International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

From Non-STEM to Engineering: A Comparative Study of Reading and Learning Preferences Among BSEE Students by Senior High School Track

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Abstract
This study compared the reading and learning preferences of 134 third and fourth-year Bachelor of Science in Electrical Engineering students. The comparison was based on the senior high school track STEM or non-STEM to identify dimensions that inform equitable instructional design. The descriptive-comparative survey design was used. Preferences across six dimensions were analyzed with chi-square tests and effect sizes. Results showed that only the device for reading differed significantly between groups. The non-STEM students predominantly preferred mobile phones while STEM students favored laptops. No significant differences were found for reading materials, reading resources, textbook format, online content, or medium of instruction. These findings indicate that a uniform approach for content, format, resources, and language is feasible across both tracks. However, the significant device disparity requires a mobile-first design strategy to remove the primary technological barrier for non-STEM learners. Responsive, smartphone-optimized digital resources alongside blended printed materials will ensure equitable access and support successful transitions from non-STEM backgrounds into engineering education.

Keywords: blended learning, device preference, electrical engineering, equitable instruction, learning materials

Introduction

Success of engineering education is greatly influenced by the design of instructional materials that students used to fit their preferences, backgrounds, and learning styles. While Outcome-based education (OBE) transformed engineering curricula globally through alignment between learning outcomes, teaching activities, and assessment tasks. Effectiveness of the instructional materials used is also contingent upon students' actual usage behavior and specific cognitive needs. Recent studies indicate that engineering students' behavior toward digital reading differs from that of other majors. Students tend to respond positively to digital resources but have also been reported with a consistent preference for printed text [16]. The study of Sherif Welsen, et. al., (2023) reflected the behavior of engineering students toward digital reading is different from other majors. Engineering students generally respond favorably to digital resources, although there have been reports of a consistent preference for printed text

[4]. This tension between resource provision and actual usage becomes more critical when student cohorts include two distinctly different sub-populations. BSEE program entrants from a STEM senior high school track and those from a non-STEM track. Non-STEM students may not have had much exposure to systematic quantitative reasoning in the past and might find mathematics challenging. Mathematics is a key gateway skill for understanding circuits.

Previous studies have investigated reading preferences of engineering students. Very few have systematically compared all six dimensions, reading materials, resources, format, online content, device, and medium of instruction between STEM-track and non-STEM-track learners within an electrical engineering program. In the Philippines, the problem is exacerbated by infrastructural issues which was the unstable internet connectivity. The digital divide compel educators to create materials that can function offline. Language is also very important. Most college engineering classes are taught in English, but most Filipino engineering students feel more comfortable using Filipino, especially when they want to ask questions [10]. Teaching in both languages has been proven to make students more interested and help them understand better. In the absence of empirical data at the student level, curriculum developers may inadvertently develop one-size-fits-all resources that do not bridge the pre-existing gap between STEM and non-STEM learners.

Thus, the present study attempts to fill that gap by reporting the results of a survey of 134 BSEE students, who were in their third and fourth years at a state university in the Philippines. This survey gathered information on their preferences over six dimensions. These are the reading materials, reading resources, textbook format, content read while online and device for reading as well as medium of instruction. Results were analyzed separately for those with a STEM background versus those with a non-STEM senior high school track. These dimensions were chosen for it catches collectively the manners of students accessibility, processes, and engagement with the subject matters which were a direct influence to the cognitive load and learning effectiveness. Investigating these dimensions for SHS tracks provide assurance that academic resource is not only based on curriculum but also designed to address the learners prior knowledge, technological accessibility, and needed medium of instruction. Additionally it addresses to foster equitable learning outcomes in the field of engineering education. The broad aim of this study is to describe in detail how students from various pre-college tracks differ in their preferences for learning resources so that evidence-based, equitable and cognitively optimized instructional materials may be created. In support of this general aim, the study specific objectives are (1) to compare STEM and non-STEM preferences for reading materials in DC circuit analysis, (2) determine group differences in reading resources, textbook format, online content, device, and medium of instruction, and (3) identify which dimensions is significantly different to inform equitable instructional design.

