial intelligence (AI) significantly influence the transformation of education. Recent studies stress the necessity of incorporating technology advancements into mathematical education to improve engagement, relevance and learning results. In a world that is becoming more and more data-driven, mathematical literacy is essential for both

professional and academic success. With the speed at which technology is developing, educational environments have changed dramatically, using digital resources to improve students' understanding of mathematics and their capacity for problem-solving [1]. With research showing that AI and big language models can help learners with complicated problem-solving tasks through interactive and adaptive learning environments, their function in supporting mathematical reasoning has gained significance [2]. By offering real-time feedback and individualized learning routes, these AI-driven tools have the ability to close knowledge gaps and help students improve their conceptual grasp of mathematics [3].

The use of digital technologies in mathematics education has evolved from basic computational tools to advanced interactive platforms that enable dynamic visualization, exploratory learning, and adaptive problem-solving [4]. Recent research highlights that digital resources such as educational software, simulations, and virtual manipulative can facilitate deeper engagement with mathematical concepts, fostering both procedural fluency and conceptual understanding [5]. Additionally, digital interventions have been found to support students with diverse learning styles, enhancing accessibility for learners with varying educational backgrounds [6].

However, while technological integration in mathematics education presents numerous opportunities, it also introduces challenges that must be carefully addressed. For instance, disparities in technological access and proficiency can create a digital divide, leading to inequitable learning outcomes [7]. Studies, again, have found that learners from underprivileged backgrounds often face barriers to accessing advanced educational technologies, which can hinder their mathematical development compared to their peers with better resources [8]. However, excessive reliance on digital tools without proper pedagogical frameworks may result in superficial learning, where students focus on tool manipulation rather than developing deep mathematical reasoning [9].

The effectiveness of technology-assisted mathematics education also depends on teacher preparedness and institutional support. Research underscores the importance of professional development programs that equip educators with the necessary skills to integrate technology into their teaching methodologies effectively [10]. The role of digital literacy among educators is particularly crucial, as it influences how digital tools are utilized in classroom settings to foster mathematical understanding [11]. Moreover, studies indicate that well-structured digital learning environments, supported by evidence-based pedagogical approaches, significantly enhance students' engagement and retention in mathematical learning [12].

Addressing the digital divide remains a priority as disparities in technological access can exacerbate existing educational inequalities and limit opportunities for learners in under-resourced regions [13]. Consequently, this study will also explore socio-economic factors influencing digital mathematics education, proposing strategies to ensure fair and effective technological integration [14]. Furthermore, the mathematical modeling of educational outcomes has been explored in recent research, providing quantitative insights into the efficacy of various technological interventions [15]. Studies have also examined the intersection of deep learning and mathematical education, revealing how hyperparameter tuning in deep neural networks can optimize predictive models for educational assessment. Additionally, computational approaches to problem-solving have been instrumental in developing AI-powered tutoring systems that simulate human-like reasoning in mathematics [16]. Such advancements highlight the growing role of AI in shaping the future of digital mathematics education and the need for empirical studies to assess their long-term impact [17].

The integration of digital tools is increasingly influencing mathematics education. One example of this is the application of AI-powered tools in specific mathematical domains. Research highlights how tools like Photomath are perceived as revolutionizing pre-calculus education by providing AI-powered mathematics tutorship [18]. The effective engagement with and utilization of such advanced digital resources for learning mathematics inherently requires digital literacy awareness, enabling learners to leverage the capabilities of these tools to enhance their understanding and skills [18].

Technological advancements in mathematics education include the use of digital tools like AI, interactive simulations and computational platforms. These tools enhance problem-solving, visualization and students' engagement, bridging the gap between theoretical knowledge and practical application. Digital tools integration, such as virtual classrooms, AI-powered applications and digital

games, significantly impacts students' engagements, promotes deeper conceptual understanding and improves overall learning outcomes.

Informed by this, the objective of the present study was to determine the correlation between digital literacy awareness to enhance learning of mathematics. By systematically examining the interplay between digital awareness and the use of mathematical tools to solve real life problems, the paper offers valuable insights for educators, policy-makers and researchers.

2. Research Design

2.1 Design and data set

Statistical techniques were used to analyze variables. The questionnaire focused on key aspects such as the frequency of technology use, the types of digital tools utilized, and participants' perceived computational mathematics ability.

