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Research Article

Employment of Generative Artificial Intelligence in Classroom Environments to Improve Financial Education in Secondary School Students

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Abstract

    Financial education is considered an essential skill that enables students to effectively manage their economic resources. However, it is still at an embryonic stage in several countries, and the ability of young people to apply financial education in life contexts has not substantially improved. To address these challenges, this study proposes and evaluates a novel approach to improve financial education among high school students by using generative artificial intelligence tools. Following a quasi-experimental design, we randomly assigned a total of 110 high school students to two conditions: an experimental group that participated in learning experiences under the financial education approach using artificial intelligence tools such as ChatGPT and a control group that engaged in the same learning activities following the traditional teaching approach. The results of the Mann-Whitney U test indicate that there are significant differences between the scores of the experimental group and the control group ($p=1.64E$-$19<0.05$, $\overline{R}$ group experimental=82.92> $\overline{R}$ group control=28.08), demonstrating the effectiveness of the generative artificial intelligence approach in enhancing financial education compared to the traditional approach. Furthermore, the Kruskal-Wallis test revealed a significance p-value of less than 0.05 ($p=0.000935<0.05$), indicating that the use of AI significantly improves the five indicators of financial education according to the post-test evaluation phase of the experimental group. On the other hand, Dunn's test for multiple comparisons reveals a significantly greater influence of the innovative approach using artificial intelligence in the following dimensions: Financial Planning Actions, Financial Analysis Actions, Financial Behavior, and Strategic Expense Management; however, the Investment Initiative dimension shows a significantly lesser influence ($\overline{R}$=103.46). The implementation of artificial intelligence in the classroom to promote student learning is favored by innovative approaches to pedagogical action. In this way, from the classroom, we can address the lack of skills and financial education in our students.

Keywords: *Artificial Intelligence, ChatGPT, Financial education, High school students*

1. Introduction

Financial education is considered an essential competency to empower students to effectively manage their economic resources (Jayaraman & Jambunathan, 2018). In this context, the vitality of incorporating financial education into the secondary school curriculum has been highlighted and advocated (Urban, 2023), providing detailed guidelines regarding content and practical activities amenable to exploration in this domain (Shao *et al.*, 2023), including but not limited to financial literacy and security, prudent consumption, saving and budgeting (Aguayo & Aros, 2023).

However, empirical evidence has been identified that postulates that the financial situation of the youth population is a cause of palpable concern and analysis (Eberle & Oberrauch, 2023). A study in Peru highlighted the remarkable acceptance of a free financial education program and an increase in trust in providing financial institutions. Despite the evident positive impact on the adoption of formal savings mechanisms, the program did not demonstrate, in the short term, significant changes in other vital financial and socioeconomic areas, such as income and female empowerment.

In another important section, the exponential proliferation of artificial intelligence (AI) progressively modulates the way individuals interact, communicate, coexist, learn, and work (Wang et al., 2023). In the education sector, the implementation of AI translates into the application of a variety of technologies, including intelligent tutoring systems, chatbots, robots, and automated assessment tools, which are used to support and enhance the educational process (Chai *et al.,* 2020) and facilitate the analysis and evaluation of digitized artifacts through various modes (Chai *et al.,* 2021). AI also has significant potential to optimize various aspects of education, such as learning, teaching, assessment, and educational administration (Al Darayseh, 2023)

On the other hand, studies highlight that financial education is still at an embryonic stage in several countries and does not substantially improve young people's ability to apply financial education in real-life contexts (Zia, 2023). Similarly, there are cross-country comparisons of financial education and knowledge, in which empirical findings denote differences in knowledge structures in specific content areas among students across countries (Kang *et al.,* 2023). In the specific case of Peru, financial illiteracy is a permanent concern both in the global financial system and in the education sector and public policies, with consequences derived from the financial, social, and economic exclusion to which a large proportion of the population is subjugated, a situation that has greater virulence in underdeveloped and developing countries (Esquivel-Espinales *et al.,* 2023). This is particularly evident in schools and rural areas, where a lack of education for the development of robust financial education is evident. This study seeks to determine the influence of the program on the lack of financial education as a preponderant factor of poverty in families due to the absence of financial knowledge and skills (Sangay *et al.,* 2023).

