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PERCEIVED USEFULNESS AND EFFECTIVENESS OF AI TOOLS AND STUDENTS' LEARNING OUTCOMES IN SCIENCE HIGH SCHOOL

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ABSTRACT

Artificial intelligence (AI) tools are increasingly used by secondary students, yet localized evidence is needed to understand how students perceive their usefulness and effectiveness in relation to learning outcomes. This study determined the association between perceived usefulness and perceived effectiveness of AI tools and students perceived learning outcomes in knowledge, skills, and values among Grade 9 and Grade 10 students in selected public science high schools in the Division of Taguig City and Pateros, Philippines. A quantitative, descriptive, cross-sectional, non-experimental design was used. A researcher-developed questionnaire was administered to 290 students selected through stratified random sampling with proportional allocation. After screening, one persistent multivariate outlier was removed, leaving 289 cases for analysis. Descriptive statistics and multivariate analysis of variance (MANOVA) were employed, with Pillai's Trace used because the homogeneity of covariance matrices assumption was violated. ChatGPT received the highest net agreement ratings for usefulness (94.12%) and perceived effect (88.58%), followed by Grammarly. Perceived learning outcomes were positive across all three domains, with knowledge receiving the highest net agreement rating (88.93%). MANOVA indicated significant multivariate differences associated with perceived effectiveness and perceived usefulness, and a significant interaction between the two perceptions. Students who simultaneously perceived AI tools as highly useful and highly effective reported the highest perceived learning outcomes. The findings support localized AI educational programs that integrate tool knowledge, practical skills, critical evaluation, and ethical responsibility rather than treating AI access as sufficient for learning.

Keywords: Artificial intelligence; Perceived usefulness; Perceived effectiveness; Learning outcomes; Localized policy; AI usage.

1 INTRODUCTION

Artificial intelligence (AI) is becoming an increasingly visible component of teaching and learning. AI-supported systems can provide explanations, feedback, personalized learning support, and assistance with academic tasks. Reviews of AI in education describe opportunities for individualized instruction, intelligent tutoring, adaptive learning, and improved access to learning resources. Generative AI has expanded these possibilities by allowing students to interact with

systems that can explain concepts, reorganize information, generate examples, and support writing and problem solving.

At the same time, AI use creates educational concerns. Students may accept AI-generated information without adequate verification, become overly dependent on automated solutions, or use generative systems in ways that conflict with academic integrity. Ethical use therefore requires more than technical access. Students need to understand the capabilities and limitations of AI, apply tools appropriately, evaluate outputs, and exercise judgment regarding responsible academic use.

These issues are particularly relevant in the Philippine basic education context. The Department of Education has recognized the potential of digital technologies and AI to support instruction, engagement, critical thinking, scientific inquiry, digital literacy, and positive learning outcomes. However, local studies also identify concerns related to technological readiness, teacher preparedness, responsible use, and emerging AI dependency among Filipino learners. Evidence specific to public science high schools remains limited, particularly evidence that examines students' perceptions of AI tools in relation to knowledge, skills, and values simultaneously.

The present study addresses this gap by examining four AI tools commonly used for academic purposes—ChatGPT, Photomath, QuillBot, and Grammarly—and determining how students' perceived usefulness and perceived effectiveness relate to their perceived learning outcomes. Perceived usefulness is grounded in the Technology Acceptance Model (TAM), while perceived effectiveness is conceptually informed by performance and effort expectations in the Unified Theory of Acceptance and Use of Technology (UTAUT). The learning-outcome dimensions of knowledge, skills, and values are informed by the AI literacy perspective, which emphasizes understanding AI, using it appropriately, and making responsible judgments about its use.

The study specifically aimed to: (1) describe the respondents' profile and AI-use patterns; (2) assess the perceived usefulness and effectiveness of ChatGPT, Photomath, QuillBot, and Grammarly; (3) determine students' perceived learning outcomes in knowledge, skills, and values; (4) determine whether assessments of AI-tool usage differed according to selected demographic characteristics; and (5) determine whether perceived effectiveness and perceived usefulness were associated with multivariate differences in learning outcomes and whether an interaction existed between the two perceptions. Because the design was cross-sectional and non-experimental, the study interprets the findings as associations and group differences rather than causal effects.

