Exploring Student Perceptions of Digital Tool Use in General Education through Factor Analysis

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ABSTRACT

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| **Aims:** This study seeks to investigate students' perspectives of digital tool utilization in General Education courses and to compare their experiences in onsite versus online learning environments. It aimed to establish the fundamental features of these perceptions and evaluate if disparities exist between modalities.**Study design:** Quantitative, cross-sectional, comparative research employing exploratory factor analysis and inferential statistics.**Place and Duration of Study:** A private higher education institution in the Philippines, conducted in the second semester of the 2024–2025 academic year.**Methodology:** A systematic 40-item survey was administered to 302 college students. Principal Axis Factoring with Varimax rotation was employed in Exploratory Factor Analysis (EFA) to ascertain fundamental dimensions. Cronbach's alpha was calculated to assess internal dependability. Descriptive data encapsulated student impressions for each element. Paired samples t-tests were employed to compare onsite and online experiences.**Results:** Three valid and reliable characteristics were identified: Digital Learning Support (α = 0.909), Engagement and Motivation (α = 0.928), and Access and Confidence (α = 0.834). Descriptive data indicated substantial concordance across all parameters, with Digital Learning Support receiving the highest rating in onsite environments. T-tests indicated that students saw digital technologies as much more beneficial in onsite learning (t = 19.74, p = 0.001), but engagement was marginally elevated in online classrooms (t = -2.23, p = 0.027). No notable change was detected in Access and Confidence (t = -1.01, p = 0.312).**Conclusion:** Students primarily maintained favorable opinions of the utilization of digital tools across both modes. Onsite environments were preferred for organized digital support, although online settings improved engagement. The results endorse the use of blended learning models that integrate the advantages of both in-person and online instruction. |

*Keywords: Student Perceptions, Digital Tools, General Education, Engagement, Academic Impact, Paired t-test, Exploratory Factor Analysis, Accessibility*

1. INTRODUCTION

Digital technology integration in education has grown to be a major worldwide trend that is changing how teachers present material and how students acquire knowledge. Globally, educational systems have adopted online platforms, interactive technologies, and digital resources to enhance instructional efficacy, learning outcomes, and student engagement (Chen et al., 2020; Ertem, 2021). This shift is supported by emerging research emphasizing that digital pedagogies, when implemented with institutional support, promote personalized learning, collaborative engagement, and knowledge retention (Tammets et al., 2022; Tang et al., 2023). The COVID-19 epidemic expedited this transition, necessitating institutions to implement adaptable, technology-based methods to maintain education amid disruptions (Dhawan, 2020). Thus, the utilization of digital resources has transitioned from an ancillary approach to a fundamental component of contemporary education, especially in higher learning.

In the Philippines, the Commission on Higher Education (CHED) has promoted flexible learning and the integration of educational technology via CHED Memorandum Orders and programs responding to the pandemic. This has prompted colleges and universities, including private institutions, to include learning management systems (LMS), video-based instruction, online examinations, and digital reading materials into many courses, particularly in General Education (GE) disciplines (CHED, 2020). The General Education subjects—such as Readings in Philippine History, The Contemporary World, and Mathematics in the Modern World—constitute essential academic experiences, and their delivery can profoundly affect student learning, retention, and motivation (Aldosemani, 2022). Aboagye et al. (2021) assert that General Education courses furnish the intellectual framework necessary for students to critically engage with academic and real-world issues, thereby necessitating the optimization of its delivery methods for accessibility and effectiveness. Similarly, Almusharraf and Khahro (2022) emphasized that effective delivery of general education content through digital formats can significantly influence learners’ cognitive and emotional engagement.

Digital tools are thought to enhance student engagement by rendering learning more dynamic, accessible, and individualized (Almarzooq et al., 2020). They can augment comprehension with multimedia information, promote engagement through gamified quizzes and forums, and facilitate autonomous learning using asynchronous resources. Furthermore, research has identified a favorable correlation between the utilization of educational technology and students' academic achievement and satisfaction (Bedenlier et al., 2020; Kintu et al., 2017). Martin and Bolliger (2018) underscored that digital engagement tactics, including video lectures, discussion boards, and online feedback mechanisms, directly enhance student satisfaction in blended contexts. More recent studies by Bower and Vlachopoulos (2023) and Chung et al. (2022) highlight that student engagement with digital tools also depends on usability, instructor feedback mechanisms, and system reliability. The efficacy of these technologies predominantly hinges on students' perceptions and interactions with them. If students experience disengagement, confusion, or overwhelm using digital platforms, the technologies may not achieve their intended advantages.

