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Changes in Students' Perceptions and Technology Acceptance in Science Education: Implementing Canva in the Context of the Digital Divide

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Abstract

This study examines changes in students' perceptions and technology acceptance in science education following the implementation of Canva in a school characterized by limited digital access. Grounded in the TAM, the research positions perception as a mediating construct linking digital media use to learning experience quality within a digital divide context. A descriptive pre–post survey design was employed involving 41 seventh and eighth-grade students at a public junior secondary school. Data were collected using a Likert-scale questionnaire administered before and after the integration of Canva into science instruction. Descriptive statistical analysis was conducted to compare mean scores across the two measurement phases. The findings indicate a substantial positive shift in students' perceptions after the implementation of Canva, particularly in perceived usefulness, perceived understanding of abstract concepts, and affective engagement. These results suggest that exposure to structured visual and multimodal learning materials may enhance students' acceptance of educational technology, especially in contexts where prior access to digital tools is limited. The study contributes theoretically by extending discussions on perception and technology acceptance within underrepresented educational settings affected by the digital divide. Methodologically, it demonstrates the relevance of pre–post descriptive approaches for capturing perceptual shifts in small-scale contexts. However, the study is limited by its reliance on self-reported data and the absence of inferential statistical testing. Future research is recommended to employ longitudinal or quasi-experimental designs and to integrate measures of academic achievement to better understand the long-term impact of digital media implementation in science education.

Keywords: Canva; Digital Divide; Science Education; Students' Perceptions; Technology Acceptance.

INTRODUCTION

The rapid advancement of information and communication technology (ICT) in the era of the Industrial Revolution 4.0 and the transition toward Society 5.0 have significantly transformed educational practices. Learning is no longer characterized by one-way transmission of knowledge; instead, it increasingly emphasizes interactivity, multimodal engagement, and digital integration. In this context, technology has shifted from being a supplementary tool to becoming an integral component of instructional design and classroom practice. Empirical evidence demonstrates that the incorporation of digital resources transforms pedagogical approaches, increases instructional adaptability, and fosters more student-cantered learning environments (Muhaimin et al., 2020; Halili & Sulaiman, 2021). As students are now immersed in visual and digital cultures, teachers are required to develop innovative and engaging learning media that foster motivation, conceptual understanding, and meaningful participation. This demand is particularly relevant in science education, where abstract concepts often require visual representation and interactive explanation (Rifa'I et al., 2024).

Canva is one digital platform that has gained significant attention in the context of education. It is an online graphic design application that allows users to create presentations, infographics, posters, animated videos, and other visual learning materials through an intuitive template-based interface. The accessibility and ease of use are in line with contemporary pedagogical needs for flexible and visually rich learning media (Darwis et al., 2024). The research has shown that Canva facilitates the development of structured and aesthetically appealing learning content while allowing integration with various digital platforms (Saputra et al., 2022; Hidayati, 2023). These features position Canva as a practical tool to support interactive and media-rich learning environments, particularly in classrooms undergoing technological transition (Wulandari & Mudinillah, 2022; Siswanjaya, 2021).

Growing empirical studies highlight the pedagogical potential of Canva at various levels of education and fields of study. Canva-based learning media development and validation have demonstrated strong feasibility and alignment with learning models such as problem-based learning (Dalimunthe & Reinita, 2022). Moreover, Canva-based media has been proven to increase student interest in learning, visual-spatial engagement, and academic achievement (Bustanil et al., 2019; Nugraha et al., 2023; Wahyuni et al., 2022). For language learning, using Canva has supported student participation and improved project-based outcomes (Aluintany & Bektiningsih, 2024; Nyoman, 2023; Nurhidayat, 2021), while in religious and thematic subjects, Canva has increased student interactivity and learning motivation (Nabillah & Tanjung, 2023; Septiani & Setiawan, 2024).

From a theoretical perspective, the effectiveness of visually rich platforms such as Canva can also be understood through the lens of media richness theory, which posits that communication effectiveness increases when media provide multiple cues and immediate feedback. Consequently, interactive visual media offer substantial potential for facilitating conceptual understanding, particularly in science education, where diagrams, models, and visual representations play a critical role in clarifying abstract phenomena. Collectively, these findings suggest that Canva is not merely a design tool but a pedagogically relevant medium capable of influencing students' perceptions, engagement, and technology acceptance, an issue that becomes even more significant within contexts marked by digital disparities (Fauzi et al., 2020).