This survey collected data across three sections to assess the impact of technological innovation on mathematical literacy. The first section gathered demographic information including age (categorized as 18, 18–24, 25–34, 35–44, and 45+), gender (Male, Female, Non-binary/Other, Prefer not to say), education level (Secondary School, Bachelor's Degree, Master's Degree, Doctorate Degree, Other), and current occupation (Student, Educator, Industry Professional, Other). The second section, focuses on Computational Mathematics Literacy & Technological Integration, measured the frequency of mathematics usage in daily life (Daily, Weekly, Occasionally, Rarely), self-rated computational mathematics literacy (Very High, High, Moderate, Low), perceived relevance of school mathematics to daily life (Strongly agree to Strongly disagree), perceived importance of mathematical literacy in today's society (Extremely important to Not important at all), and comfort level in using mathematical concepts in everyday decisions (Very comfortable to Uncomfortable). The final section, Use of Technology in Mathematics Education, assessed support for incorporating more technology in math education (Strongly support to Strongly oppose), confidence that improves digital literacy would improve mathematical literacy (Very confident to Not confident), agreement on the effectiveness of traditional teaching methods (Strongly agree to Strongly disagree), belief in the future importance of mathematical literacy due to technology (Strongly agree to Disagree), and the perceived importance of adapting math curricula to incorporate new technologies (Extremely important to Not important at all). Participants were informed about the purpose of the survey, assured of the confidentiality of their responses, and their voluntary participation was implied through their decision to complete and submit the survey.

2.2 Analysis

All responses were reviewed for completeness, and any responses that were incomplete were removed from the dataset. Additionally, erroneous entries, including extreme outliers and inconsistent data points, were either corrected or eliminated to ensure the integrity of the analysis. Responses from the Likert-scale survey were numerically coded to facilitate statistical analysis, while qualitative responses were categorized into thematic groups for quantification. The cleaned dataset was then imported into Statistical Package for the Social Sciences (SPSS) version 30 for analysis. Descriptive statistics were used to summarize demographic characteristics and frequency distributions to provide an overview of the sample population. Correlation Analysis is applied to measure both the strength and direction of relationships between variables, such as technological exposure and mathematical literacy levels. Regression modelling was used to establish predictive relationships and assess the extent to which variations in technological exposure influence mathematical literacy. A one-way ANOVA was conducted to examine differences in mathematical literacy across demographic groups, including variations by age and education level. Heatmaps were used to visually represent interactions and relationships within the dataset, facilitating an intuitive understanding of complex data patterns.

3. Results and Discussion

In exploring the impact of technological innovations on computational mathematics literacy, our study employed a robust analytical framework combining correlation analysis, regression analysis and a one-way ANOVA. These methodologies were instrumental in dissecting the connections between various

technological teaching tools and students' performance in computational mathematics, thus underscoring the need for effective integration of digital innovations into curricula to enhance mathematical engagement and proficiency. The results are presented in Table 1 and Figures 1 to 6.

Table 1 provides a comprehensive overview of the demographic and educational background of individuals in relation to digital literacy for mathematics learning, covering age distribution, gender, education levels and occupations.

Table 1: Demographics and educational background of respondents

Category	Subcategory	Percentage (%)
Age Groups	18	3.31
	18-24	17.13
	25-34	25.97
	35-44	37.02
	45+	16.57
Gender Distribution	Male	60.77
	Female	38.67
	Non-binary/Other (Prefer not to say)	0.56
Education Level	Secondary School	11.6
	Bachelor's Degree	40.33
	Master's Degree	33.15
	Doctorate Degree	14.92
Current Occupation	Student	24.86
	Educator (Teacher, Lecturer, etc.)	34.25
	Industry Professional	21.47
	Other	19.42