Finally, considering that financial education plays a preventive and regulatory role in indebtedness, leading to an increase in savings and investment, it is important to combine efforts to enhance young people's financial education (Gianakos et al., 2023), enabling them to make informed and responsible decisions about their finances (Xu et al., 2021). Insufficient information about fundamental economic and financial topics constrains individuals' ability to make responsible decisions, which can negatively impact them, their families, and their communities. The research questions guiding this study are as follows:

- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their group performance from those who participated in the sessions following the traditional approach?
- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their financial planning performances from those who participated in the sessions following the traditional approach?
- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their behavioral finance actions from those who participated in

the sessions following the traditional approach?
- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their behavioral finance actions from those who participated in the sessions following the traditional approach?
- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their strategic management of spending from those who participated in the sessions following the traditional approach?
- Do students who participate in the sessions with generative artificial intelligence to improve financial literacy differ in their strategic management of spending from those who participated in the sessions following the traditional approach?
- What is the influence of the application of a pedagogical approach based on the use of artificial intelligence to improve financial education in the experimental group according to dimensions?

2. Literature Review

Jiang, (2021) addressed the growing demand for AI systems in financial literacy education for elementary school students by focusing on the development of an AI system that would provide financial literacy lessons. This system was integrated into an NAO robot, designed specifically for educational contexts, and evaluated using a variety of metrics, including effectiveness, robustness, feasibility in the classroom, and student enjoyment. Although the results indicated that the system was conducive to the retention of educational material, it did not prove to be significantly more effective than traditional teaching methods based on guided worksheets. However, students expressed greater enjoyment of interacting with the robot than with the worksheets. Thus, these findings offer a promising outlook for the future use of the system and highlight areas for possible improvements in its subsequent application in financial education for young students.

(Hu *et al.,* 2023) aimed to strengthen young people's financial competence to increase their resilience to economic risks, identifying that many of them struggle to make optimal financial decisions. To address this, the researchers designed a system using machine learning that analyzed users' previous spending habits and modeled them against a decision tree framework to calculate the optimal decision within users' budgets, which was tested using questionnaire data from 62 participants. The methodology implements affective interaction and anthropomorphic communication to educate users in real-time shopping environments. The results from user testing indicated that the design helped with cognitive offloading and encouraged critical thinking when making purchasing decisions, illuminating possible approaches for applying AI virtual assistants to improve skills when resources are lacking.

(Murugiah *et al.,* 2023), focusing on the issue of mapping data analytics to audit tasks, developed a framework that aligns audit stages and AI, employing data analytics in teaching audits with AI, using process model methodology and a hybrid approach to curriculum development, complemented by the inclusion of knowledge areas and skills recommendations at each stage, aligned with guidelines from leading accounting bodies to ensure compliance with course certification and future job prospects. Using the MindBridge AI audit management platform, the developed framework was evaluated by a focus group of academics and practitioners from the accounting industry, and its application was analyzed in a series of workshops and a survey with participants, demonstrating the practical implementation of the framework in the teaching and learning materials developed.

(Miu et al., 2022), aiming to address the notable lack of financial literacy across diverse demographics and backgrounds of U.S. citizens, proposed a solution focused on ensuring instruction in fundamental financial education from an early age. The team developed a virtual voice assistant designed to improve financial literacy by providing lessons that covered all topics within the National

Standards of K-12 Personal Financial Education. Data were collected and analyzed to evaluate the effectiveness, robustness, and engagement of the assistants. Although the basic objectives were met in terms of the effectiveness and robustness of the bot, and further analysis on engagement is recommended, it is envisioned that improved instruction of intentions and testing on potential users could further optimize its performance in future implementations.

3. Theoretical Framework

The field of financial education has been a subject of growing interest, given the need to prepare individuals to make complex financial decisions throughout their lives (Lučić *et al.*, 2020). In this context, (Avendaño *et al.,* 2021) highlight the importance of financial planning actions, ranging from the organization of payments and bills through the establishment of financial goals at different time frames to proper planning when using financial products such as credit cards. This planning is not merely a list of tasks but a structure that guides an individual's financial behavior, allowing him/her to visualize and organize their finances, making use of visual tools to project future expenses and income (Gilenko & Chernova, 2021). It is essential to understand that these skills not only allow us to maintain an economic balance but also project a stable and sustainable financial future.

However, planning is only a component of the financial landscape. Avendaño *et al.,* (2021) also stress the relevance of behavioral financial actions, which refer to the detailed and considered analysis of all financial decisions made (Sezgin *et al.,* 2023). This implies that beyond mere planning, it is crucial to evaluate how each purchase or financial decision affects personal economic balance. Thus, when considering the use of financial products, it is essential to analyze aspects such as interest, timing, and other variables that may impact financial well-being in the short and long term (Blaschke, 2022). It is an exercise of financial introspection, where one seeks to understand one's personal situation and how each choice will affect the big picture, avoiding impulsive decisions and maintaining a proactive approach toward sound financial health.