However, the pedagogical effectiveness of Canva cannot be separated from how students perceive and interpret its use in the classroom. Student perception constitutes a central psych pedagogical variable because it shapes engagement, motivation, and cognitive processing during learning activities. Positive perceptions of digital media are associated with higher levels of participation, increased confidence, and stronger learning enthusiasm, whereas negative perceptions such as perceiving media as complex, irrelevant, or cognitively overwhelming can reduce engagement and hinder achievement (Nurhayati et al., 2022). Empirical studies indicate that visually structured and interactive media, including infographic-based and Canva-assisted learning, can foster learning interest and improve classroom involvement when students perceive them as meaningful and accessible (Ananka et al., 2024; Nugraha et al., 2023). Similarly, research on Canva integration across subject areas shows that students' behavioral responses and classroom participation are strongly influenced by how they experience the platform's usability and visual affordances (Ajani, 2025;

Hidayati, 2023; Warmansyah et al., 2023; Zefriyenni et al., 2022). These findings suggest that perception operates as a mediating factor between technological affordances and learning outcomes.

Although a growing number of studies have documented Canva's effectiveness in enhancing instructional quality, much of the existing literature emphasizes product development, teacher creativity, or measurable learning gains rather than examining students' perceptual shifts. For instance, Canva-based media development has been validated in thematic and elementary contexts (Dalimunthe & Reinita, 2022; Septiani & Setiawan, 2024), while professional development initiatives have focused on improving teachers' videography skills and classroom media production (Wijayanti et al., 2023; Maolida & Salsabila, 2021). Other investigations report improvements in learning achievement and instructional innovation (Bangkara et al., 2023; Putri, 2022), yet fewer studies explicitly analyse how students interpret and accept such technologies, particularly in science learning. This gap becomes more pronounced in junior secondary schools located in non-urban or structurally disadvantaged areas, where technological infrastructure and digital exposure differ substantially from urban settings.

In this regard, SMP Negeri Satu Atap 11 Tanjung Jabung Timur represents a context shaped by limited technological access and uneven digital resources. Research on digital integration in rural or less-developed regions demonstrates that disparities in infrastructure and teacher readiness significantly influence how educational technology is implemented and experienced (Muhaimin et al., 2020; Darmawan et al., 2024). Students' prior exposure to digital tools, frequency of technology use, and availability of supportive learning ecosystems may vary considerably, thereby shaping their expectations and perceptions of new platforms such as Canva. Such contextual differences are closely related to the broader issue of the digital divide, which highlights structural inequalities in access, skills, and opportunities to benefit from digital innovation (Jayanthi & Dinaseviani, 2022; Lestari et al., 2025). Beyond access alone, inequities in participation and cumulative advantage may further exacerbate differences in educational outcomes (Ross-Hellauer et al., 2022). Consequently, understanding student perception in remote contexts requires attention not only to the tool itself but also to structural and socio-digital conditions that frame its use.

The relationship between perception and technology use can be theoretically grounded in the Technology Acceptance Model (TAM), which posits that perceived usefulness and perceived ease of use determine attitudes toward technology and subsequent behavioural intentions. Within educational environments characterized by rapid technological transformation, students' acceptance of digital media is also influenced by their readiness to engage with Education 4.0 practices and their familiarity with digital ecosystems (Halili & Sulaiman, 2021). Moreover, media richness theory suggests that platforms offering multiple visual cues, structured templates, and interactive affordances are more likely to be perceived as effective and engaging. In science education, where abstract phenomena often require visualization, students who perceive Canva as intuitive and beneficial for conceptual clarification are more likely to develop positive attitudes, stronger engagement, and sustained participation. In this sense, perception functions as a bridging construct linking technological characteristics with cognitive and affective learning dimensions.