Notwithstanding these global and national advancements, there exists a paucity of empirical research within Philippine private schools that investigates students' opinions regarding the utilization of digital tools, specifically in the realm of General Education. The emphasis has predominantly been on online delivery logistics rather than on student experience and feedback (Alvarez, 2020). Furthermore, perceptions of involvement, accessibility, and academic advantage may differ based on the subject matter, student demographics, and the institution's digital infrastructure. Perception-based studies are significant as they provide insights into student satisfaction and the environmental aspects influencing the learning process (Lee, 2021). Recent literature emphasizes that learner perceptions are crucial for refining pedagogical frameworks and understanding emotional and cognitive barriers in both online and hybrid settings (Zhao et al., 2021; Rahman et al., 2023).

A particular private higher education school in the Philippines has implemented diverse digital technologies for instructing General Education subjects at the local level. In accordance with its BlendFlex learning model, the university has established a system facilitating both onsite and online education, wherein digital tools are not just adaptable but indispensable. This adaptable learning framework underscores the need of comprehending how students engage with and react to educational technologies in various learning contexts. Nonetheless, no official research has been conducted to assess students' perceptions of these tools on their engagement, usability, and academic influence. Comprehending student opinions is crucial as it offers insights into effective practices, ineffective ones, and the optimization of digital tools for instructional enhancement.

This study aims to address that deficiency by distributing a structured 40-item questionnaire to students participating in Readings in Philippine History, The Contemporary World, and Mathematics in the Modern World. The study employs Exploratory Factor Analysis (EFA) to discern the fundamental elements influencing students' evaluations across four dimensions: Engagement, Technology Acceptance, Academic Impact, and Accessibility. Descriptive statistics will be employed to assess the degree of student perception for each element. Furthermore, as all students engage in both onsite and online formats via a predetermined rotation, the study will employ paired samples t-tests to analyze student impressions across the two delivery modalities. The results are anticipated to inform faculty development, technological integration, and curriculum design initiatives inside the school.

2. methodology

2.1 Research Design

This research utilized a quantitative, exploratory, and comparative methodology to investigate student perspectives regarding the utilization of digital tools in General Education (GE) courses, specifically Readings in Philippine History, The Contemporary World, and Mathematics in the Modern World. The main objective was to discern the fundamental characteristics of these views through Exploratory Factor Analysis (EFA) and evaluate whether students' experiences vary between onsite and online learning modalities. A 40-item Likert-scale questionnaire, devised by a researcher, was employed to assess four principal dimensions: Engagement, Technology Acceptance, Academic Impact, and Accessibility. The questionnaire was administered once and featured concurrent evaluations for both onsite and online environments. Following the exploratory factor analysis (EFA), descriptive statistics were employed to encapsulate student responses for each factor, and paired samples t-tests were performed to contrast student perceptions across the two modalities. The statistical analyses were conducted using JAMOVI, a free and open-source software for quantitative research.

**2.2 Research Respondents**

The study focused on students who had finished the three designated General Education subjects, guaranteeing that all participants possessed direct experience with the integration of digital tools in both in-person and online settings. The participants were chosen using purposive sampling, concentrating on students currently enrolled in or who had recently finished these courses at a private higher education institution in Misamis Occidental.

Given that the questionnaire included 40 items, and considering EFA best practices which recommend a minimum of 5 to 10 respondents per item (Osborne & Costello, 2004), the ideal sample size ranged from 200 to 400 students. This range guarantees statistical sufficiency for dependable factor extraction and instrument validation. A conclusive sample within this range was deemed adequate and pragmatic to represent varied student perceptions within the institution's BlendFlex learning framework. Participation was optional, adhering to ethical guidelines that included informed permission and the anonymity of all responses.