The identification of significance with the dimension to inform equitable instructional design was evaluated by formulating and testing the two-tailed hypothesis at 0.05 level of significance. The null hypothesis states that there is no significant association between senior high school track (STEM vs. non-STEM) and the preferences of BSEE students across any of the six dimensions, which are the reading materials, reading resources, textbook format, reading content while online, device for reading, and medium of instruction. The study goal is to inform the design of rejection to adopt the single approach format or a one instructional design decision applied to all BSEE students. Moreover, the multiple approaches format tailors different versions of materials for each subgroups due to significantly different preferences.

Methodology

A descriptive-comparative survey design was used in this study. This is to answer the student's six preference dimensions such as reading materials, reading resources, textbook format, online reading content, device for reading, and medium of instruction. Compare the responses of STEM and non-STEM BSEE students. The researcher does not manipulate any variable but rather describes existing differences between naturally occurring groups on certain dependent variables. In this case, the Senior High School (SHS) track is the independent variables and the six dimensions are the dependent variables. The data were from the survey of 134 BSEE third and fourth year students enrolled in DC Circuit Analysis subject in the first semester of Academic Year 2025 to 2026 at a university in the Philippines.

The respondents SHS track demography were 64(47.8%) BSEE students from STEM track and 70(52.2%) BSEE students from non-STEM track with reference to the total students. The representation of subgroups was almost half, the non-STEM exceeds 4.4% the STEM students. This was a very common case for the state colleges and universities in the Philippines due to Commission on Higher Education (CHED) Memorandum Order number 105 in 2017 which allows all graduates of the newly adopted SHS program regardless of the strand to enroll in any college program choice. The university gave chances to those that are in non-STEM track who passed the standardized exam of the university to matriculate in engineering program. The opportunity for the students for a job security and opportunities after graduation when they graduated in a STEM related course was the reason for higher enrolment. This was supported by the study of Gaviola et al. (2023) in a research on the view of factors influencing decision to shift from non- stem to stem related college programs among students in a catholic university. The researcher uses "Survey on the Textbook Usage of BSEE Students in DC Circuit Analysis" which was adopted from the two previously validated instruments. First, the Reading Habits and Preferences of Resources by Pandey, et. al. (2024) was designed to understand the reading habits of college students with regards to several sides of reading. This allowed the research to capture precisely students' preferred format of reading resources, textbook format, online content, and device. The second was the Perceptions Toward the Medium of Instruction by Maria Charlene Melegrito (2022) which was a quasi-experimental with regards to the language that is more effective as medium of instruction in engineering courses in selected universities in the Philippines. It was meant to assess how well English and Filipino worked as languages of instruction by capturing subtle preferences for various classroom tasks (e.g. understanding explanations, asking questions). It has also a section on demography regarding the SHS Track of the BSEE student's respondents.

Survey data were gathered from all 3rd and 4th year Bachelor of Science in Electrical Engineering students of the state university during the first semester of academic year 2024 to 2025. The survey were written in electric format using the google service application particularly the Google form. The purpose of which is to have a "real-time" collection of the survey data from the students. The survey was directed by a letter of requests, statement of the privacy act and directions in answering the research questions. The link of the survey were posted to the group chats of the class. A total of 134 students enrolled for that academic year answered this survey. Collection was done immediately with receipt of filled-up questionnaires. Responses to surveys were then encoded, organized, and readied for analysis.

The data collected for the subgroups SHS track STEM and non-STEM summary of responses were computed using frequency counts and percentage distribution. Patterns and trends of the responses were clearly identified on the preferences of reading materials in DC circuit analysis along reading resources, textbook format, online content, device, and medium of instruction. Moreover, the two-tailed test Chi-

square Test of Independence or the Fisher's Exact tests were used at alpha level of significance of 0.05. These were chosen making the SHS track as the independent variable and the other six preference dimensions as dependent variables. The statistical tool used determined the decision for the null hypothesis of the research study. The expected cell output of < 5 in the contingency table were observed to use the Fisher's Exact test instead of the Chi-square test. Moreover, the 2 x 2 contingency table uses the Fisher's exact test for association. The effect size calculation for Chi-square test of independence were the Cramer's V or the Odds ratio (OR).