Therefore, examining how students from remote communities perceive Canva in science learning extends beyond evaluating instructional effectiveness. It contributes to a deeper theoretical understanding of how structural inequality, digital readiness, and contextual constraints shape technology acceptance and learning experiences. By situating perception within the intersection of educational technology and the digital divide, this study provides a more comprehensive framework for designing equitable and context-sensitive technology integration strategies in science education.

RESEARCH METHODS

Research Design

The research employed a descriptive quantitative methodology to ascertain and elucidate students' perceptions on utilizing Canva as a medium for science education. A survey was employed as the method. This methodology was selected to quantitatively assess perceptions and descriptively examine the responses. Data collection was executed with a Likert-type questionnaire distributed to students through Google Forms. Sugiyono (2017) defines a questionnaire as a form of data collecting that entails presenting respondents with a sequence of written inquiries for their responses.

Research Subjects

This research was undertaken during the even semester of the 2024/2025 academic year, specifically in May and June 2025. This study encompassed all seventh and eighth grade students at SMP Negeri Satu Atap 11 Tanjung Jabung Timur who engaged in scientific courses utilizing Canva as a learning medium. The total number of pupils in both classes was 41, rendering them all responders in this survey.

The employed sample technique was complete sampling. This method encompasses the entire population as the research sample due to its relatively small size and accessibility. Total sampling was selected to ensure that the data collected accurately represents the conditions of all pupils, hence removing bias in sample selection and enabling the research findings to reflect the perceptions of the entire population. This study employed total sampling to acquire a thorough understanding of the perceptions of all students engaged in learning with Canva.

Research Procedures

The systematic implementation and procedural transparency of this study were ensured through a series of structured stages. They were designed to capture changes in students' perceptions before and after the integration of Canva into science teaching. All the sequential procedures carried out in this study are summarised in Table 1.

Table 1. Research procedures

Stage	Procedure	Description
1	Preparation	Identification of research focus; development of a Likert-scale questionnaire via Google Forms; validation and feasibility checking of the instrument.
2	Pre-Intervention Data Collection	Administration of the questionnaire to capture students' perceptions under conventional teaching methods as baseline data.
3	Learning Implementation	Delivery of science instruction using Canva through structured and interactive visual presentations according to the lesson plan.
4	Post-Intervention Data Collection	Re-administration of the questionnaire to measure changes in students' perceptions after the intervention.
5	Data Processing	Calculation of mean scores for each indicator using Likert-scale analysis and comparison of pre- and post-intervention results.
6	Report Preparation	Compilation and interpretation of findings to present overall changes in students' perceptions.

Instruments, and Data Collection Techniques

The instrument employed a questionnaire constructed utilizing a Likert scale. According to Sugiyono (2017), a questionnaire is a form of data collecting that consists of a sequence of questions for respondents to answer. This study included a questionnaire of 10 items, divided into two primary categories: four statements pertaining to students' learning experiences prior to utilizing Canva and six statements addressing their experiences during learning with Canva. The latter category of items was further delineated into three dimensions: perceived usefulness (two statements), perceived

understanding (two statements), and perceived student attitudes (two statements). A Likert scale was utilized to assess student replies, in accordance with Widoyoko (2017), with four response options: Strongly Disagree (1), Disagree (2), Agree (3), Strongly Agree (4).

Data analysis technique

Data analysis methods involved calculating the average score for each statement before and during the intervention, then comparing the two results to identify trends in changes in student perceptions. The average findings were then categorised into Likert scale classifications according to the intervals defined by Ardhini and Isyawati (2019), which were 1.00–1.75 (Very Poor), 1.76–2.50 (Poor), 2.51–3.25 (Good), and 3.26–4.00 (Very Good). The technique was used to characterise changes in students' perceptions qualitatively without conducting statistical significance tests, thus allowing the research findings to be interpreted in the context of comparative trends rather than inferentially significant differences.