2 MATERIAL AND METHODS

2.1 Research Design and Setting

The study used a quantitative, descriptive, cross-sectional, non-experimental research design. It was conducted among Grade 9 and Grade 10 students in three selected public science high schools in the Division of Taguig City and Pateros. The selected schools were Taguig Science High School (TAGSCI), Sen. Renato Cayetano Memorial Science and Technology High School (SRCC), and Makati Science High School (MAKSCI). The population comprised 1,189 students. The setting was selected because the schools emphasize science, technology, research, and innovation and therefore provide a relevant context for examining AI-supported learning.

2.2 Participants and Sampling

A sample of 290 students was determined using a priori power analysis for MANOVA, with a medium multivariate effect assumption, $\alpha = 0.05$, desired power of 0.80, and three dependent variables. The sample achieved an estimated statistical power of approximately 0.99. Stratified random sampling with proportional allocation was used so that each school and grade level was represented according to its population proportion. Student lists served as the sampling frame, and respondents were randomly selected within strata.

Table 1: Profile of analyzed respondents (N = 289)

Characteristic	N	%
Age 13	25	8.65
Age 14	148	51.21
Age 15	115	39.79
Age 16	1	0.35
Male	119	41.18
Female	170	58.82
Grade 9	135	46.71
Grade 10	154	53.29
Total analyzed sample	289	100.00

2.3 Instrument

The researcher-developed questionnaire was based on the reviewed literature and the study's theoretical framework. It contained three parts. Part I gathered age, sex, grade level, and frequency of use. Part II measured perceived usefulness and perceived effectiveness of ChatGPT, Photomath, QuillBot, and Grammarly. Part III measured perceived learning outcomes in knowledge, skills, and values. Items in Parts II and III used a five-point Likert scale from 5 (strongly agree) to 1 (strongly disagree). Perceived effectiveness reflected accuracy, reliability, clarity, and academic support; perceived usefulness reflected learning performance, understanding, productivity, and task completion; knowledge referred to understanding AI tools and their academic purposes; skills referred to the ability to apply AI tools in academic tasks; and values referred to ethical and responsible AI use, including academic integrity.

Content validity was established through expert review. The instrument was then pilot tested with nine respondents. Cronbach's alpha coefficients indicated acceptable to excellent internal consistency: effectiveness $\alpha = 0.908$, usefulness $\alpha = 0.880$, values $\alpha = 0.877$, skills $\alpha = 0.847$, and knowledge $\alpha = 0.822$.

2.4 Data Collection and Ethical Considerations

Data were collected through Google Forms after respondents were informed about the purpose and procedures of the study. Informed consent was obtained, and confidentiality of participant information was maintained. Because the participants were minors, the study also used parent/guardian consent documentation. The thesis records document ethical clearance and institutional permissions for data collection. Responses were checked for completeness, encoded, and prepared for analysis.

2.5 Data Analysis

Frequency and percentage were used to summarize respondent characteristics and AI-use patterns. Net agreement ratings (NAR) were used to summarize positive, negative, and neutral perceptions. Composite mean scores were computed for the effectiveness, usefulness, knowledge, skills, and values constructs. For inferential analysis, perceived effectiveness and perceived usefulness were categorized into low, moderate, and high levels using the observed score groupings in the original study.

MANOVA was selected because the study examined multiple related dependent variables—knowledge, skills, and values—simultaneously. Before analysis, the data were screened for normality, outliers, and covariance homogeneity. The 164th response was identified as a persistent multivariate outlier across the dependent variables and was removed; the analyzed sample therefore decreased from 290 to 289. After removal, skewness values were 0.06 for knowledge, −0.38 for skills, and −0.39 for values, while kurtosis values were approximately −0.64, 0.45, and 0.66, respectively. Box's M test indicated violation of the homogeneity of covariance matrices assumption; consequently, Pillai's Trace was used as the more robust multivariate statistic. Statistical decisions used $\alpha = 0.05$.

3 RESULTS

3.1 Perceived Usefulness and Effectiveness of AI Tools

ChatGPT received the strongest positive assessment among the four tools. Its net agreement rating was 94.12% for perceived usefulness and 88.58% for perceived effectiveness. Grammarly was also positively assessed, with NAR values of 78.20% for usefulness and 75.43% for perceived effectiveness. Photomath and QuillBot showed more mixed assessments, with larger neutral proportions and lower positive NAR values.