Delving deeper into financial behavior, Dare et al., (2020) emphasize the effective execution of planned strategies. That is, once a path has been charted through planning, it is essential to follow it with consistent actions, and ongoing savings is one of these essential behaviors aligned with preestablished goals at different timeframes. In addition, it is imperative to maintain a commitment to financial responsibilities and pay debts, bills, and credits over time (M. Yao *et al.,* 2023). A thorough understanding of one's level of indebtedness facilitates informed decision making, thus minimizing impulse purchases and reserving funds for emergencies, which not only reflects momentary financial health but also a mindset focused on preparedness and foresight, which are key components for dealing with future financial uncertainties and challenges (Elifneh, 2022).

In relation to the strategic management of expenditures, (Avendaño *et al.,* 2021) point out the relevance of the meticulous administration of financial resources. Preparing detailed budgets of income and expenses is not only an accounting task but also a tool that promotes organized and responsible financial behavior. This strategic approach demands that monthly expenses do not exceed income, which seems to be a simple rule but is essential to avoid unnecessary indebtedness. Similarly, prioritizing expenses based on personal needs and goals facilitates the distinction between the essential and superfluous, leading to more conscious financial management (Rinaldi et al., 2022). This awareness ultimately protects against spending on products or services, which can unbalance personal financial stability.

Investment initiatives represent a leap forward in financial maturity and go beyond simply managing expenses and income. According to (Dare et al., 2020), this initiative manifests itself in anticipation and planning for long-term financial goals such as higher education or the purchase of a home. However, it is not limited only to a vision of the distant future; true investment initiatives are reflected in the willingness to devote time and resources to understanding the various investment opportunities available (Cheng, 2020). Whether investing in one's own business or in traditional investment vehicles, the key factor is the strategy behind each financial decision; on the other hand,

investing is not just about spending money in the hope of making a profit but about planning and learning how to maximize the value of available resources to address problems, meet needs, or capitalize on opportunities (Adamba, 2023).

While financial education has traditionally been based on static principles and theoretical approaches, the introduction of AI promises to revolutionize this field. AI, with its ability to analyze patterns and adapt to different contexts, can offer personalized and adaptive tools for financial learning (Ruiz-Palomo *et al.*, 2023). This personalization is crucial, especially for high school students who are at the stage of discovering and defining their financial goals (Jali *et al.*, 2023). Rather than offering a monolithic approach, AI can tailor content and strategies according to the specific needs and circumstances of each student.

On the other hand, the interactivity and simulation offered by AI allows students to experiment with financial decisions in safe and controlled environments (Yang & Stivers, 2023). For example, when considering the investment initiative, students can simulate different investment scenarios and understand the associated risks and benefits without facing real consequences, which not only enriches their theoretical understanding but also strengthens their confidence and ability to make informed financial decisions in the real future.

AI's transformative role in financial education extends to strategic expense management. Traditionally, many individuals, including students, rely on manual tools or simple software programs to manage their finances (Gigante & Zago, 2023). However, with the incorporation of AI, proactive recommendations can be received based on spending patterns, income predictions, and past financial behaviors (Bazeliuk *et al.*, 2023). For example, an intelligent system can analyze spending patterns and suggest areas for savings or even anticipate future spending based on past habits.

This level of personalized analysis and recommendation empowers the students' ability to make informed decisions. It can also provide alerts and reminders, helping young people avoid impulsive spending or stay within a preset budget (Adamba, 2023). For example, a system that, upon recognizing a pattern of impulse purchases, provides educational information about the long-term implications of such behavior or suggests more cost-effective alternatives.

Savings and investment are fundamental pillars of financial health, and in this context, artificial intelligence can be instrumental (He *et al.*, 2021) by providing tools that allow students to visualize future scenarios based on their current savings patterns. AI can be a powerful motivator (Cui, 2021). For example, by inputting a monthly savings rate, an AI system could project the growth of savings over the next few years, considering variables such as interest rates, inflation, and other market factors. This tangible vision of the financial future can inspire students to commit more strongly to their savings goals (Jiang, 2021).

In the investment domain, AI can demystify many concepts that are often perceived as complex or inaccessible. Through simulations and predictive modeling, students can explore different investment strategies and understand the associated risks and rewards (M. Li, 2021), which can guide young people through different investment options, provide contextual information about each, and help students align their investment choices with their goals and risk tolerance.