Results and Discussion

This section provides the results based on the data collected comparing student's preferences of subgroups STEM and non-STEM BSEE students according to the six dimensions vitally considered for the design of an efficient academic resource materials.

Table 1 reflect the student preferences for reading materials. The most preferred reading materials for both groups was the subject textbooks. The 82.8% of the STEM and 72.9% non-STEM students chose the Subject textbook option. Moreover, these choice reflects 77.6% of the total respondents.

Table 1: Student Preferences for Reading Materials by SHS Track

SHS Track	Subject textbook f(%)	General books f(%)	Informational books f(%)	Others f(%)	Total f(%)
STEM	53(82.8)	3(4.7)	7(10.9)	1(1.6)	64(100)
Non-STEM	51(72.9)	9(12.9)	8(11.4)	2(2.9)	70(100)
Total	104(77.6)	12(9.0)	15(11.2)	3(2.2)	134(100)

Table 1 emphasizes that regardless of their academic track, the BSEE students mostly value materials that match the curriculum. This supports what we see in some literature about engineering classrooms where textbooks are considered as primary educational resource [5]. It is also interesting to note an observed gap between two groups in terms of preference. This may be attributed to prior academic socialization. Research indicates that students from a STEM background who have been exposed to highly curriculum-driven environments are more inclined toward viewing the subject textbook as central to their studies (Respecia et al., 2025). Alternatively, lower preference for textbooks among non-STEM students along with higher selection of general and informational books indicates compensation for gaps in foundational knowledge. Thus, instructional materials meant to equitably serve such diverse populations should ideally be designed with the subject textbook at their core. Additionally it should be enhanced by supplementary modules that provides more context and support for the first time learner.

Table 2 is the result for the student preferences comparing the STEM and non-STEM track for reading resources. Both groups chose the blended format (both digital and printed) in which 68.75% of STEM students 70% of the non-STEM students. This choice was overwhelming majority of 93% of the total respondents as compare to the other options. The traditional printed reading was preferred by 22.86% of non-STEM students as compared to 17.19% of STEM students having a 5.7% difference percentage points. Among the STEM students 14% preferred digital resources which was nearly doubled as compared to 7.14% of non-STEM students.

Table 2: Student Preferences for Reading Resources by SHS Track

SHS Track	Printed reading f(%)	Digital resources f(%)	Both Digital & Printed f(%)	Total f(%)
STEM	11.0(17.19)	9.0(14.06)	44.0(68.75)	64.0(100)
Non-STEM	16.0(22.86)	5.0(7.14)	49.0(70.00)	70.0(100)
Total	27.0(20.15)	14.0(10.45)	93.0(69.40)	134.0(100)

The preferred blended format by the majority which combines printed and digital resources (69%), strongly aligns with the ongoing trend in engineering education. This finding is consistent with the landmark Academic Reading Format International Study (ARFIS) that surveyed over 21,000 students from 33 countries(Mizrachi et al., 2021). It was empirically validated that students consistently place a high value on the cognitive benefits of printed reading materials. This reading resources offers deep focus and retention while at the same time appreciating the convenience and accessibility afforded by digital formats. In another study done about Open University STEM students revealed that the ideal package of study materials would be a combination of books and digital content (Pikkarainen & Gaspar, 2017). That preference for a balanced hybrid model takes on added significance in the Philippine context where educational disruptions are common and the digital divide remains a reality. Hence to ensure equity in cognitive accessibility within learning environments, engineering educators must design resources that are neither purely print nor fully digital.

The student preference for textbook format by SHS track subgroups were shown by table 3. The preference of the students was the hardback textbooks which comprises 65.6% of STEM and 52.9% of non-STEM.