**2.3 Instrument of the Study**

This study employed a researcher-created questionnaire to investigate student attitudes regarding the utilization of digital tools in General Education courses. The instrument originally consisted of 40 items, developed according to four conceptual areas discovered in the literature: Engagement, Technology Acceptance, Academic Impact, and Accessibility, with 10 items allocated to each domain. All items were evaluated using a 5-point Likert scale, with 1 denoting Strongly Disagree and 5 denoting Strongly Agree.

In accordance with the institutional BlendFlex delivery strategy, each item was administered twice to document students' experiences in both onsite and online learning modalities, facilitating a matched comparison of responses across different learning contexts.

The questionnaire was subjected to Exploratory Factor Analysis (EFA) utilizing Principal Axis Factoring with Varimax rotation through JAMOVI version 2.6.23 to delineate the underlying factor structure based on real student responses. Before factor extraction, the Kaiser-Meyer-Olkin (KMO) test and Bartlett’s Test of Sphericity were utilized to verify the appropriateness of the data for factor analysis. The quantity of retained factors was established using the eigenvalue-greater-than-one criterion, corroborated by a scree plot analysis. Items exhibiting factor loadings below 0.40 or substantial cross-loadings were omitted from the final factor structure.

Post-extraction, the internal consistency of each factor was assessed utilizing Cronbach’s Alpha, with a benchmark of 0.70 established to signify satisfactory reliability. The ultimate factor structure provided the basis for ensuing descriptive and inferential analysis.

**2.4 Data gathering procedure**

The researchers created a Google Form version of the questionnaire and distributed it through digital media. Participants were recruited using convenience sampling, primarily focusing on students who had completed the General Education courses: Readings in Philippine History, The Contemporary World, and Mathematics in the Modern World. The survey link was disseminated directly to students and coordinated through faculty members responsible for these courses.

According to best practices for Structural Equation Modeling (SEM), a minimum of 200 responders is deemed adequate. To improve the reliability and generalizability of the findings, the researchers sought to gather data from a minimum of 300 pupils.

**2.5 Statistical Treatment of Data**

The gathered data were processed and analyzed utilizing JAMOVI version 2.6.23. The subsequent statistical methods were employed:

* Exploratory Factor Analysis (EFA): Principal Axis Factoring with Varimax rotation was employed to discern the underlying dimensions of the 40-item instrument. Before extraction, the Kaiser-Meyer-Olkin (KMO) test and Bartlett’s Test of Sphericity were performed to evaluate the appropriateness of the data for factor analysis. Factors with eigenvalues exceeding 1.0 and corroborated by the scree plot were preserved. Items exhibiting factor loadings below 0.40 or possessing substantial cross-loadings were omitted.
* Reliability Analysis: The internal consistency of the resultant factors was assessed using Cronbach’s Alpha, with a threshold of 0.70 or above signifying adequate reliability.
* Descriptive Statistics: Means and standard deviations were calculated to encapsulate students' impressions across the specified dimensions.
* Paired Samples t-test: Paired t-tests were performed to compare students' responses between onsite and online learning modes for each factor.

The analyses were conducted to verify the instrument, delineate broad trends, and evaluate perceptual differences across various instructional modalities.

3. results and discussion

This section explores the outcomes of the statistical studies conducted to investigate student perceptions on the utilization of digital tools in General Education topics. The results encompass the conclusions of the Exploratory Factor Analysis (EFA), the reliability of the identified factors, descriptive statistics, and the paired samples t-test comparison of onsite and online learning experiences.

Descriptive statistics were computed for the elements inside each dimension. The results demonstrated a predominantly high degree of consensus regarding all aspects, indicating that students perceived digital technologies as advantageous for learning. Elements Pertaining to Digital Learning Assistance, Engagement, and Motivation Onsite garnered notably elevated mean ratings, indicating favorable impressions regarding the use of digital technologies and their contribution to sustaining focus and engagement during onsite sessions. The standard deviations were comparatively low, signifying uniform responses among subjects.

**3.1 Exploratory Factor Analysis (EFA)**

Exploratory Factor Analysis (EFA) was conducted using Principal Axis Factoring with Varimax rotation via JAMOVI (v2.6.23) to examine the underlying structure of student perceptions. The instrument initially consisted of 40 elements. Before extraction, the dataset was assessed with the Kaiser-Meyer-Olkin (KMO) metric, resulting in a value of 0.955, signifying exceptional sample adequacy. Bartlett’s Test of Sphericity was significant (χ² = 6900, df = 630, p < .001), indicating that the inter-item correlations were adequate for factor analysis. These initial assessments are deemed crucial for validating the outcomes of factor analysis (Hair et al., 2020; Arifin, 2022).