At the institutional level, the integration of artificial intelligence into financial education presents a golden opportunity for schools and other educational institutions. In particular, high schools can adopt AI systems to offer students more adaptive and contextualized financial education programs (T. Li, 2022). This means that programs would not only be based on standard content but could also be tailored to each student's socioeconomic, cultural, and personal circumstances, making financial education more relevant and effective.

Furthermore, with AI's analytical capabilities, institutions can receive constant feedback on the effectiveness of their programs and can assess in real time how students interact with the tools, what concepts they find most challenging, and where they are making the most progress (Davoyan, 2021). This feedback can be used to iterate and continually improve financial education programmes, ensuring that they remain relevant and effective.

The incorporation of artificial intelligence in financial education, while promising, also comes with ethical and implementation challenges, such that one of the main challenges is the protection of personal and financial data (Zhou *et al.,* 2020). It is imperative that the AI-based solutions adopted by educational institutions have robust security protocols to ensure that students' personal information is handled confidentially and securely. In addition, it is essential that students and their families are informed about how their data will be used and that their explicit consent is obtained (Berradi *et al.,* 2020).

However, accessibility should also be considered. Although AI has the potential to personalize financial education, it is crucial to ensure that all students, regardless of their socioeconomic background, have access to these advanced tools (X. Yao *et al.,* 2020). This implies a coordinated effort to ensure that AI implementation does not deepen the existing educational gaps (Huang & Wang, 2019). Finally, the human components remain irreplaceable. While AI-based tools can provide analytics and simulations, the guidance and context that a human educator can provide is essential for a holistic understanding of financial education (Xinman, 2017).

Table 1. Characteristics of the artificial intelligence tools used in the study

Designation	URL	Company	Access
ChatGPT	https://chat.openai.com/	OpenAi	Freemium / paid
Paymefi	https://www.paymefy.com/es/	Paymefy	Freemium / paid
Wallet.ai	https://wallet.ai/origin.html	Wallet.ai	Paid
Mid Journey	https://www.midjourney.com/home	Independent laboratory	Freemium / paid
Microsoft Designer	https://designer.microsoft.com/	Microsoft	Freemium / paid
Adobe Express	https://new.express.adobe.com/	Adobe Systems Incorporated	Freemium / paid
Canva	https://www.canva.com/	Canva	Freemium / paid

4. Method

To answer these research questions, a quasi-experimental study was designed to evaluate the influence of the application of the teaching approach based on the use of artificial intelligence to enhance financial literacy in students.

4.1 Participants

Prior to developing the program to improve financial literacy in high school students, 8 programs were selected that incorporated generative artificial intelligence, some of which are subscription-based, while others are freely accessible. Participants were recruited from a secondary education institution in Peru. A total of 110 voluntary students from the fourth year of secondary school were enrolled. The average age was 15 and 17 years (mean 15.25, standard deviation± 0.51), and all the participants were male. Before starting the study, the parents and legal guardians signed an informed consent document in which they authorized the participation of their minor child. All students filled out an informed consent form as a requirement to participate in the study. Similarly, all participants were informed that they could leave the study at any time.

4.2 Experimental procedure

The experimental procedure is illustrated in Fig. 1. First, students were randomly selected to form two groups: experimental (n=55) and control (n=55). The pretest evaluation phase was conducted in which all participants completed a 15-minute questionnaire on financial education and its dimensions: financial planning actions, financial analysis actions, financial behavior, managing expenses, and investment initiative.

Second, one of the people in charge of the study explained the nature of the experiment, in addition to explaining how all the artificial intelligence tools that the members of the control group will use to acquire their financial education work. They were also given the opportunity to ask questions before using the tool.