Table 3: Student Preferences for Textbook Format Grouped by SHS Track

SHS Track	Hard back f(%)	Paper back f(%)	Loose leaf f(%)	E- book f(%)	E –book with B. & W. Loose leaf f(%)	Total f(%)
STEM	42.0(65.6)	8.0(12.5)	0.0(0)	11.0(17.2)	3.0(4.7)	64.0(100)
Non-STEM	37.0(52.9)	15.0(21.4)	1.0(1.4)	12.0(17.1)	5.0(7.1)	70.0(100)
Total	79.0(59.0)	23.0(17.2)	1.0(0.75)	23.0(17.2)	8.0(6.0)	134.0(100)

The 59% rating of all respondents opted hardback text book format. This is consistent with findings that engineering students perceive physical textbooks as more durable and spatially anchoring. Hence facilitation of deeper cognitive processing and sustained attention may be particularly appreciated by students from a STEM background who are used to solving problems in-depth with one authoritative reference book. Non-STEM students have a greater preference for paperback (21.4% vs. 12.5%) and hybrid e-book with black-and-white loose leaf (7.1% vs. 4.7%), which indicates an inclination towards more flexible and cost-effective solutions. The nearly equal preference for e-books, about 17% in each group, suggests that digital formats will be equally acceptable to all. This is in line with meta-analysis results indicating that many students like the portability and searchability of e-textbooks but still prefer print books over others (Amirtharaj et al., 2023). In the Philippine engineering context, where resource constraints and fluctuating class schedules are common, offering a mix of hardback and e-book would

equitably serve both STEM and non-STEM learners. Instructional designers should think about a tiered format strategy that has a hardback core textbook with an optional e-book version plus budget-friendly paperback option. This respects the stronger hardback preference of STEM students while accommodating the more diverse needs of non-STEM learners.

The results in table 4 reflects the BSEE students preference for reading content while online.The main online activity for STEM and non-STEM BSEE students is accessing course content, with almost equal shares (56.2% versus 57.1%) followed by entertainment (20.3% STEM and 24.3% non-STEM).

Table 4: Student Preferences for Reading Content While Online Grouped by SHS Track

SHS Track	Online news, stories, novels f(%)	Entertain-ment f(%)	Course content f(%)	Re-search article f(%)	Other f(%)	Total f(%)
STEM	12.0(18.7)	13.0(20.3)	36.0(56.2)	2.0(3.1)	1.0(1.6)	64.0(100)
Non-STEM	7.0(10)	17.0(24.3)	40.0(57.1)	2.0(2.9)	4.0(5.7)	70.0(100)
Total	19.0(14.2)	30.0(22.4)	76.(56.7)	4.0(3)	5.0(3.7)	134.0(100)

This strong, consistent preference for academic material over non-academic content aligns with wider literature on engineering students' digital behavior. A study of online reading patterns among engineering undergraduates found that while they do use multimedia for learning they use it mostly to complete course-related tasks rather than extensive research or general browsing (Alexander et al., 2023). In addition, very low preference for "research articles" (approximately 3%) resonates with findings that undergraduate engineering students often do not have the skills or confidence to locate and use primary research sources (Phillips et al., 2019). In the Philippine context where unstable internet connectivity is common, this focused goal-oriented use of online time may also be a practical adaptation to resource constraints since casual browsing can be frustrating on slow or intermittent connections. Therefore, instructional designers should focus on developing high-quality curriculum-aligned digital resources that directly support course objectives.

Table 5 shows the students preferred device for reading. It shows that the most preferred device was the mobile phone having 50% of the total respondents, 40% were non-STEM and 27% for the STEM track with a 14.9% point difference. Second preferred device was the laptop where 57.8% from the STEM track and 31.4% from the non-STEM track. Desktop rate 0% of the STEM and 4.3% non-STEM with the lowest rating for overall.

