International Journal of Sustainability and Advanced Integrated Research
Volume 2, Issue 2 (April-June 2026) | ISSN: 3107-7854
DOI: https://doi.org/10.65339/ijsair.V2.I2.261

AI Chatbots on Students Acquisition of Home Economics Skills in Secondary Schools in Solano, Nueva Vizcaya

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Publication history: Received: March 9, 2026; Revised: April 14, 2026; Accepted: April 19, 2026
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Abstract

This study investigates the integration of AI chatbots in Home Economics instruction in secondary schools, focusing on teaching practices, student perceptions, and learning outcomes within a rural Philippine context. Anchored on the Technological Pedagogical Content Knowledge (TPACK) framework and an Input-Process-Output model, the research examines how AI chatbot integration influences skill acquisition and instructional effectiveness. A descriptive-comparative research design was employed, involving approximately 30–50 teachers and 200–300 students from public secondary schools in Solano, Nueva Vizcaya. Data were collected through validated survey questionnaires, perception scales, and performance-based assessments, and analyzed using descriptive and inferential statistics, including independent samples t-tests and non-parametric equivalents. Findings reveal increased student engagement and frequency of AI chatbot use, while teacher integration remained limited. Both teachers and students demonstrated improved perceptions after exposure, with students consistently showing high acceptance. Learning outcomes improved in both groups; however, students exposed to AI chatbot-supported instruction achieved significantly higher gains and more consistent performance, with a large effect size. Challenges identified include issues in information accuracy, internet connectivity, teacher readiness, cognitive overload, and academic integrity. Despite these constraints, AI chatbot integration proved effective in enhancing learning outcomes when complemented with appropriate pedagogical strategies. The study concludes that AI chatbots are valuable supplementary tools in Home Economics education, supporting personalized learning and instructional improvement. It recommends strengthening teacher training, infrastructure, and institutional policies to ensure effective and ethical implementation. This study aligns with SDG 4 (Quality Education) by promoting innovative, technology-enhanced learning, and SDG 9 (Industry, Innovation and Infrastructure) through the integration of emerging technologies in education. Its sustainability impact lies in improving educational practices, enhancing digital competencies, and supporting equitable access to quality instruction in rural contexts.

Keywords: AI Chatbot Integration; Home Economics Education; Learning Outcomes; Rural Education; Student Perceptions; Teacher Perceptions; TPACK Framework

1. Introduction

This study examines the integration of AI chatbots in Home Economics instruction in secondary schools, focusing on their impact on teaching practices, student perceptions, and learning outcomes. As education increasingly adopts digital innovations, AI chatbots offer opportunities to enhance lesson planning, engagement, and personalized learning. However, their application in practical subjects such as Home Economics remains underexplored, particularly in rural Philippine contexts. Guided by the Technological Pedagogical Content Knowledge (TPACK) framework, this research investigates how AI chatbot integration influences students' acquisition of Home Economics skills and informs instructional development.

1.1 AI Chatbot Integration in Home Economics Instruction for Secondary Students

Home Economics education develops essential life skills such as food preparation, budgeting, and family management, contributing to students' independence and problem-solving abilities (Azonuche, 2020; Pendergast et al., 2013). Despite its importance, instruction often relies on traditional demonstration and hands-on approaches that may not fully address diverse learning needs. The rise of artificial intelligence (AI), particularly chatbots, provides new opportunities to enhance instruction through personalized feedback, interactive learning, and real-time support (Abdallah et al., 2024; Gupta, 2024; Cheng, 2023; Putri & Sain, 2025; Xu et al., 2024). In the Philippines, only 32% of public secondary teachers have integrated technology into instruction, and AI chatbot use in Home Economics remains largely undocumented (Pecasion et al., 2023). The Department of Education promotes digital transformation to enhance critical thinking and problem-solving skills (Pecasion et al., 2023; Alashwal, 2024; Correia et al., 2024). However, uncertainties remain regarding teacher readiness, student engagement, and the effectiveness of AI-supported instruction (Wu & Yu, 2023; Chichekian & Benteux, 2022; Kohler, 2024; Chan et al., 2023; Griszbacher, 2024).