After the demonstration, all participants in the experimental group participated in eight learning sessions for the development of financial education with a length of one pedagogical hour (40 - 45 minutes). The primary distinction was that participants in the experimental group had the opportunity to utilize artificial intelligence to enhance financial education through didactic sessions, whereas the control group did not. After completing each session, students presented their tests and/or group products, and an interview was conducted with all participants from each group.
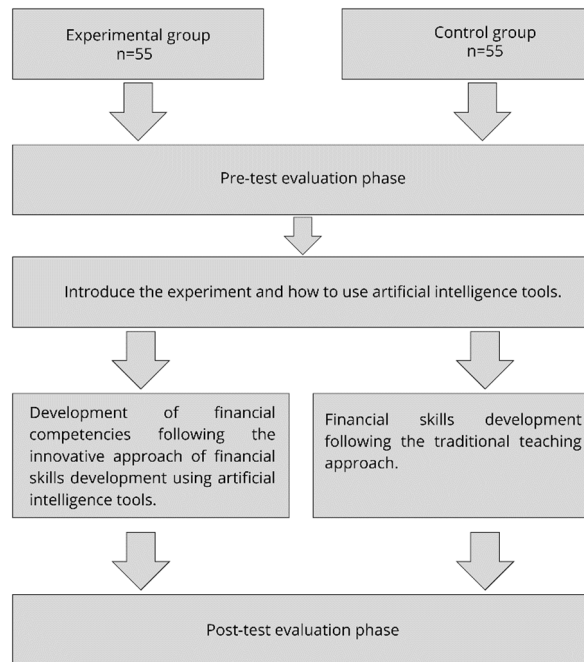

Figure 1: Quasi-experimental research procedure

Finally, in the third stage, the posttest evaluation phase was carried out, where all participants were surveyed for 15 min to measure the development of their financial education.

4.3 Program duration

The duration of the program was approximately 6 months (starting on March 15 and ending on September 17, 2023) and was part of the "Education for Work" course proposed in the National Curriculum for Basic Education (CNEB) of Peru. In total, 28 one-hour pedagogical sessions were conducted, divided into five learning units aimed at developing financial education both at the variable level and in each of its dimensions (financial analysis actions-6 sessions, financial planning actions-6 sessions, financial behavior-6 sessions, strategic management of expenses-6 sessions, investment initiative-6 sessions).

Furthermore, all sessions were conducted in two pedagogical innovation classrooms (for the

control and experimental groups) of the educational center equipped with computers and stable internet access (see Figure 2), allowing students to utilize generative artificial intelligence tools during their participation in the program.

Figure 2: Students participating in the study of the pedagogical innovation classroom using generative artificial intelligence tools to enhance financial education.

4.4 Instruments

The financial education questionnaire proposed by (Avendaño *et al.,* 2021; Dare *et al.,* 2020) consists of 20 items with three response options ranging from (1) "Never" to (3) "Always". The dimensions of financial education measured in the questionnaire are financial planning actions, financial planning analysis, financial behavior, strategic management of expenses, and investment initiatives.

To calculate the reliability of the measurement instrument, Cronbach's alpha reliability coefficient was used, where financial education showed a value (α=0.862), financial planning actions (α=0.866), financial analysis actions (α=0.859), financial behavior (α=0.859), strategic management of expenses (α=0.860), and investment initiatives (α=0.864), showing that the internal consistency was high. Meanwhile, the content validity of the research instrument was established by expert judgment, whose evaluations yielded a V-Aiken coefficient (V=9.45), showing high content validity.

5. Method of Data Collection and Analysis

The study collected 110 prequestionnaires, 108 post-questionnaires, and 25 pieces of evidence from the participants. To answer the research questions, the data were analyzed using descriptive and inferential statistical techniques, in addition to an evaluation of the group work using a holistic rubric.

In the data processing, descriptive statistics were employed, including the creation of contingency tables, double-bar graphs, and boxplots. Inferential statistics were also utilized, applying the Mann-Whitney U test for independent groups to determine the difference between the scores of the experimental and control groups. Furthermore, the nonparametric Kruskal-Wallis test was used to determine the influence of implementing a didactic approach based on the use of artificial

intelligence for improving financial education at the dimension level in the posttest evaluation phase of the experimental group. The processing was conducted using RStudio software, version 4.3.2.

6. Results

Table 2*:* The nonparametric Mann-Whitney U test of the influence of the teaching approach based on the use of artificial intelligence to enhance financial education among fourth-year high school students in Trujillo, 2023, according to the evaluation group in the pretest assessment phase.

Variable: Financial education			
Group	**N**	**Average range**	**p-valor***
Control	55	49.84	0.062
Experimental	55	61.16	
Dimension 1: Financial planning actions			
Group	**N**	**Average range**	**p-valor***
Control	55	51.48	0.179
Experimental	55	59.52	
Dimension 2: Financial analysis actions			
Group	**N**	**Average range**	**p-valor***
Control	55	57.35	0.177
Experimental	55	63.65	
Dimension 3: Financial behavior			
Group	**N**	**Average range**	**p-valor***
Control	55	52.62	0.336
Experimental	55	58.38	
Dimension 4: Strategically manages expenses			
Group	**N**	**Average range**	**p-valor***
Control	55	52.28	0.284
Experimental	55	58.72	
Dimension 5: Investment initiative			
Group	**N**	**Average range**	**p-valor***
Control	55	55.61	0.971
Experimental	55	55.39	

*p-value of significance of the nonparametric Mann-Whitney U test, due to noncompliance with normality by the Kolmogorov-Smirnov test, both in the Financial Education variable and in each of its dimensions, according to evaluation group.