Three components were extracted according to the eigenvalue-greater-than-one criterion, and this conclusion was additionally corroborated by an examination of the scree plot. Items 1, 2, 17, and 27 were eliminated due to factor loadings falling below 0.40 or exhibiting substantial cross-loadings across many factors. Zhao et al. (2021) and Rahi (2022) assert that loadings under 0.40 generally lack significant contribution to factor interpretation, whereas cross-loading items diminish the clarity and discriminant validity of constructs.

The optimized approach preserved 36 components, which distinctly clustered into three interpretable factors: Digital Learning Support, Engagement and Motivation, and Access and Confidence. Internal consistency was evaluated by Cronbach’s alpha, revealing strong dependability across all three factors: Digital Learning Support (α = 0.909), Engagement and Motivation (α = 0.928), and Access and Confidence (α = 0.834). These values surpass the well-recognized criterion of 0.70, signifying robust internal consistency (Nunnally & Bernstein, 1994; Fitriani & Afifah, 2023).

The findings validate that the instrument consistently measures distinct and comprehensible aspects of students' perceptions of digital tools in General Education, in accordance with recent research highlighting the significance of psychometrically validated instruments for assessing student technology experiences in post-pandemic educational settings (Chen & Lee, 2022; Rahman et al., 2023).

**Table 1: Factor Summary and Reliability Coefficients for the Retained Dimensions**

|  |  |  |  |
| --- | --- | --- | --- |
| Factor | Description | NO. of Items | Cronbach’s alpha |
| Digital Learning Support | Usefulness, efficiency, and reliability of digital tools for learning and task management | 15 | 0.909 |
| Engagement and Motivation  | Interest, attention, and motivation when digital tools are used during onsite classes | 15 | 0.928 |
| Access and Confidence  | Comfort in accessing and navigating digital tools in face-to-face learning. | 6 | 0.834 |

**3.2 Descriptive Statistics**

Descriptive statistics were calculated to encapsulate students' opinions of digital tool utilization across three specified factors: Digital Learning Support, Engagement and Motivation, and Access and Confidence, in both onsite and online educational environments. Per-item scores were derived by dividing total scores by the quantity of items per factor, facilitating a standardized comparison across all dimensions.

Of the three criteria, Digital Learning Support exhibited the greatest mean in the onsite environment (M = 4.231, SD = 2.07), indicating that students placed significant value on the trustworthiness, accessibility, and academic utility of digital technologies inside organized classroom contexts. This corresponds with the findings of Almarzooq et al. (2020), who observed that digital platforms can improve understanding and decrease task completion time when effectively integrated into education. The online counterpart (M = 3.970, SD = 1.97) received favorable evaluations, suggesting that students saw online resources as beneficial, albeit potentially less reliable due to infrastructural or instructional constraints.

The mean scores for Engagement and Motivation were comparably stable in both learning environments (M = 3.793 onsite; M = 3.827 online). This discovery corroborates the assertions of Martin and Bolliger (2018), who highlighted that digital engagement strategies—such as interactive content, films, and discussion forums—can sustain or elevate student motivation in both hybrid and entirely online environments. The analogous ratings indicate that students in this study valued these tools irrespective of medium; nevertheless, their motivational effect may hinge on the extent of active utilization by instructors.

Access and Confidence had comparable means in both online (M = 3.657, SD = 1.74) and onsite (M = 3.643, SD = 1.69) delivery modalities. This indicates student trust in utilizing learning platforms and regularly accessing information across various environments. The findings align with Bedenlier et al. (2020), who determined that digital competency and accessibility greatly affect students' adoption and continued utilization of technology in higher education.

The descriptive statistics indicate that students held predominantly favorable views toward the utilization of digital tools, especially for learning assistance and accessibility. Nonetheless, sustaining elevated engagement levels may necessitate deliberate planning and proactive facilitation by educators.