Table 2: Net agreement ratings for perceived usefulness and perceived effect

AI tool	Usefulness NAR	Effectiveness NAR	Neutral usefulness	Neutral effect
ChatGPT	94.12%	88.58%	5.88%	11.42%
Photomath	41.52%	27.34%	47.40%	48.44%
QuillBot	35.29%	49.48%	52.25%	42.21%
Grammarly	78.20%	75.43%	17.65%	21.11%

3.2 Perceived Learning Outcomes

Respondents reported positive perceived contributions of AI tools across knowledge, skills, and values. Knowledge obtained the highest NAR at 88.93%, followed by values at 78.55% and skills at 77.85%. Disagreement was minimal across the three domains, while neutral responses were more pronounced for skills and values.

Table 3: Net agreement ratings for perceived learning outcomes

Learning outcome	NAR	Agree	Disagree	Neutral
Knowledge	88.93%	88.93%	0.00%	11.07%
Skills	77.85%	78.55%	0.69%	20.76%
Values	78.55%	79.58%	1.04%	19.38%

3.3 Differences According to Demographic Profile

Three-way factorial MANOVA showed no statistically significant multivariate differences in AI-tool assessments according to age, sex, or grade level. Age yielded Pillai's Trace = 0.009, F = 0.420, p = 0.866; sex yielded Pillai's Trace = 0.002, F = 0.301, p = 0.740; and grade level yielded Pillai's Trace = 0.005, F = 0.689, p = 0.503. The two-way interactions were also nonsignificant: age × sex, p = 0.332; age × grade level, p = 0.474; and sex × grade level, p = 0.491. The three-way interaction was likewise nonsignificant, p = 0.161.

Table 4: Multivariate differences in AI-tool assessment by respondent profile

Profile effect	Pillai's Trace	F	p
Age	0.009	0.420	0.866
Sex	0.002	0.301	0.740
Grade level	0.005	0.689	0.503
Age × Sex	0.016	1.150	0.332
Age × Grade	0.005	0.748	0.474
Sex × Grade	0.005	0.713	0.491
Age × Sex × Grade	0.013	1.839	0.161

3.4 Multivariate Relationship Between Perceived Effectiveness, Usefulness, and Learning Outcomes

The principal MANOVA showed statistically significant multivariate effects for perceived effectiveness and perceived usefulness on the combined learning-outcome variables of knowledge, skills, and values. The null hypothesis of no multivariate effect was therefore rejected for both factors. The analysis also identified a statistically significant interaction between perceived effectiveness and perceived usefulness. Estimated marginal means and profile plots indicated that students who simultaneously perceived AI tools as highly effective and highly useful reported the highest levels of perceived learning outcomes.

These findings indicate that usefulness and effectiveness should not be treated as isolated perceptions. A tool may be considered helpful, but the perceived contribution to learning is strongest when students also regard the tool as effective for accomplishing academic tasks. The result is consistent with TAM and UTAUT, which emphasize perceived usefulness and performance-related expectations in technology acceptance.

4 DISCUSSION

The strong assessment of ChatGPT suggests that students value AI tools that can support a broad range of academic activities. ChatGPT's ability to explain concepts, provide examples, assist with writing, and respond interactively may help explain its comparatively high ratings. Grammarly was also positively assessed, consistent with the role of AI writing-support tools in improving language accuracy and providing immediate feedback. The lower and more neutral ratings for Photomath and QuillBot may reflect their more task-specific functions rather than an objective judgment that they are inferior tools. The results therefore support selecting AI tools according to instructional purpose rather than adopting a single tool for all learning tasks.

The highest perceived learning outcome was knowledge. This pattern is consistent with literature describing AI systems as sources of cognitive scaffolding, explanation, information access, and personalized support. Students may readily recognize AI's contribution when it clarifies information or provides an explanation. However, the lower NAR values for skills and values are educationally important. Accessing an explanation does not necessarily mean that a learner can independently apply the concept, solve a new problem, or make an ethical decision about AI use.

The findings regarding skills and values reinforce the need for guided use. AI can support writing, problem solving, self-regulated learning, and analytical activities when students actively engage with feedback and use AI as a scaffold rather than a substitute for thinking. Conversely, overreliance may reduce independent problem solving and deeper cognitive engagement. Classroom activities should therefore require students to explain their reasoning, verify AI-generated claims, revise outputs, and complete selected tasks without AI assistance.