Note: Authors' elaboration with the results obtained using RStudio software version 4.3.2.

Table 3. The nonparametric Mann-Whitney U test on the influence of applying a didactic approach based on the use of artificial intelligence to improve financial education among fourth-year high school students, Trujillo-2023, according to the evaluation group in the posttest assessment phase.

Variable: Financial education			
Group	**N**	**Average range**	**p-valor***
Control	55	28.08	1.64E-19
Experimental	55	82.92	
Dimension 1: Financial planning actions			
Group	**N**	**Average range**	**p-valor***
Control	55	29.58	4.34E-18
Experimental	55	81.42	
Dimension 2: Financial analysis actions			
Group	**N**	**Average range**	**p-valor***
Control	55	31.56	9.70E-16
Experimental	55	79.44	

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Variable: Financial education			
Dimension 3: Financial behavior			
Group	**N**	**Average range**	**p-valor***
Control	55	32.72	1.82E-14
Experimental	55	78.28	
Dimension 4: Strategically manages expenses			
Group	**N**	**Average range**	**p-valor***
Control	55	32.29	7.63E-15
Experimental	55	78.71	
Dimension 5: Investment initiative			
Group	**N**	**Average range**	**p-valor***
Control	55	36.43	1.80E-10
Experimental	55	74.57	

*p-value of significance of the nonparametric Mann-Whitney U test, due to noncompliance with normality by the Kolmogorov-Smirnov test, both in the Financial Education variable and in each of its dimensions, according to evaluation group.

Note: Authors' elaboration with the results obtained using RStudio software version 4.3.2.
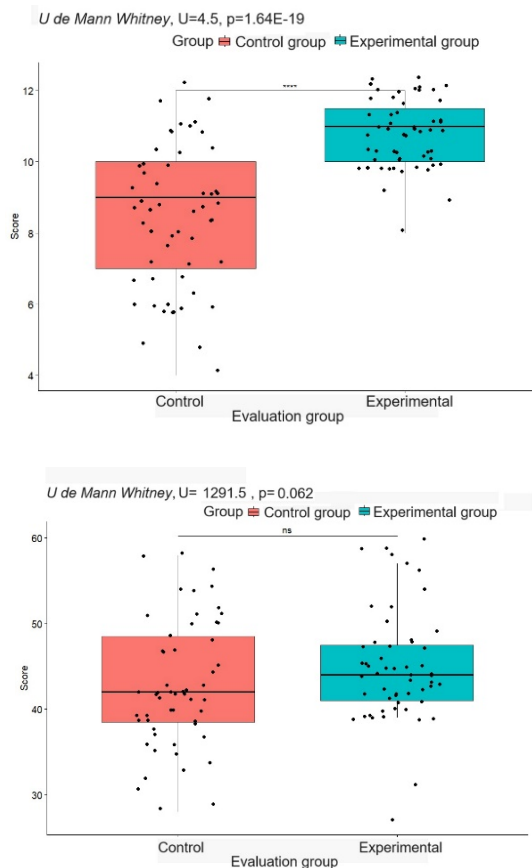

Figure 3: Boxplot of the evaluated results on the influence of the application of a didactic approach based on the use of artificial intelligence to enhance financial education among fourth-year high school students, Trujillo-2023, according to the evaluation group in the pretest and posttest assessment phases.