RESULTS AND DISCUSSION

The findings of this study indicate a clear improvement in students' perceptions of science learning after Canva was integrated as a learning medium. Before using Canva, students' perceptions of science learning were measured using a pre-intervention questionnaire. The initial measurement results showed an overall average score of only 1.67, which is categorized as very poor. At this stage, students perceive science learning as ineffective, boring, and difficult to apply in everyday life. For example, their ability to provide examples related to science material scored 1.78 (poor), while their ability to conduct experiments only scored 1.70 (very poor). In the affective aspect, the score was even lower, at 1.50, indicating a lack of enjoyment and motivation in participating in science learning. These scores were then compared with the results of the post-intervention questionnaire, which students completed after learning using Canva. The difference between pre-intervention and post-intervention scores served as the basis for understanding changes in students' perceptions after digital media was integrated into the learning process.

After Canva was introduced, student perceptions improved significantly. The overall average score rose to 3.39, which is considered excellent. Students strongly agreed that Canva increased the effectiveness of their learning (average 3.43) and improved their practical skills in science experiments (3.40). The platform's flexibility and accessibility were also highly valued (3.45), while its features such as visuals, text, and audio were considered most helpful in understanding abstract concepts, achieving a top score of 3.60. These results indicate that Canva provides not only functional support for content delivery but also cognitive scaffolding through multimodal representation. In addition to cognitive and psychomotor aspects, students' affective responses also showed positive changes. They reported increased enjoyment (3.30, very good) and enthusiasm (3.20, good) when teachers used Canva in classroom presentations. This suggests that Canva can create a more engaging and motivating learning environment, encouraging active participation and sustained interest in science.

The shift from very poor to very good perceptions underscores Canva's transformative impact on science learning. These results are consistent with Ningrum (2024), who found that college students' perceptions shifted from very poor (1.68) to very good (3.26) after using Canva. This consistency across educational levels suggests that Canva is not only effective for college students but also highly beneficial in the high school context.

Canva's effectiveness can be attributed to its design-oriented and multimodal features, which simplify the visualization of abstract concepts, enhance student creativity, and encourage independent exploration. This finding aligns with Wulandari and Mudinillah (2022), who argued that Canva fosters learning motivation through creative and interactive presentations. Similarly, Yundayani et al. (2019) emphasized its role in strengthening analytical skills, as visualization helps bridge the gap between abstract content and concrete understanding.

Overall, the findings demonstrate that the integration of Canva as a digital learning medium contributes meaningfully to the enhancement of science education. The results indicate improvements not only in students' cognitive understanding, particularly in visualizing abstract scientific concepts, but also in the development of psychomotor skills during practical activities and in affective engagement throughout the learning process. These outcomes are consistent with prior research emphasizing that students' acceptance of digital tools is closely linked to perceived usefulness and perceived ease of use, two central constructs of the TAM (Granić & Marangunić, 2019; Gil-Fernández, 2026). Empirical studies on Canva adoption further confirm that when students perceive the platform as intuitive and beneficial, their engagement and learning performance tend to increase (Putri, 2025; Utama et al., 2025).

Importantly, the positive impact observed in this study is particularly pronounced in schools located in areas characterized by limited technological access. In such contexts, where students are rarely exposed to digital learning media, Canva functions not merely as a supplementary tool but as a transformative learning resource. This finding aligns with longitudinal and contextual studies showing that exposure to well-designed digital platforms can exceed students' initial expectations and reshape their attitudes toward technology use in education (Raes & Depaepe, 2019; Tao et al., 2022). Thus, within the framework of the digital divide, the implementation of Canva appears to act as a catalyst for shifting students' perceptions and strengthening technology acceptance in science learning environments.

From a pedagogical perspective, these results underscore the strategic role of teachers in facilitating the meaningful integration of innovative digital platforms. Research has consistently shown that successful technology integration depends not only on the availability of tools but also on educators' willingness and capacity to incorporate them into instructional practice (Barkoczi et al., 2024; Khong et al., 2022). The present findings therefore highlight the need for professional support systems that enable teachers in remote or under-resourced schools to design interactive, context-sensitive learning experiences using accessible platforms such as Canva.