1.2 Teacher and Student Perceptions of AI Chatbots in Home Economics Learning

Home Economics is recognized as a multidisciplinary field that supports sustainable personal and community development (Pendergast, 2021; Erjavek, 2021). It enhances practical competencies, confidence, and entrepreneurial skills (Kostanjevec, 2021; Smith & Garcia, 2018; Anyakoha & Lemchi, 2025). Effective teaching combines theoretical knowledge with hands-on learning, where demonstration methods significantly improve skill acquisition (McCloat & Caraher, 2016; Basheer et al., 2016; Adhikari et al., 2024). AI chatbots function as intelligent tutoring systems that support personalized learning, lesson planning, and student engagement (Hashem, 2024). They enhance feedback, collaboration, and self-directed learning but remain limited in fostering critical thinking and interpersonal skills (Bation, 2024; Ravelj et al., 2025). Teacher perceptions are generally positive, citing reduced workload and increased engagement, though concerns include autonomy, training needs, and cultural relevance (Akanzire, 2025; Belloula, 2025; Hadad, 2021; Pratiwi, 2024). Students show high familiarity with AI tools but demonstrate mixed confidence and concerns about reliability, ethics, and academic integrity (Ravelj et al., 2025; Davis, 2021; Johnson & Williams, 2022; Lin & Chen, 2024). Hands-on learning remains essential in Home Economics, fostering engagement, collaboration, and problem-solving (Nina et al., 2024; LEGO Education, 2024; Bogeholz, 2010). Thus, AI integration must complement rather than replace experiential learning.

1.3 AI Chatbot Use in Home Economics within Local, National, and Global Contexts

Globally, AI technologies are transforming education by enhancing instructional efficiency and engagement (Hashem, 2024). However, their effectiveness depends on context-specific implementation. In the Philippines, digital transformation faces challenges, particularly in rural areas where infrastructure limitations and resource constraints hinder technology adoption. Socioeconomic disparities further restrict access to digital tools, widening educational gaps. Despite these challenges, studies indicate that institutional support, training, and policy alignment can improve digital literacy and facilitate successful technology integration (A Case Study Exploring the Digital Literacy Gaps in a Rural Philippine School, 2024; Perceived Institutional Support and Its Effects on Student Perceptions of AI-Supported Learning, 2025).

1.4 TPACK Framework for AI Chatbot Integration in Home Economics Education

This study is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Koehler & Mishra, 2009), which emphasizes the integration of content, pedagogy, and technology. TPACK highlights that effective AI chatbot use requires teachers to align technological tools with pedagogical strategies and subject content. The framework includes interconnected domains such as Content Knowledge, Pedagogical Knowledge, and Technological Knowledge, culminating in Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006). In Home Economics, this integration ensures that AI chatbots support skill development, personalized learning, and instructional effectiveness while preserving hands-on practice. The study also adopts an Input-Process-Output model, examining AI chatbot integration, stakeholder perceptions, and challenges as inputs; comparative analysis and evaluation as processes; and student skill acquisition and instructional materials as outputs.

1.5 Research Gaps on AI Chatbots and Home Economics Skill Acquisition in Secondary Schools

Despite growing research on AI in education, limited studies focus on its application in practical subjects such as Home Economics, particularly at the secondary level. Existing literature provides mixed findings on learning outcomes, with some studies reporting improvements while others show no significant differences (Pham et al., 2025; The Impact of Artificial Intelligence Chatbots on Student Learning, 2024; Hajian et al., 2025). There is also insufficient empirical evidence on teacher and student perceptions in rural contexts, as well as challenges related to infrastructure, cultural relevance, and ethical concerns (Belloula, 2025; Hadad, 2021; Lin & Chen, 2024). This study addresses these gaps by examining AI chatbot integration in Home Economics instruction in secondary schools in Solano, Nueva Vizcaya, focusing on perceptions, learning outcomes, and instructional development.