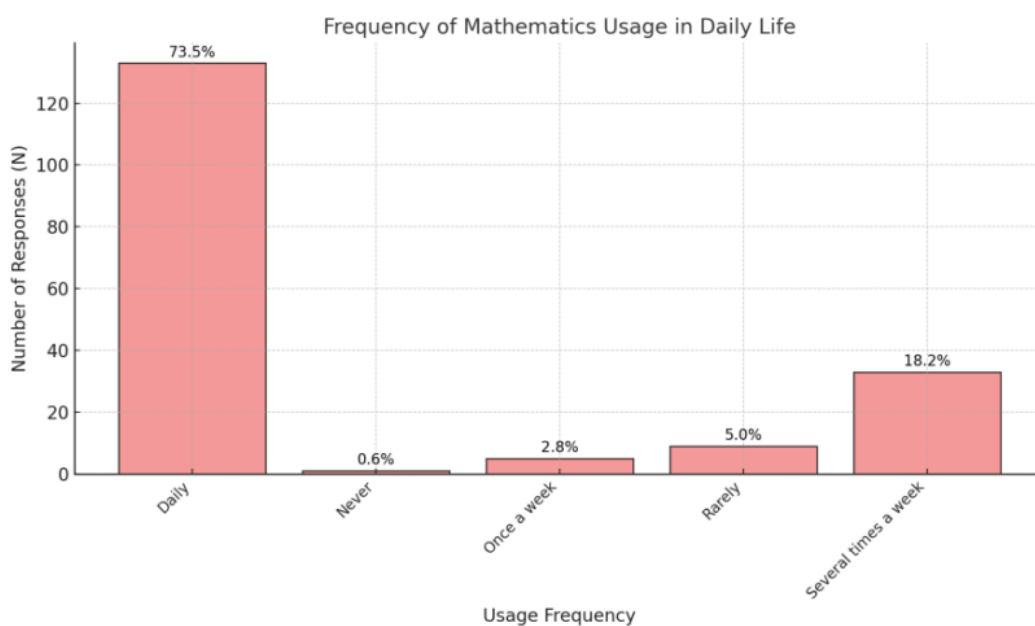


Fig. 1: Histogram representing the frequency of mathematics usage in daily life

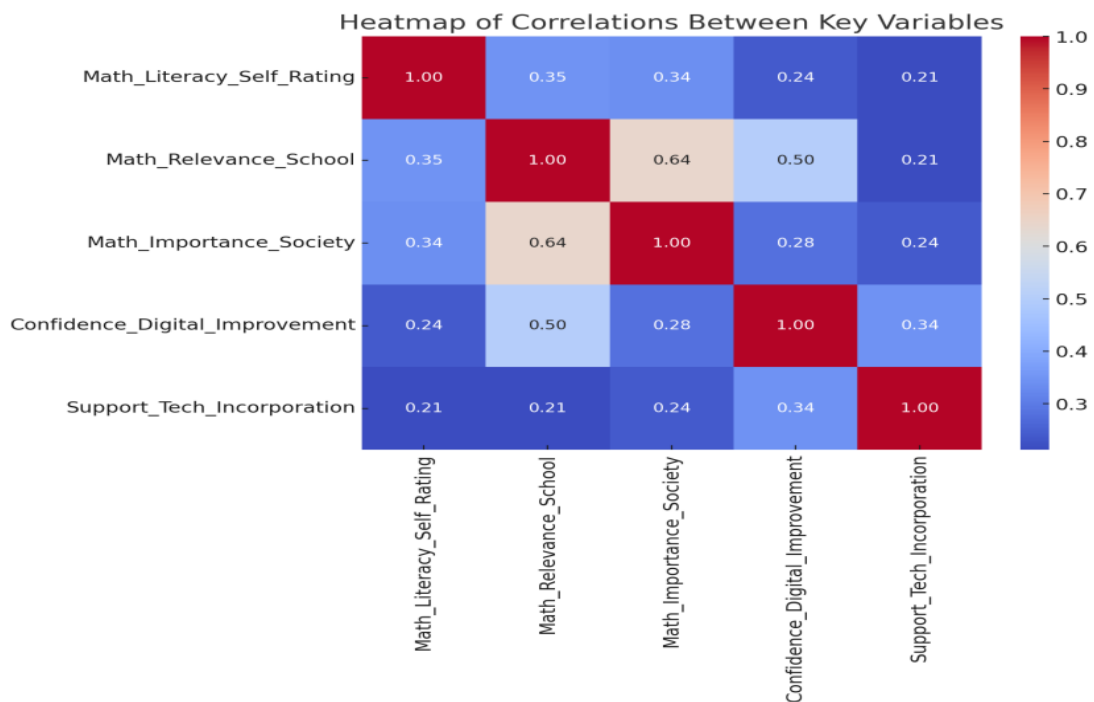


Fig. 2: Heatmap visual representation of perceptions of technology and mathematical literacy