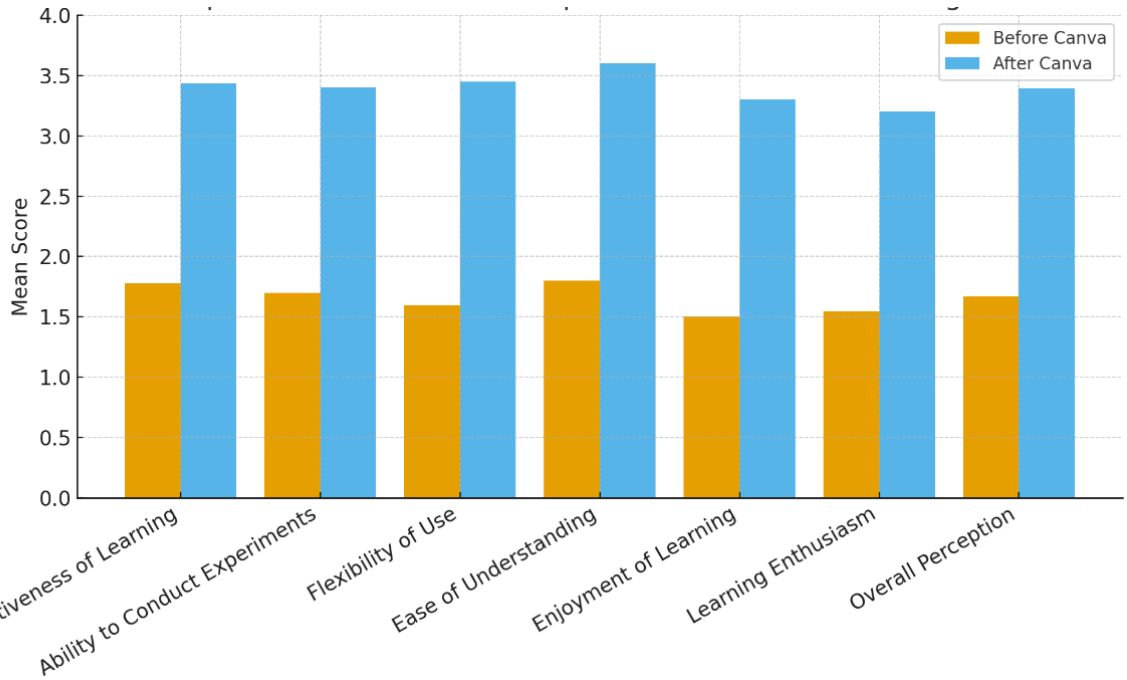

Figure 1. Perception comparison of students before and after using Canva

At the policy level, the implications extend beyond classroom practice. Strengthening institutional support for educational technology adoption, particularly in regions with limited digital infrastructure is essential to narrowing educational disparities. Systematic reviews of technology acceptance research emphasize that structural and contextual factors significantly influence sustained

technology integration in schools (Granić & Marangunić, 2019; Gil-Fernández, 2026). Consequently, policies aimed at expanding digital access, providing teacher training, and ensuring equitable technological resources are critical for reducing learning gaps and promoting equitable access to high-quality science education across diverse geographic contexts.

The present findings reveal a pattern of perceptual change that aligns with broader research documenting positive shifts in students' attitudes following exposure to interactive digital media. Systematic reviews of TAM applications in educational contexts indicate that initial engagement with user-friendly digital tools frequently enhances perceived usefulness and ease of use, which subsequently shape favourable attitudes toward learning technologies (Granić & Marangunić, 2019; Tang & Hsiao, 2023). Similarly, studies examining students' perspectives on emerging technologies highlight that positive perception is often influenced by prior digital experience and contextual readiness (Cao et al., 2023). However, unlike research conducted in higher education environments characterized by relatively high digital literacy, the present study was situated in junior high schools within areas of limited technological access. Consequently, the observed perceptual shift cannot be assumed to reflect identical psych pedagogical dynamics. In digitally constrained settings, changes in perception may partly derive from a novelty effect rather than exclusively from the intrinsic pedagogical qualities of Canva. This contextual sensitivity is supported by longitudinal investigations demonstrating that early enthusiasm toward digital platforms may exceed expectations but requires sustained exposure to confirm deeper attitudinal transformation (Raes & Depaepe, 2019; Wohlfart & Wagner, 2024). Therefore, the increase in positive perceptions should be interpreted cautiously and situated within the specific realities of the learning environment.