1.6 Alignment of AI Chatbot Integration in Home Economics with Sustainable Development Goals (SDGs)

This study aligns with several Sustainable Development Goals. It supports SDG 4 – Quality Education by exploring innovative approaches to improve teaching and learning through AI integration. It contributes to SDG 8 – Decent Work and Economic Growth by enhancing skills such as entrepreneurship, financial literacy, and household management. It also aligns with SDG 9 – Industry, Innovation and Infrastructure by promoting the adoption of emerging technologies in education.

1.7 Multidisciplinary Sustainability Contributions of AI Chatbots in Home Economics Education

This research contributes to educational sustainability by improving instructional practices and learning outcomes through technology integration. It supports technological sustainability by examining effective and responsible use of AI tools in education. The study also promotes socio-economic sustainability by strengthening practical life skills that enhance employability and family well-being. In rural contexts, it contributes to community and institutional sustainability by addressing digital divides and informing policy, infrastructure, and professional development needs. Overall, the findings provide multidisciplinary insights that support sustainable innovation in education while preserving the practical and experiential nature of Home Economics learning.

2. Material and methods

2.1 Research Design

The study utilized a descriptive-comparative research design (Polit & Beck, 2007; Gale, 2011) to describe AI chatbot integration, stakeholder perceptions, and learning outcomes, while comparing students exposed to AI chatbot-supported instruction with those receiving traditional instruction. The descriptive component examined teacher perceptions of AI chatbot effectiveness, student perceptions as learning aids, and student performance in both theoretical and practical domains (Tourigny et al., 2011). The comparative component analyzed differences in learning outcomes and perceptions between groups using independent samples t-tests or non-parametric equivalents (Polit & Beck, 2007; Gale, 2011). Naturally occurring groups were used, where students were assigned to AI-supported or traditional instruction based on school implementation rather than randomization, reflecting real-world conditions (Polit & Beck, 2007; Tourigny et al., 2011). Both groups received the same content from the same teachers, differing only in AI chatbot integration. Data were collected through surveys, questionnaires, and performance assessments, and analyzed using descriptive and inferential statistics to ensure comprehensive evaluation (Gale, 2011).

2.2 Locale of the Study

The study was conducted in Solano, Nueva Vizcaya, Philippines, a major commercial and educational hub in the Cagayan Valley region (Philatlas, 2020). Located at approximately 16° 31' North and 121° 11' East, and about 214.45 kilometers from Metro Manila, the municipality has a population of around 65,287 (Solano, Nueva Vizcaya, 2005). Solano was selected due to its strong implementation of TVL-Home Economics programs, availability of qualified teachers and diverse student populations, and its representation of rural Philippine educational contexts facing both opportunities and challenges in technology integration (Philatlas, 2020; Department of Education, 2016). The presence of multiple secondary schools enabled comparative analysis across varying instructional environments, strengthening the applicability of findings.

2.3 Respondents of the Study

The respondents consisted of Home Economics teachers and secondary school students enrolled in TVL-Home Economics subjects (Grades 7–10) in public secondary schools in Solano, Nueva Vizcaya. Teachers were categorized into those integrating AI chatbots and those using traditional instruction, while students were grouped based on whether they experienced AI chatbot-supported instruction or not. This classification enabled comparison of perceptions and learning outcomes across stakeholder groups.

2.4 Sample and Sampling Procedure

The study employed stratified purposive sampling, dividing participants into relevant groups and selecting them based on characteristics aligned with the research objectives (Polit & Beck, 2007; Creswell & Creswell, 2018). The sample included approximately 30–50 teachers and 200–300 students across multiple schools. This size ensured adequate representation and statistical power, particularly for comparative analysis using t-tests or Mann–Whitney U tests, and allowed examination of variations across groups and contexts.