Considering the results from Table 2 and Figure 3(a), it was found that the significance p-value of the Mann-Whitney U test exceeded 0.05 (p>0.05) in the pretest evaluation phase. This indicates that prior to the implementation of a didactic approach based on the use of artificial intelligence for improving financial education in fourth-year high school students, there was no significant difference in the outcomes obtained from the control and experimental groups. This was observed in the Financial Education variable (p=0.062>0.05), as well as in the dimensions: Financial Planning Actions (p=0.179>0.05), Financial Analysis Actions (p=0.177>0.05), Financial Behavior (p=0.336>0.05), Strategic Expense Management (p=0.284>0.05), and in the Investment Initiative dimension (p=0.971>0.05). Additionally, in Table 3 and Figure 3(b), the significance p-value of the nonparametric Mann-Whitney U test in the posttest evaluation phase registered a value less than 0.05 (p<0.05). This was evident both in the comparison of the Financial Education variable results and in each of its dimensions between the control and experimental groups, showing that there is a significant difference between the groups where the significantly higher average rank was found in the experimental group, as visualized in the Financial Education variable (p=1.64E-19<0.05, $\overline{R}$ group experimental=82.92> $\overline{R}$ group control=28.08), as well as in the dimension Financial Planning Actions (p=4.34E-18<0.05, $\overline{R}$ group experimental=81.42> $\overline{R}$ group control=29.58), as well as in the dimension Financial Analysis Actions (p=9.70E-16<0.05, $\overline{R}$ group experimental=79.44> $\overline{R}$ group control=31.56), as well as in the dimension Financial behavior (p=1.82E-14<0.05, $\overline{R}$ group experimental=78.28> $\overline{R}$ group control=32.72), also in the dimension Strategically manages its expenses (p=7.63E-15<0.05, $\overline{R}$ group experimental=78.71> $\overline{R}$ group control=32.29) and finally in the dimension Investment initiative (p=1.80E-10<0.05, $\overline{R}$ group experimental=74.57> $\overline{R}$ group control=36.43), therefore, we can conclude that the application of a didactic approach based on the use of artificial intelligence to enhance financial education in fourth-year high school students was effective.

Table 4. Nonparametric Kruskal-Wallis test of the influence of the application of a teaching approach based on the use of artificial intelligence to improve financial education in fourth-year high school students across the evaluated dimensions, according to the posttest evaluation phase.

Kruskal Wallis test	**Statistic**	**p-valor***
	18.615	0.000935
Dimensions	**Homogeneous groups**	**Average range**
Financial Planning Actions	a	158.45
Financial Analysis Actions	a	133.14
Financial Behavior	a	152.34
Strategic Expense Management	a	142.62
Investment Initiative	b	103.46

Note: Own elaboration with the results obtained with RStudio software version 4.3.2.

* p-value of significance of the nonparametric Kruskal Wallis test.

** Homogeneous groups were formed according to Dunn's multiple comparisons test.

The significance p-value of the Kruskal-Wallis test was less than 0.05 (p=0.000935<0.05). This indicates that the influence of the teaching approach based on the use of artificial intelligence to improve financial education in high school students in the post-test evaluation phase showed a significant difference in the influence exerted on at least two of the evaluated dimensions. Furthermore, Dunn's test for multiple comparisons revealed no significant difference in the outcomes resulting from the influence of the teaching approach based on the use of artificial intelligence in the dimensions of Financial Planning Actions, Financial Analysis Actions, Financial Behavior, and Strategic Expense Management. However, the influence exerted on the Investment Initiative dimension was significantly less than that on the other dimensions, with the Investment Initiative dimension also registering a significantly lower average rank ($\overline{R}$=103.46). The lesser influence in the Investment Initiative dimension could be attributed to the more complex and abstract nature of its

content, compared to other dimensions that involve more concrete and day-to-day applicable skills and knowledge. Investment Initiative requires students to have a deeper understanding of financial markets, risk assessment, and long-term decision making. Additionally, the teaching methodology based on artificial intelligence might not be fully adapted to effectively impart more sophisticated aspects like financial investment. Therefore, it will be important to consider this in future research.

7. Discussion

This study aimed to evaluate the influence of the application of a novel financial education development approach based on artificial intelligence tools on fourth-grade high school students. The results showed that this innovative pedagogical approach based on AI tools such as ChatGPT, Paymefi, Wallet.ai, Luzia, Mid Journey, Microsoft Designer, and Adobe Express had a positive effect on the development of financial education of students in the experimental group and in each of the dimensions: financial planning actions, financial analysis actions, financial behavior, strategic expense management, and investment initiative. These findings are consistent with previous research demonstrating the potential of AI in education, not only for its ability to personalize and optimize learning but also for the increased motivation and engagement of students when interacting with these types of technologies (Baker *et al.*, 2019; Seldon & Abidoye, 2018). In sum, these results provide empirical evidence of the effectiveness of the application of AI tools in education and their contribution to Goal 4, ensuring inclusive, equitable, and quality education and promoting lifelong learning opportunities for all (UNESCO, 2015).