When compared with prior studies emphasizing Canva's effectiveness in enhancing science learning outcomes, an important analytical distinction emerges. Research on LMS and digital platform adoption has often linked technology use with measurable academic gains (Ilyassov, 2023; Santiana et al., 2024). However, systematic analyses of technology acceptance literature underscore that perceptual indicators and learning outcomes represent distinct, though related, constructs (Gil-Fernández, 2026; Shayan et al., 2023; Wulandari and Mudinillah's, 2022). The current study focuses specifically on perception and acceptance variables rather than direct achievement measures. While positive perceptions may serve as an early signal of successful implementation, they do not automatically confirm improved academic performance. This limitation is particularly relevant given that empirical studies integrating TAM with performance metrics typically employ multi-variable modeling or behavioral data to establish causal pathways (Mejía-Mancilla & Mejía-Trejo, 2024; Tao et al., 2022). Accordingly, the absence of direct learning outcome measurement should be recognized as a methodological boundary of this research.

From a theoretical standpoint, the increase in perceived usefulness and perceived ease of use observed in this study may be interpreted as an indication of strengthened technology acceptance, consistent with the core assumptions of TAM (Chabani & Askri, 2025; Granić & Marangunić, 2019). Nevertheless, contemporary extensions of TAM emphasize that genuine acceptance is more robustly demonstrated through behavioural intention and sustained usage patterns over time (Bhat et al., 2025; Mazrur, 2025). Multi-level analyses of learning management systems further suggest that stable adoption depends on contextual, institutional, and motivational factors beyond initial perception (Shayan et al., 2023). Because this study did not investigate long-term behavioural intention or actual usage continuity, its findings are more accurately interpreted as evidence of an initial attitudinal response to intervention rather than confirmation of enduring technology integration.

Moreover, comparisons with studies reporting improvements in academic performance through Canva-based or AI-supported digital media must be approached with methodological caution. Investigations into Canva adoption in both higher education and vocational contexts have demonstrated positive associations between perceived usefulness and applied outcomes (Putri, 2025; Utama et al., 2025). However, these studies often combine perceptual instruments with performance indicators or behavioural analytics. In contrast, the present research relies exclusively on Likert-scale perception data. Although favourable perceptions may reflect enhanced motivation, clarity, and enjoyment in science learning, they do not necessarily indicate deep conceptual mastery. Without triangulation

through cognitive assessments or observational data, the relationship between perception and learning quality remains indicative rather than conclusive.

Within the broader discourse on the digital divide, the findings suggest that students in technologically limited regions can respond enthusiastically to digital innovation when provided with accessible and intuitive tools. Research on technology integration in post-pandemic educational transitions emphasizes that contextual disparities significantly shape adoption trajectories (Khong et al., 2022; Wohlfart & Wagner, 2024). In such environments, minimal prior exposure may amplify the perceived impact of new platforms. This raises an essential forward-looking question: will these positive perceptions persist once Canva use becomes normalized rather than novel? Addressing this issue requires longitudinal and mixed-method designs capable of capturing attitudinal stability, behavioural continuity, and learning outcomes simultaneously. Only through such comprehensive inquiry can changes in perception be confidently interpreted as indicators of sustained transformation in science education within digitally divided contexts.

Theoretically, this study contributes to the expanding body of research on technology acceptance in education by positioning student perceptions as a mediating construct that connects the implementation of digital learning tools with the perceived quality of the learning experience. Within the framework of the TAM, perceptions of usefulness and ease of use are foundational determinants of attitude formation and behavioural intention (Granić & Marangunić, 2019; Chabani & Askri, 2025). Recent systematic reviews further emphasize that TAM-based studies increasingly recognize perception not merely as an outcome variable, but as a dynamic mediator shaped by contextual, institutional, and pedagogical factors (Gil-Fernández, 2026; Tang & Hsiao, 2023). By situating these constructs within junior high school science classrooms in non-urban areas, the present study extends prior applications of TAM that have predominantly focused on higher education settings, LMS platforms such as Canvas, or technologically advanced environments (Gao, 2024; Santiana et al., 2024; Ilyassov, 2023). In doing so, it contributes to a more context-sensitive understanding of technology acceptance, particularly within the structural constraints associated with the digital divide.