Table 5: Student Preferences Device for Reading Grouped SHS Track

SHS Track	Laptop f(%)	Mobile phon f(%)	Desktop f(%)	Other f(%)	Total f(%)
STEM	37.0(57.8)	27.0(42.2)	0.0(0)	0.0(0)	64.0(100)
Non-STEM	22.0(31.4)	40.0(57.1)	3.0(4.3)	5.0(7.1)	70.0(100)
Total	59.0(44.1)	67.0(50)	3.0(2.2)	5.0(3.7)	134.0(100)

This difference in device preference mirrors findings from a 2021 study among undergraduate students (Gamage & Perera, 2021), wherein the majority of them used multiple devices. Those from Engineering Schools had a significantly higher propensity towards using only one device, which was the laptop. The disproportions on the device used by the students are not new. This is attributed to the student's strong prediction on the access to requisite technological tools for learning which has an implication to an equitable instruction. Research has consistently documented a "digital capital" divide within Philippine higher education (Ateneo & Clamor, n.d.). This was characterized by highly unequal access to technology where the typical indicator for low socioeconomic student status is ownership of "only a mobile phone." If instructional materials are not created with the "mobile-first approach", then most non-STEM students will experience an unnecessary extraneous cognitive load. This could further exacerbate the learning gap and impede their transition into engineering. This finding thus translates directly into an imperative for equitable instructional design. Learning materials must be fully optimized for and functional on mobile devices so that a student's device preference does not become another barrier to his or her learning.

Table 6 indicates that most BSEE students from both tracks prefer Filipino (54.7% STEM, 60% non-STEM) to English (45.3% STEM, 40% non-STEM) as the language for understanding explanations from teachers.

Table 6: Student Preferences for Medium of Instruction Grouped by SHS Track

SHS Track	English f(%)	Filipino f(%)	Total f(%)
STEM	29.0(45.3)	35.0(54.7)	64.0(100)
Non-STEM	28.0(40)	42.0(60)	70.0(100)
Total	57.0(42.5)	77.0(57.5)	134.0(100)

This is consistent with empirical evidence regarding Filipino engineering students who face language barriers when complex concepts are communicated exclusively in English(Melegrito, 2022). Filipino language becomes the most accessible option when direct guidance and clarification are needed. The strong preference for Filipino, especially among non-STEM students, emphasizes the critical role that language plays in reducing cognitive load. This is based on Bernardo (2004) historical documentation of the ongoing struggle between English as the official medium of instruction and natural classroom use of Filipino, which creates a gap that practically demands a scaffolded bilingual approach. Although code-switching has been proven to facilitate understanding particularly in STEM contexts, this does not mean that a preference for one's native language will result in a more effective content performance on summative assessments. Instructional design should therefore not replace English but rather provide supportive scaffolding activating prior knowledge in the learner's comfortable language before moving into professional English. Such an approach responds to growing calls for nuanced support through mother tongue or local language use within technical fields.

Table 7 presents results in which, out of six dimensions analyzed, only Device Use (laptop versus mobile phone) has a statistically significant difference between STEM and non-STEM BSEE students (x^2 (3) = 14.1, p = 0.003, Cramér's V=0.324, medium effect). The other dimensions, such as reading materials (p = 0.365), reading resources (p = 0.355), textbook format (p = 0.441), online content (p = 0.463), and medium of instruction (p = 0.601), are not significantly different.

Table 7: Group Differences by SHS track (STEM and non-STEM)

Dimension	X^2(df)	p-value	Effect size	Remarks
Reading Materials	3.18(3)	0.365	Cramer' V=0.154	Not significant
Reading Resources	2.07(2)	0.355	Cramer' V=0.124	Not significant
Textbook Format		0.441	Cramer' V=0.167	Not significant
While Online	3.60(4)	0.463	Cramer' V=0.164	Not significant
Device Use	14.1(3)	0.003	Cramer' V=0.324	Significant
Medium of Instruction		0.601	OR = 1.24	Not significant

Note. Chi-square test used for all except Medium of Instruction (Fisher's Exact). Effect size: Cramer's V (for > 2x2 tables) or Odds Ratio (OR for 2x2). *Cramers V interpretation: 0.10 = small, 0.30 = medium, 0.50 = large (Cohen, 1998)* Significance level at 0.05.