2.5 Research Instrument

Multiple quantitative instruments were used to ensure valid and reliable data collection (Polit & Beck, 2007; McLeod, 2025). A researcher-developed survey questionnaire measured teacher and student perceptions of AI chatbots across dimensions aligned with TPACK, learning effectiveness, challenges, and institutional support. It used a 5-point Likert scale to quantify responses and included optional open-ended items for deeper insights (McLeod, 2025). Content validity was established through expert review (Rato et al., 2015; Kalkbrenner, 2021), while reliability was assessed through pilot testing and Cronbach's Alpha analysis, with acceptable values above 0.70 (McLeod, 2025). A student learning outcomes assessment measured both cognitive and psychomotor competencies using multiple-choice, short-answer, and performance-based tasks (Polit & Beck, 2007). A Table of Specifications ensured alignment with curriculum standards and cognitive levels (Department of Education, 2016). Content and face validity were confirmed through expert evaluation, ensuring clarity, appropriateness, and alignment with learning objectives (Kalkbrenner, 2021).

2.6 Data Gathering Procedure

Data collection began with securing approval from school authorities and obtaining informed consent from teachers and students, including parental consent for minors. Instruments underwent validation and pilot testing before full implementation. Surveys were administered in person to ensure clarity and completeness of responses. Student performance assessments were conducted for both AI-supported and traditional instruction groups using validated tools aligned with curriculum standards. Data were reviewed for accuracy, securely stored, and encoded for analysis. Throughout the process, the researcher ensured adherence to ethical standards and consulted with a thesis adviser to maintain methodological rigor.

2.7 Data Analysis Techniques

Descriptive and inferential statistics were used to analyze perceptions and learning outcomes. Means and standard deviations summarized Likert-scale data, which were considered appropriate for large samples despite their ordinal nature (Sullivan & Artino, 2013). Normality was assessed using Shapiro–Wilk or Kolmogorov–Smirnov tests, while homogeneity of variance was evaluated using Levene's test (Mishra, 2019; Polit & Beck, 2007). Independent samples t-tests were applied for normally distributed data, while Mann–Whitney U tests were used for non-normal or ordinal data. Statistical significance was set at 0.05, and effect sizes were calculated using Cohen's d or rank-biserial correlation (Sullivan & Artino, 2013). Learning outcomes were further analyzed across groups and relevant characteristics to provide comprehensive interpretation.

2.8 Ethical Considerations

The study was approved by the Isabela State University Institutional Research Ethics Board (ISU-IREB Code 2026-01-216). Participation was voluntary, with informed consent obtained from all respondents and guardians for minors. Confidentiality and anonymity were ensured through secure data handling and restricted access. Participants were informed of their right to withdraw at any time without penalty. The study posed minimal risk and adhered to ethical principles of respect, beneficence, and justice, with no declared conflict of interest.

3. Results and Discussion

3.1 AI Chatbot Integration, Perceptions, and Learning Outcomes

3.1.1 Extent of AI Chatbot Integration in Home Economics Instruction

The findings show a substantial increase in student use of AI chatbots from pretest to post-test. Daily usage rose from 4.00% to 25.40%, while weekly usage increased from 24.30% to 37.60%. Conversely, occasional use decreased from 58.40% to 19.70%. In contrast, teacher integration remained minimal, with only 1.70% reporting daily use and the highest usage recorded at 2.30% monthly. Overall, students demonstrated a clear shift toward more frequent chatbot use, while teacher adoption remained limited. These results align with technology adoption patterns where student engagement often precedes teacher integration (Henderson et al., 2023; Gudmundsdottir & Hatlevik, 2018). However, this contradicts expectations that teachers lead technology adoption (Laurillard, 2012). The findings suggest that students are more comfortable with AI tools, possibly due to familiarity and accessibility, while teachers may require structured professional development to support effective integration.

