Calculator Reliance and Computational Self-Efficacy among Electrical Engineering Technology Students

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ABSTRACT

Calculator use is common in engineering and engineering technology education, particularly in courses that involve quantitative problem solving. While calculators may support efficiency and reduce unnecessary computational burden, excessive dependence on calculator outputs may also shape students' confidence, mental effort, and independent computational behaviour. This exploratory study used selected concepts from educational psychology to examine calculator reliance and computational self-efficacy among Electrical Engineering Technology students. The study used a quantitative descriptive-correlational design. Data were collected from 55 Electrical Engineering Technology students through a structured questionnaire using five-point Likert-scale items. Calculator Reliance was measured using six items, Computational Self-Efficacy using six items, and Perceived Cognitive Offloading using four supporting items. Descriptive statistics, Cronbach's alpha, and Spearman's correlation analysis were used.

The mean score was 3.75 (standard deviation [SD] = 0.73) for calculator reliance and 3.22 (SD = 0.57) for computational self-efficacy. Calculator reliance was not significantly associated with computational self-efficacy (Spearman's $\rho = 0.173$, $p = 0.206$), but it was significantly associated with the exploratory measure of perceived cognitive offloading (Spearman's $\rho = 0.384$, $p = 0.004$). Computational self-efficacy was significantly associated with self-perceived analytical accuracy (Spearman's $\rho = 0.372$, $p = 0.005$). Calculator reliance should not be treated as direct evidence of weak computational ability because actual performance was not assessed. The results suggest that calculator reliance may involve confidence, external support, and perceived mental effort. Given the limited sample and use of self-reported measures, the findings should be interpreted as exploratory and specific to this engineering technology programme.

Keywords: calculator reliance, computational self-efficacy, perceived cognitive offloading, educational psychology, engineering technology students

INTRODUCTION

Quantitative problem solving is a central part of engineering and engineering technology education. Students in electrical engineering technology programmes are regularly required to work with numerical values, algebraic manipulation, scientific notation, unit conversion, circuit-related calculations, and engineering formulas. In such contexts, calculators are not merely optional accessories. They often function as routine learning tools that help students perform computations efficiently and reduce the burden of repeated arithmetic operations.

However, the educational and psychological implications of calculator use are more complex than the question of whether calculators are "good" or "bad". On one hand, calculators can reduce unnecessary computational load and allow students to focus on conceptual understanding, interpretation, and engineering reasoning. On the other hand, frequent reliance on calculators may influence how students monitor their own calculations, judge the reasonableness of numerical answers, and develop confidence in performing computations independently. This issue becomes particularly relevant in engineering technology education, where students are expected not only to obtain numerical answers, but also to understand whether those answers are reasonable within a technical context.

Calculator reliance in this study is treated as more than a routine tool-use habit. The study examines whether calculator reliance is related to students' confidence in performing calculations independently and their perceived mental effort. Cognitive offloading is used as a supporting concept. It refers to the use of an external tool to reduce the mental demands of a task [1]. In this study, the calculator is treated as such a tool.

The study also uses the concept of self-efficacy. Self-efficacy refers to individuals' beliefs about their capability to perform specific tasks successfully [2]. In educational contexts, self-efficacy is important because it influences effort, persistence, strategy use, and willingness to engage with difficult tasks. For engineering technology students, computational self-efficacy can be understood as students' perceived capability to perform numerical and algebraic operations independently in engineering-related problem solving.

Although previous studies have examined mathematics self-efficacy, engineering self-efficacy, calculator use, and technology-supported learning, less attention has been given to the relationship between calculator reliance and computational self-efficacy among engineering technology students. This gap is important because engineering technology students often work in applied, calculation-heavy learning environments where calculators are heavily used. Understanding this relationship can help educators distinguish between productive calculator use and unreflective dependence on calculator outputs.

Therefore, this study investigates calculator reliance and computational self-efficacy among Electrical Engineering Technology students. Perceived cognitive offloading was included as a supporting measure to help interpret calculator use in this engineering technology context.

LITERATURE REVIEW

Calculator Use and Calculator Reliance

Calculator use has long been discussed in mathematics and science education. Earlier meta-analyses generally indicated that calculators do not necessarily harm students' mathematical achievement when used appropriately, and may even support attitudes and performance in certain learning contexts [3], [4]. These findings suggest that calculator use itself should not be treated as inherently negative. The more important issue is how students use calculators and whether they continue to develop independent numerical reasoning alongside tool-supported computation.