Table 2: Descriptive Statistics of Student Perceptions by Factor and Modality

|  |  |  |
| --- | --- | --- |
| Factor | Mean | Standard Deviation |
|  | Online | Onsite | Online | Onsite |
| Digital Learning Support | 3.970 | 4.231 | 1.97 | 2.07 |
| Engagement and Motivation  | 3.827 | 3.793 | 2.42 | 2.42 |
| Access and Confidence  | 3.657 | 3.643 | 1.74 | 1.69 |

**3.3 Paired Sample T-test**

A paired samples t-test was conducted for each of the three identified factors—Digital Learning Support, Engagement and Motivation, and Access and Confidence—to ascertain significant differences in students’ perceptions of digital tool usage between onsite and online learning modalities. The difference was computed using the formula onsite – online, indicating that a positive t-value reflects a superior onsite impression, whereas a negative t-value implies that students evaluated the online modality more favorably.

The findings for Digital Learning Support revealed a statistically significant difference, t(301) = 19.74, p = 0.001, demonstrating that students regarded onsite digital tools as considerably more beneficial than those employed in online environments. This finding indicates that students saw in-person access to learning materials, instructor support, and the incorporation of digital resources in the classroom as more organized and successful. Baber (2021) and Chen & Lee (2022) assert that physical classroom environments integrating technology facilitate real-time assistance, reduce technical obstacles, and provide immediate feedback, hence enhancing perceptions of digital support.

Conversely, involvement and Motivation produced a significant negative t-value, t(301) = -2.23, p = 0.027, suggesting that students indicated greater involvement and motivation in online environments than in onsite settings. This may indicate the advantages of self-directed learning, adaptable accessibility, or multimedia-enhanced environments offered by online platforms. Rahman et al. (2023) and Martin et al. (2021) saw analogous findings, indicating that digital learners frequently perceive online learning environments as engaging when educators integrate gamification, asynchronous discussions, and multimedia resources.

No significant difference was seen for Access and Confidence, t(301) = -1.01, p = 0.312. This indicates that students perceived themselves as equally confident and competent in navigating digital platforms, regardless of whether they were onsite or online. This conclusion aligns with Zhao et al. (2021), who highlighted that enhanced digital literacy and ongoing engagement with virtual platforms have enabled students to attain proficiency and adaptability in diverse learning contexts.

The t-test results indicate that students experienced greater digital support in onsite environments, but they reported somewhat higher engagement and motivation in online learning, with no significant differences in confidence or access across the two modalities. These patterns underscore the dynamic nature of student choices and the necessity for hybrid methodologies that optimize both structure and flexibility.

**Table 3: Paired Samples T-Test Results Comparing Onsite and Online Modalities**

|  |  |  |  |
| --- | --- | --- | --- |
|  | t-value | p-value | Verbal Interpretation |
| Digital Learning Support | 19.74 | 0.001 | Significant |
| Engagement and Motivation  | -2.23 | 0.027 | Significant |
| Access and Confidence  | -1.01 | 0.312 | Not Significant |

4. Conclusion

This research investigated student perceptions regarding the utilization of digital tools in General Education courses using Exploratory Factor Analysis (EFA), descriptive statistics, and paired samples t-tests. The EFA results validated the instrument's psychometric integrity, identifying three distinct and dependable factors: Digital Learning Support (α = 0.909), Engagement and Motivation (α = 0.928), and Access and Confidence (α = 0.834). Descriptive data indicated that students predominantly possessed positive impressions of digital resources, with elevated ratings specifically for digital help in onsite environments and uniform levels of access and confidence across both learning modalities. The findings of the paired samples t-test revealed significant differences in Digital Learning Support and Engagement and Motivation, with the former favoring onsite locations and the latter showing a small preference for online settings. No substantial difference was observed in Access and Confidence, indicating that students perceived themselves as equally proficient with digital tools irrespective of the delivery medium. These findings underscore the necessity of including well-organized digital tools in both modalities, while also acknowledging the imperative to improve incentive techniques in physical settings and provide consistent access in online delivery. Educators and academic planners are advised to implement hybrid educational methods that merge the organization and immediacy of onsite digital integration with the adaptability and engagement techniques provided by online platforms. Subsequent research could enhance this study by using qualitative methodologies to further investigate student preferences and digital engagement patterns.

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