This pattern confirms the major finding of the Academic Reading Format International Study (ARFIS) (Mizrachi et al., 2021) that preferences for reading formats may vary slightly by country. The same study reveals that preferences for learning resources remain fundamentally stable across student groups, even those with different academic backgrounds. Yet this significant difference in device preference is a sharp reality that continues to exist. Studies about digital capital in Philippine universities show access to technology as very inequitable. The most typical indicator for a student from a low socioeconomic status is ownership of mobile phone which was the common device in a household ownership(Moreno et al., 2023). Additionally, a national SWS survey discovered that among students who obtained devices, 79 percent received a smartphone and just 13 percent got a desktop or laptop; this divide was sharply intensified by the pandemic(*Four of 10 Filipino Students Lack Distance Learning Tech | Philstar.Com*, n.d.). Since only device preference varies, it is the main lever for fair instructional design based on Universal Design for Learning (UDL) principles(*Universal Design for Learning*, n.d.). A UDL framework clearly demands that materials be designed to work on the devices students really have. The "mobile-first" strategy, where all content works fully and is readable on a small-screen device is an essential tactic for eliminating unnecessary engagement barriers(*Mobile-First Design Principles: A Comprehensive Guide*, n.d.). In the absence of other dimensional differences, a standard approach to content formatting, resources, and language is suitable. Hence, the derivable practical conclusion from this finding is a mobile-first design strategy that eliminates the digital access barrier for non-STEM learners. A student's device preference should not become an impediment to learning and thereby achieving the study's goal of supporting students "from non-STEM to engineering."

Since the other five dimensions do not present significant differences, a uniform approach regarding content format (for example, blended both printed and digital), textbook format (hardback with the option of an e-book), online reading content (course - centric), and medium of instruction (bilingual) is suitable for both groups. This will facilitate resource development under equitable conditions. In brief, the only difference that can be translated into an equitable design concerns device preference. Adopting a mobile-first strategy would eliminate the main technological barrier to non-STEM students' transition from their non-STEM backgrounds into engineering.

Conclusion

This study comparatively shows that STEM and non-STEM learners hold almost identical preferences across five out of six pedagogical dimensions such as, reading materials, reading resources, textbook format, online content, and medium of instruction. The only statistically significant and educationally meaningful difference is in device preference. The non-STEM students predominantly use mobile phones while STEM students prefer laptops with a medium effect size. Therefore, the path toward equitable instructional design for students "from non-STEM to engineering" does not require separate materials for content, format, or language but rather a mobile-first design strategy. All digital resources like QR-coded videos, interactive quizzes, and downloadable PDFs must work perfectly on smartphones to eliminate the main technological barrier for non-STEM learners without disadvantaging their STEM counterparts. Engineering educators can then use such an approach to create inclusive learning environments. Actual access to devices by students fosters cognitive equity. These support successful transitions into electrical engineering irrespective of a student's pre-college academic background.

Recommendation

Engineering educators and instructional designers should consider using a mobile-first design approach for all digital learning content. QR-coded videos, interactive quizzes, and downloadable PDFs should work well on smartphones since most non-STEM learners use mobile phones. This also should remain accessible on laptops. A blended printed and digital format, hardback with optional e-book, course-centric online content, and bilingual (Filipino/English) support for all titles should be maintained to facilitate development without compromising equity. Brief printed scaffolds such as math backgrounders for non-STEM students will also help bridge foundational gaps. Institutions must train faculty to create mobile-compatible content and ensure that campus infrastructure supports mobile learning. Future research should explore whether device access translates into academic outcomes but in the meantime, the first step is to design for mobile use to eliminate this major technological barrier for students moving from non-STEM to engineering.

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