In engineering education, calculators are commonly accepted because engineering tasks often involve complex numerical procedures. Nevertheless, calculator reliance may become problematic when students use calculators for even simple numerical operations, feel unable to begin problem solving without a calculator, or accept calculator outputs without checking whether the answer is reasonable. These behaviours suggest that calculator reliance involves more than frequency of use. It may also involve confidence-related reliance on external computational support.

In this study, calculator reliance was measured as students' reported tendency to depend on a calculator for starting, performing, and checking calculations, as well as for confidence during problem solving. This construct differs from ordinary calculator use. A student may use a calculator frequently and still have strong computational understanding. Conversely, another student may rely on a calculator because of low confidence or weak internal calculation habits. This distinction is important for interpreting the role of calculators in engineering technology education.

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Cognitive Offloading and Mental Effort

Cognitive offloading is used in this study to describe how an external tool may reduce the mental demands of a task. Risko and Gilbert described cognitive offloading as the use of external action or external tools to reduce internal cognitive demand [1]. In everyday life, people offload memory to notes, navigation to maps, and calculations to digital devices. Such offloading is often adaptive because it allows individuals to conserve cognitive resources for other tasks.

In quantitative learning, calculator use may reduce mental effort during arithmetic or procedural computation. This can be beneficial when the educational goal is conceptual interpretation, problem formulation, or engineering decision making. However, excessive offloading may also reduce students' engagement with the calculation process itself. Recent work on technology-supported cognition also suggests that cognitive offloading can support immediate task performance, although it may involve trade-offs when cognitive processes are delegated to external tools [5]. Studies on digital offloading and internet use have shown that access to external tools can change how people approach memory, information retrieval, and future reliance on technology [6], [7]. Although calculators are simpler tools than internet search engines or artificial intelligence systems, they can still function as cognitive offloading devices in numerical problem solving.

Perceived cognitive offloading was used only as a supporting measure. The main focus remained calculator reliance and computational self-efficacy. This measure helped describe whether students viewed calculators as reducing mental effort or allowing them to focus on other parts of a problem.

Computational Self-Efficacy

Self-efficacy refers to a person's belief in their ability to perform a specific task [2], [8]. In education, stronger self-efficacy is generally associated with greater effort, persistence, and willingness to attempt difficult tasks. Task-specific measures are more suitable when a study focuses on a particular activity [8].

Mathematics self-efficacy has been associated with mathematical problem solving [9] and the selection of science-based college majors [10]. More broadly, self-efficacy and self-regulated learning have been linked to classroom academic performance [11]. In higher education, task-specific measures such as calculus self-efficacy have been developed to assess students' confidence in solving particular forms of mathematical problems [12]. Similarly, engineering self-efficacy research has emphasized students' belief in their ability to succeed in engineering-related tasks and programmes [13], [14]. More recent studies have continued to show the relevance of self-efficacy in undergraduate engineering education. In an undergraduate statics course, Hunsu et al. found that self-efficacy remained a significant predictor of achievement after accounting for prior knowledge and regular class attendance [15]. Power et al. also highlighted that engineering self-efficacy may vary across specific dimensions and learning contexts during undergraduate engineering education [16].

In this study, computational self-efficacy refers to students' reported confidence in performing numerical and algebraic tasks used in engineering courses, including basic arithmetic, fraction-based calculations, scientific notation, algebraic manipulation, and other numerical computations. This construct is especially relevant for engineering technology students because their learning requires both conceptual understanding and practical computational fluency.

Study Focus

Previous studies have examined self-efficacy, calculator use, and cognitive offloading as separate topics. More recent studies involving digital technologies have also examined the relationship between self-efficacy and dependence on external technological support. Findings from these broader technology contexts suggest that the relationship may be complex rather than representing a simple inverse association between greater dependence and lower self-efficacy [17], [18]. However, less is known about the relationship between calculator reliance and computational self-efficacy among engineering technology students. This study examines that relationship and includes perceived cognitive offloading as a supporting measure. The focus is calculator use in a calculation-intensive engineering technology learning context.