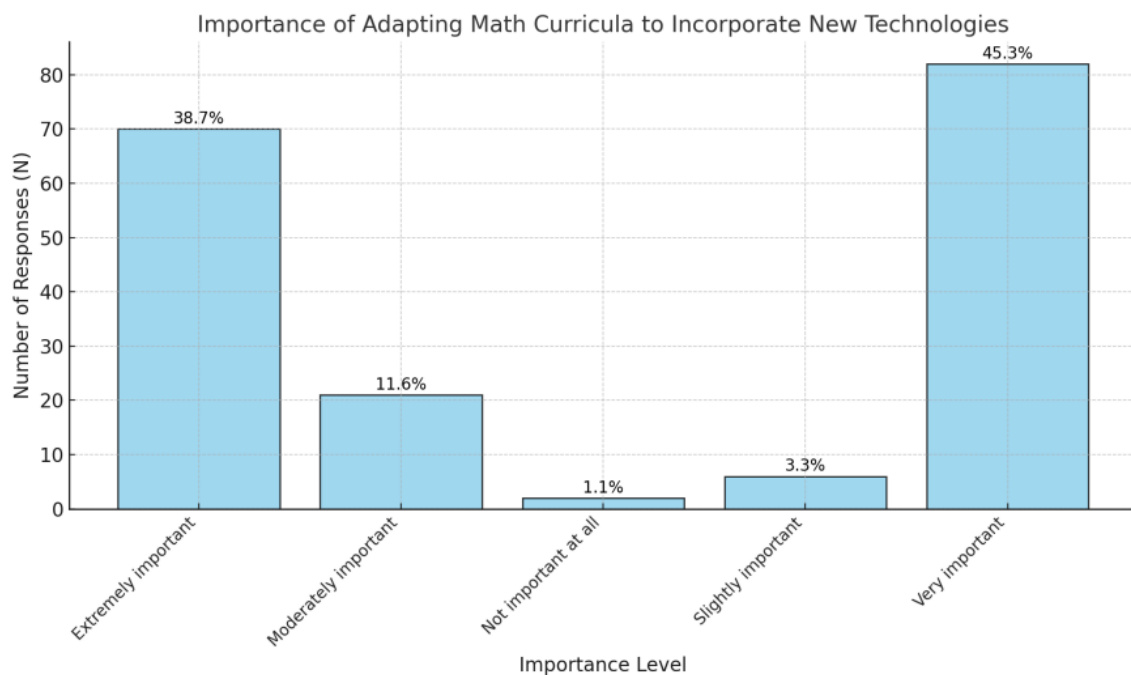


Fig. 3: Bar chart illustrating the distribution of responses and their level of importance