3.1.2 Teacher Perceptions of AI Chatbots in Home Economics

The results indicate that teachers maintained generally high perceptions across all domains, with overall mean scores increasing from 3.62 to 3.91 after the intervention. Notable improvements were observed in Technological Knowledge Support, Pedagogical Content Knowledge Support, and Lesson Planning and Instruction Effectiveness. The highest post-test rating was in Challenges and Concerns, reaching a very high level, while Technological Pedagogical Knowledge slightly decreased from a high to moderate level. These findings are consistent with the TPACK framework, which suggests that teachers develop technological competencies unevenly across domains (Koehler & Mishra, 2009). The increased awareness of challenges aligns with findings that professional development enhances teachers' ability to recognize implementation issues (Akcaoglu and Lee, 2016). Improved perceptions of institutional support also reflect the role of organizational backing in technology adoption (Amasha et al., 2023). This suggests that while teachers became more confident, they also developed a more critical understanding of AI integration challenges.

3.1.3 Student Perceptions of AI Chatbots in Home Economics

Students consistently reported high perception levels across all domains, with overall mean scores improving from 3.71 to 3.99. The highest post-test rating was in Institutional Support, while the lowest pretest score was in Technological Pedagogical Knowledge. Gains were observed across all domains, particularly in Content Knowledge, Pedagogical Knowledge, and Technological Knowledge. These results support findings that students generally have positive attitudes toward AI-enhanced learning when tools are effectively integrated (Selwyn, 2019). Increased perceptions of institutional support align with research emphasizing its importance in technology adoption (Voogt and McKenney, 2016). The consistent improvements across domains also reflect the Technology Acceptance Model, where perceived usefulness and ease of use drive adoption (Davis, 1989). This indicates that students view AI chatbots as beneficial and supportive across learning dimensions.

3.1.4 Differences in Teacher and Student Perceptions

The results show minimal differences between teachers and students, with only a few statistically significant variations. At pretest, a difference was observed in Technological Knowledge Support, with students reporting higher perceptions. At post-test, differences emerged in Technological Pedagogical Knowledge Support and Institutional Support, favoring students, and in Challenges and Concerns, favoring teachers. Overall, perception differences were small, indicating general agreement between groups. These findings align with research showing that teachers tend to have greater awareness of implementation challenges than students (Kim and Komm, 2016). Students' higher perceptions of institutional support may reflect their reduced responsibility for instructional design. The narrowing of differences after intervention supports findings that stakeholder perceptions converge over time with structured exposure to technology (Gough, 2020). This suggests a balanced perspective where both groups recognize benefits, but teachers maintain a more critical view of limitations.

3.1.5 Learning Outcomes of Students Using AI Chatbots and Traditional Instruction

The results reveal that both groups improved, but the AI chatbot group achieved higher gains. The AI group increased from 11.26 to 23.52, reaching an Outstanding level, while the traditional group improved from 11.74 to 20.50, reaching a Very Satisfactory level. The AI group also showed lower variability, indicating more consistent outcomes. These findings are consistent with research showing that AI tutoring systems enhance learning outcomes through personalized feedback and practice (Gauthier et al., 2023; Dunlosky et al., 2013). Reduced variability aligns with findings that intelligent systems support equitable learning outcomes (Corbett and Anderson, 2001). The higher performance level reflects the effectiveness of AI tools in maintaining engagement and improving knowledge acquisition (VanLehn, 2011). This suggests that AI chatbots significantly enhance both performance and consistency in learning.