In particular, the positive impact on the financial planning dimension can be attributed to the fact that AI tools enable students to set goals, organize their finances, and forecast short-, medium- and long-term expenses and income. In this regard, Jiang, (2021) integrated an AI system to improve financial literacy in a robot, the results of which show that students manifest greater enjoyment when interacting with the robot compared to worksheets.

Progress in financial analysis was due to students being able to examine financial products in detail and foresee how a purchase would affect their personal financial situation. Similarly, (Hu et al., 2023) reported that the design helped students with cognitive offloading and encouraged critical thinking when making purchasing decisions, illuminating possible approaches to apply AI virtual assistants.

Likewise, the AI-based financial education development approach favored the adoption of better financial behavior in the students, increasing their saving habits and planning for the timely payment of their debts. It also helped them to strategically manage their resources, prepare budgets, prioritize expenses and avoid unnecessary purchases. Finally, the investment initiative awakened the students' interest in planning long-term investments, learning about investment options and developing a business venture. The strengthening of these dimensions is similar to those addressed by Miu *et al.,* (2022), whose results show that the virtual assistant improves users' saving and expense planning habits, in addition to promoting investment initiative and project development.

The long-term effects of implementing artificial intelligence tools in financial education are expected to be profound and enduring. Early familiarization of students with complex financial concepts and their practical application through AI not only enhances their current understanding but also lays the groundwork for greater financial competence in their adult life. Therefore, the long-term impact could manifest in more responsible financial behaviors and better-informed decisions in the future.

Therefore, the implementation of this strategy for the development of financial education using artificial intelligence tools proves to be a highly effective method for enhancing financial education in secondary education centers. It is recommended to implement such programs in more educational institutions, as they contribute to forming financially responsible students who are prepared to make informed decisions about managing their economic resources.

Although this study employed random sampling, the generalization of findings to other

educational settings should be approached with caution, as the effectiveness of artificial intelligence tools in financial education can be influenced by various contextual factors. These include differences in technological infrastructure, teacher training, and the sociodemographic and cognitive characteristics of the student body. Therefore, it is crucial to consider the adaptability and customization of these tools to different educational environments to maximize their efficacy. While the results of this study were positive, their extrapolation is not direct, and it is key to adjust artificial intelligence solutions in financial education according to the local context.

It is important to emphasize that this study considered various ethical aspects of using generative artificial intelligence in the classroom, such as student privacy, data security, and the ethical use of AI tools. Their implementation in educational settings carries great responsibility. The protection of personal data and the privacy of students is extremely important, as AI tools can collect and process large volumes of personal information. Therefore, it is essential to ensure that these tools comply with privacy and data protection regulations such as the General Data Protection Regulation (GDPR) in Europe. Likewise, it is crucial that educators and developers of these technologies work together to ensure that students' rights and privacy are respected, while taking advantage of the benefits of AI.

While the use of artificial intelligence tools in education is innovative and motivates student learning, they still have limitations compared to traditional methods. The lack of direct human interaction can affect emotional and social understanding. Although AI provides instant personalized responses, it does not replicate the empathy, judgment, and intuition of a teacher. Additionally, excessive technological dependence could discourage critical and independent thinking skills.

Another notable disadvantage is the technological gap in terms of unequal access to AI tools depending on socioeconomic contexts, leading to different learning opportunities and contradicting inclusive education. Traditional methods are more accessible as they do not rely on advanced technology.

8. Conclusion

The financial education development approach based on artificial intelligence tools in fourth grade high school students had a significant impact at the variable level and in each of the dimensions of financial education. Consequently, this demonstrates that the appropriate use of AI in education can contribute to financial literacy and help ensure quality and inclusive education, as stated in SDG number four. However, it is necessary to take into account that although it is true that in this study, it was prioritized that the participants of the experimental group interact with the AI tools, the guiding and motivating role of the teacher is very important and is not left aside because their guidance is key to the development of financial education in students.

Nevertheless, these findings offer a promising outlook, where the implementation of AI can be favorable to strengthen the financial education of young students and thus contribute to financial education.

9. Limitations and Recommendations

Among the limitations of the study is that it only evaluated students from a section that included 13 classrooms and a single school, so further research with larger and more diverse samples is needed to confirm the generalizability of the findings. In addition, there was no long-term follow-up to determine whether positive effects were sustained over time. Despite this, this study provides evidence of the great potential of AI in teaching financial education and may motivate the design of more innovative educational proposals in this field. It is recommended to promote educational policies aimed at improving the integration of AI in education to take advantage of its benefits and minimize its negative impacts.

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