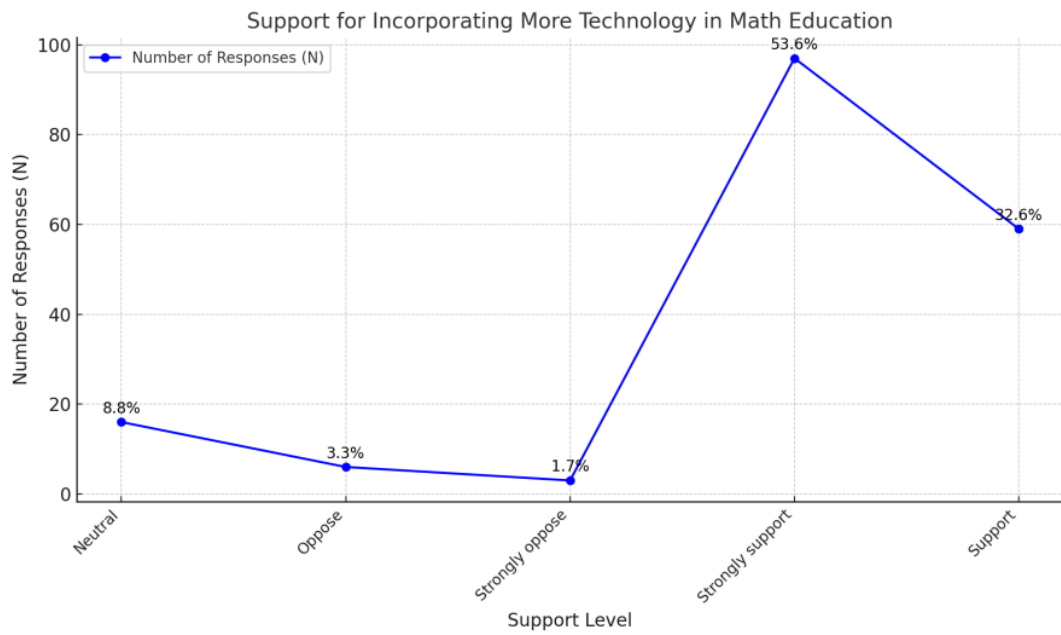


Fig. 4: Distribution of responses and their support level

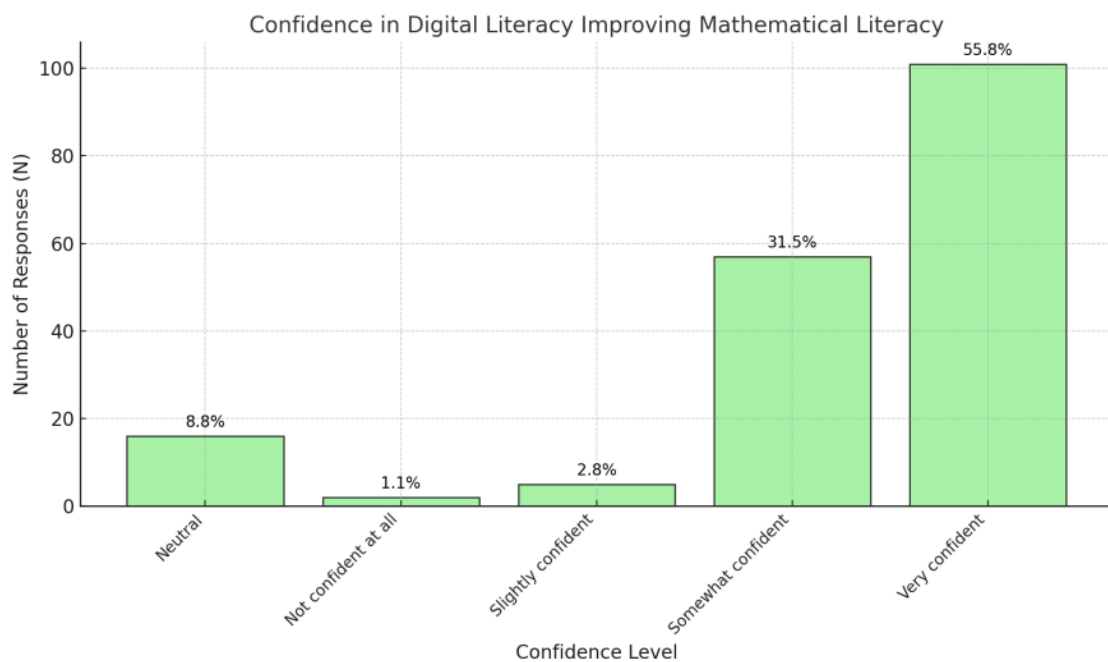


Fig. 5: Number of responses and their confidence levels

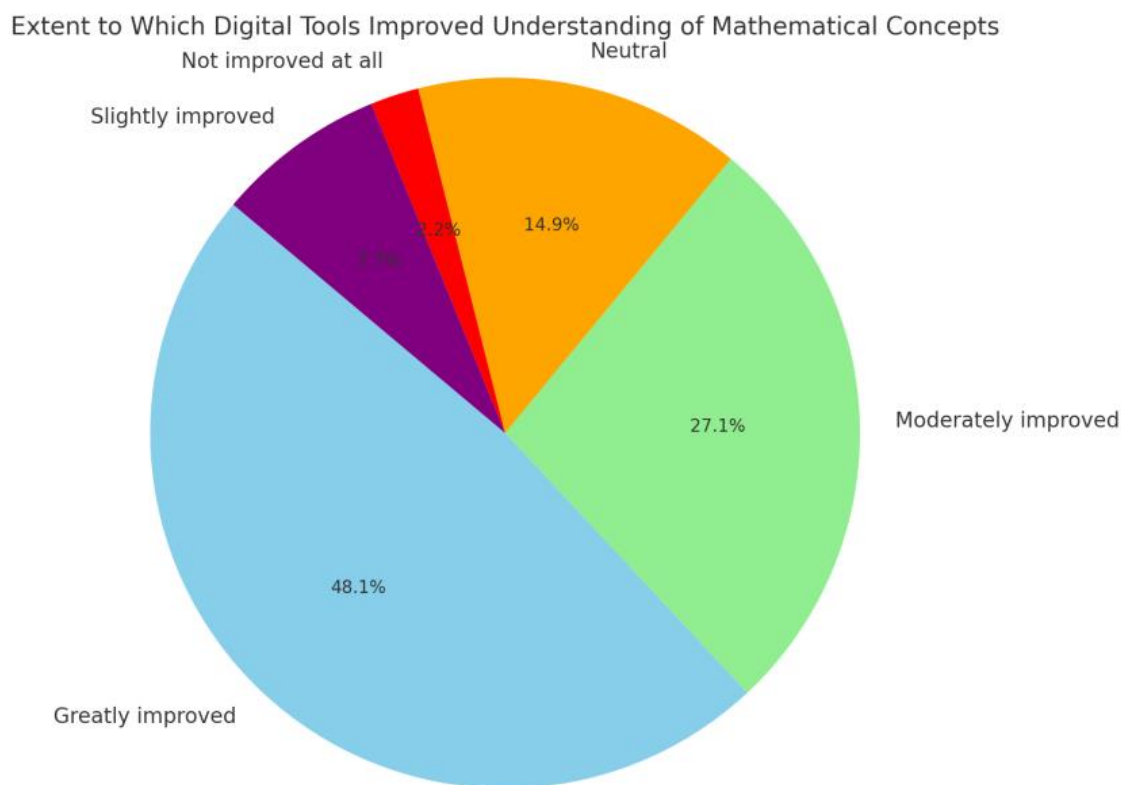


Fig. 6 A pie chart showing the extent to which respondents believe digital tools aid understanding of mathematical concepts

Based on the correlation and regression analysis, there's a strong indication that certain perceptions and beliefs are significantly linked to digital literacy, which in turn can enhance mathematics learning. The high positive correlation (0.945) between the perceived relevance of school mathematics and digital literacy suggests that when individuals believe that the mathematics they learn in school is useful, they are more likely to possess higher digital literacy skills. Similarly, viewing mathematics as important in society also shows a strong positive correlation (0.838) with digital literacy, implying that recognizing the broader societal value of math motivates individuals to develop digital skills, potentially to better engage with and understand mathematical concepts in real-world contexts.

Furthermore, the regression analysis reinforces these findings. The perceived relevance of school math and the belief in the importance of math in society are positive predictors of digital literacy ratings, with the latter being the strongest predictor. This suggests that emphasizing the relevance and societal importance of mathematics can significantly contribute to improved digital literacy.

Support for the incorporation of technology in education also shows a moderately positive correlation (0.712) and a good positive predictive relationship with digital literacy. This implies that a positive attitude towards using technology in education is associated with higher digital literacy levels, which can then be applied to enhance the learning of mathematics through access to digital resources, tools, and interactive platforms.

The ANOVA results indicate statistically significant differences in literacy ratings across education levels, suggesting that educational background influences digital literacy. This highlights the importance of considering educational stages when implementing strategies to enhance digital literacy for mathematics learning.

4. Conclusions

This study reveals a significant positive correlation between digital literacy, as indicated by familiarity with AI and related terms, and the frequency of applying basic mathematical principles to solve real-life problems. Notably, variations in this relationship were observed across different age groups, educational backgrounds and professional domains within the sample. These findings underscore the importance of digital awareness in fostering the practical application of mathematical skills. Consequently, educational strategies should prioritize the integration of digital tools to enhance both digital literacy and the real-world utilization of mathematics.

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Conflict of Interests

The authors declare that they have no conflicts of interest.

Author Contributions

All authors have read and approved the final version of the manuscript.

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