The positive multivariate effects associated with perceived effectiveness and usefulness provide empirical support for combining technology-acceptance perspectives with AI literacy. TAM explains why students may value a technology when it improves performance or productivity, while UTAUT provides a complementary account through performance and effort expectations. The AI literacy framework extends this perspective by emphasizing that meaningful engagement requires knowledge of AI, the ability to use it, and responsible judgment about its outputs and consequences.

The significant interaction between perceived effectiveness and perceived usefulness has a direct implication for educational program design. Providing access to AI tools alone may not produce the desired learning experience. Students need structured opportunities to use tools for clearly defined purposes and to recognize when a tool is appropriate, useful, and sufficiently reliable for the task. The strongest perceived learning outcomes among students who rated AI as both highly effective and highly useful suggest that instructional design should attend to both dimensions simultaneously.

The study also found no significant multivariate differences in AI-tool assessments according to age, sex, grade level, or their interactions. This suggests that school-wide guidance may be feasible across Grade 9 and Grade 10 rather than creating fundamentally different AI policies solely by demographic group. Nevertheless, instructional differentiation should be based on students' actual AI literacy, proficiency, and academic needs. A common policy can establish expectations for verification, disclosure of AI assistance, academic integrity, and responsible use, while classroom tasks can be adjusted to learners' competencies.

4.1 Implications for Educational Program Design

The findings support a localized AI literacy approach built around three integrated domains: understanding, application, and responsibility. First, students should learn what AI tools can and cannot do, including the possibility of inaccurate or misleading outputs. Second, students should practice using AI for authentic academic and science-related tasks,

including prompting, evaluating, revising, and integrating information. Third, students should explicitly consider academic integrity, attribution, privacy, bias, and the appropriate level of AI assistance.

A practical classroom cycle may therefore involve: (1) learning the capability and limitation of an AI tool; (2) using the tool to investigate or solve a science-related task; (3) verifying the output against credible sources; (4) explaining or revising the AI-generated response independently; and (5) reflecting on the ethical implications of the AI-assisted task. Such activities shift AI use from answer generation toward supported inquiry and critical learning.

Schools should also provide continuing professional development for teachers. Teacher training should focus not merely on how to operate AI tools but on how to design pedagogically sound AI-supported activities, establish acceptable-use boundaries, require verification, and assess student reasoning and originality. The goal should be responsible integration rather than unrestricted access.

4.2 Limitations

The study has several limitations. First, the data were self-reported and therefore represent students' perceptions rather than direct measures of learning performance or observed AI use. Second, the cross-sectional design does not establish causal relationships or changes over time. Third, the study focused on selected public science high schools in the Division of Taguig City and Pateros; findings may not generalize to other school types or geographic settings. Fourth, the study examined four AI tools and therefore does not represent the full range of AI applications available to students. Finally, the removal of one persistent multivariate outlier reduced the analyzed sample from 290 to 289, although the remaining sample retained high statistical power.

5 CONCLUSION

Students in the selected public science high schools generally perceived AI tools positively and reported positive contributions to their learning outcomes. ChatGPT received the highest ratings for usefulness and perceived effectiveness, while knowledge obtained the highest perceived learning-outcome rating. The multivariate findings indicate significant differences associated with perceived effectiveness and perceived usefulness, as well as a significant interaction between the two. Thus, students who viewed AI tools as both highly useful and highly effective reported the strongest perceived learning outcomes.

The results do not establish that AI tools caused improvements in learning. Rather, they show that students' perceptions of AI tools are associated with differences in their perceived knowledge, skills, and values. The findings support an educational approach in which AI is treated as a guided learning resource and where access is accompanied by AI literacy, critical evaluation, practical application, and ethical responsibility. Localized policies should therefore integrate knowledge, skills, and values and should guide teachers and students toward purposeful, verifiable, and responsible AI use.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The author declares no financial or non-financial conflict of interest related to this study.

Statement of ethical approval

Ethical clearance and institutional permission were obtained as documented in the underlying thesis.

Statement of informed consent

Participants were informed of the study's purpose and procedures, informed consent was obtained, parent/guardian consent documentation was used for minor participants, and respondent information was treated confidentially. Participation was voluntary.

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