3.1.6 Differences in Learning Outcomes Between AI Chatbot and Traditional Groups

The results indicate a statistically significant difference in learning gains between groups. The AI chatbot group achieved a mean gain of 12.26 compared to 8.77 for the traditional group, with a large effect size of 0.756 and a highly significant p-value. These findings align with broader educational research indicating that AI-based instruction yields strong effects on learning (Hattie, 2008; Gauthier et al., 2023; Kulik and Fletcher, 2016). The large effect size confirms that AI chatbot integration provides a meaningful advantage over traditional instruction. The robustness of results supports the reliability of AI-assisted learning in improving academic performance.

3.2 Challenges Affecting Chatbot-Aided Instruction

The findings identify multiple challenges experienced by both students and teachers, including issues related to information accuracy, internet connectivity, output comprehensiveness, teacher readiness, and academic integrity. Respondents frequently reported that chatbot outputs were sometimes inaccurate or irrelevant, while limited internet access restricted usability. Some students experienced information overload, and teachers highlighted insufficient training and lack of institutional guidelines. These challenges are supported by research indicating that AI systems may produce inaccurate information and require critical evaluation (Dwivedi et al., 2023). Connectivity limitations reflect broader barriers in developing contexts (Siddiqui & Khan, 2023). The need for teacher training aligns with findings that effective technology integration depends on pedagogical preparation (Kumar & Bhatnagar, 2023). Concerns about academic integrity also support the need for clear institutional policies. Overall, these findings emphasize that successful AI integration requires both technical infrastructure and pedagogical support.

3.3 Overall Implications of AI Chatbot Integration

The results demonstrate that AI chatbot integration positively influences student engagement, perception, and learning outcomes, while also revealing implementation challenges. Students showed higher adoption and consistently positive perceptions, while teachers exhibited cautious but improving attitudes. Significant gains in learning outcomes highlight the effectiveness of AI-supported instruction, although challenges such as infrastructure and training must be addressed. These findings suggest that AI chatbots can serve as effective instructional tools when properly integrated, supported by institutional policies, and complemented by teacher training. The balance between benefits and challenges highlights the importance of strategic implementation to maximize educational impact.

4. Conclusion & Recommendations

The study demonstrates that AI chatbot integration in Home Economics instruction resulted in increased student usage, improved teacher and student perceptions, and significantly higher learning outcomes compared to traditional instruction. Students showed greater adaptability and engagement, while teachers exhibited improved competence and critical awareness across TPACK domains, despite limited adoption levels. Perceptions between teachers and students were largely aligned, with only minor differences, indicating broad acceptance of AI tools. Identified challenges—including information accuracy, connectivity, cognitive overload, teacher readiness, and academic integrity—were evident but manageable. Overall, AI chatbot-assisted instruction produced superior and more consistent learning gains, confirming its effectiveness even within a rural educational context.

It is recommended that educators integrate AI chatbots as complementary tools to support instruction while maintaining hands-on learning, and strengthen students' critical evaluation skills when using AI-generated information. Schools should provide continuous professional development, improve technological infrastructure, and establish clear policies on AI use and academic integrity. Curriculum developers and policymakers should design AI-integrated instructional materials, support teacher training, and ensure equitable access to technology. These actions should focus on sustaining effective implementation and maximizing the benefits of AI chatbot integration in Home Economics education.

The study was limited to a specific rural secondary school context with a defined sample of teachers and students, which may affect generalizability to other settings. Variations in infrastructure, teacher readiness, and student access to technology may influence outcomes in different contexts. Additionally, the study focused on current AI chatbot tools and a specific timeframe of implementation, which may not reflect long-term effects or future technological developments.

Compliance with ethical standards

The authors conducted the study in accordance with established ethical standards for research involving human participants. Ethical approval was obtained from the Isabela State University Institutional Research Ethics Board (ISU-IREB Code 2026-01-216). Participation was voluntary, and informed consent was secured from all respondents, including parental or guardian consent for minors. The authors ensured confidentiality and anonymity through secure data handling and restricted access, and participants were informed of their right to withdraw at any time without penalty. The study adhered to the ethical principles of respect for persons, beneficence, and justice, and no conflict of interest was declared.

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