Moreover, the study complements recent investigations into teachers' and students' acceptance of emerging and AI-supported technologies, which highlight that contextual readiness and digital exposure significantly influence adoption trajectories (Barkoczi et al., 2024; Bhat et al., 2025). While previous TAM-based research has examined technology integration in Islamic education, smartphone-based learning, and AI-driven platforms (Mazrur, 2025; Mejía-Mancilla & Mejía-Trejo, 2024; Cao et al., 2023), relatively limited attention has been directed toward middle school contexts in geographically disadvantaged areas. By addressing this gap, the present findings reinforce the argument that technology acceptance must be interpreted within socio-educational ecosystems rather than as a universally transferable construct. In digitally marginalized settings, perception may function not only as a predictor of behavioural intention but also as an adaptive response to newly introduced learning opportunities.

Despite these theoretical contributions, several methodological limitations warrant explicit acknowledgment. First, the study employed a descriptive design without inferential statistical testing, limiting its ability to establish causal relationships among constructs. Contemporary TAM research increasingly relies on structural modelling, multi-level analysis, or longitudinal approaches to examine the stability of acceptance and its behavioural consequences (Shayan et al., 2023; Tao et al., 2022). Second, the relatively small sample size confined to a single school restricts external validity and generalizability. Longitudinal perspectives on technology integration have demonstrated that contextual diversity significantly shapes adoption sustainability (Wohlfart & Wagner, 2024; Raes & Depaepe, 2019). Third, measurement in this study focused exclusively on perceptual indicators without incorporating academic achievement data, behavioural observation, or usage analytics approaches that have been shown to strengthen explanatory robustness in digital learning research (Putri, 2025; Utama et al., 2025).

Taken together, these limitations suggest that the findings should be interpreted as context-bound insights rather than universal claims. Future research would benefit from quasi-experimental or longitudinal designs incorporating inferential statistical analysis, multi-source data triangulation, and performance-based measures. Integrating perceptual constructs with behavioural intention and actual usage data as recommended in contemporary TAM extensions would enhance both internal and external

validity (Gil-Fernández, 2026; Bhat et al., 2025). Such methodological strengthening is particularly critical in digitally divided regions, where the sustainability of positive perceptions and their translation into enduring improvements in science learning quality remain empirically open questions.

CONCLUSION

The study shows that the integration of Canva as a science learning medium correlates with a shift in student perceptions toward more positive outcomes in school contexts with limited technology access. This shift not only reflects an increased preference for digital visual media but also suggests that perception serves as a psych pedagogical variable bridging technology use and the quality of learning experiences. In the context of the digital divide, these findings strengthen the argument that technology acceptance in non-urban environments may have a stronger perceptual impact due to lower prior exposure to innovative media. Thus, this study makes a theoretical contribution by expanding the discourse on perceptions and acceptance of learning technology within the framework of the Technology Acceptance Model developed by Fred Davis, specifically at the junior secondary level in areas with limited digital infrastructure.

Methodologically, this study demonstrates that a descriptive pre-post survey design can be used as an initial approach to map changes in student perceptions of learning innovations. While simple, this approach effectively describes the dynamics of student responses contextually and provides an empirical basis for developing more complex follow-up research. The use of total sampling within a small population also allows for a comprehensive representation of the conditions of the schools studied.

However, several limitations should be noted. First, the analysis used was descriptive without inferential testing, so the findings are not intended to be broadly generalized. Second, this study focused solely on student perceptions without integrating learning outcome data, behavioral observations, or long-term measurements of the sustainability of Canva use. Third, the study's scope was limited to a single school, so variations in social, economic, and digital readiness contexts were not comparatively accommodated.

Based on these limitations, further research is recommended using quasi-experimental or longitudinal designs to more comprehensively examine the relationship between perceptions, learning engagement, and academic outcomes. Future studies should also involve cross-samples of schools with varying levels of digital readiness to analyse the influence of the digital divide more deeply. Furthermore, the integration of mixed methods approaches can provide a richer understanding of how digital media-based learning experiences shape the ongoing transformation of science learning.

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