RESEARCH QUESTIONS

This study was guided by the following research questions:

1. What is the mean calculator reliance score among Electrical Engineering Technology students?
2. What is the mean computational self-efficacy score among Electrical Engineering Technology students?
3. Is there a relationship between calculator reliance and computational self-efficacy?
4. How is calculator reliance associated with perceived cognitive offloading?
5. Does computational self-efficacy relate to students' self-perceived analytical accuracy?

METHODOLOGY

Research Design

This study employed a quantitative descriptive-correlational design. A descriptive approach was used to summarise calculator reliance, computational self-efficacy, and perceived cognitive offloading. A correlational approach was used to examine associations among the study variables without changing the teaching or learning conditions.

Participants

The analysed sample comprised 55 students enrolled in Electrical Engineering Technology programmes who voluntarily completed the online questionnaire. Of these, 54 students were enrolled in the Industrial Automation and Robotics programme, while one student reported the Bachelor of Electrical Engineering Technology programme without a stated specialisation. The respondents represented different years of study, although most were in Year 1 and Year 2. Table 1 presents the demographic profile of the respondents.

Table 1. Respondent Profile

Profile variable	**Category**	**n**	**%**
Programme	Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics)	54	98.2
Programme	Bachelor of Electrical Engineering Technology	1	1.8
Year of study	Year 1	30	54.5
Year of study	Year 2	23	41.8
Year of study	Year 3	1	1.8
Year of study	Year 4	1	1.8
Pre-university background	Diploma	36	65.5
Pre-university background	Foundation	14	25.5
Pre-university background	Matriculation	5	9.1

Instrument

Data were collected using a structured questionnaire. The questionnaire contained demographic items, calculator use profile items, and Likert-scale items measuring calculator reliance, computational self-efficacy, perceived cognitive offloading, perceptions of manual computation, and self-perceived analytical accuracy.

The questionnaire was developed specifically for this study and was informed by literature on calculator use [3], [4], [19], cognitive offloading [1], and task-specific self-efficacy [2], [8], [9], [12]–[14]. No existing validated scale was adopted in full. The items on perceptions of manual computation and self-perceived analytical accuracy were included as study-specific supporting items.

The Likert-scale items were rated from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating stronger agreement with each statement. For the purpose of this article, the analysis focused on the following measures:

1. Calculator Reliance (CR): six items measuring students' discomfort without a calculator, reliance on calculators for simple operations, preference for calculator use, difficulty starting without a calculator, calculator use for confirming numerical steps, and confidence when a calculator is available.
2. Computational Self-Efficacy (CSE): six items measuring students' confidence in arithmetic, fractions, scientific notation, algebraic manipulation, solving quantitative problems without heavy calculator reliance, and handling numerical computations in engineering courses.
3. Perceived Cognitive Offloading (PCO): four supporting items covering perceived reduction in mental effort, reduced attention to calculation processes, greater focus on concepts, and reliance on calculator outputs without deep questioning.
4. Self-Perceived Analytical Accuracy: one item measuring students' belief that their final numerical answers in quantitative subjects are usually accurate.

Composite scores for Calculator Reliance, Computational Self-Efficacy, and Perceived Cognitive Offloading were calculated by averaging the relevant item scores for each respondent. Higher scores indicated greater calculator reliance, stronger computational self-efficacy, or greater perceived cognitive offloading. No reverse coding was required for the items included in these three measures.

Data Collection and Ethical Considerations

The questionnaire was administered online, and participation was voluntary. The introductory section of the online form stated that participation or non-participation would not affect students' academic evaluation. Institutional login was required to restrict submissions to one response per account. Identifying information was excluded from the statistical analysis, and the findings were reported only in aggregate form. No individual student was identified in the reporting of the study.

Data Analysis

Data were analysed using descriptive statistics, reliability analysis, and correlation analysis. Frequencies and percentages were used to summarise demographic information and calculator use profiles. Means and standard deviations were used to describe calculator reliance, computational self-efficacy, and perceived cognitive offloading. Normality of the composite scores was assessed using the Shapiro–Wilk test. Spearman's rank-order correlation was used because some composite scores were non-normally distributed and self-perceived analytical accuracy was measured using a single ordinal item. This approach is consistent with recommendations that Likert-type responses should be analysed and interpreted carefully, particularly when the assumptions for parametric analysis may not be fully met [20]. Cronbach's alpha was used to assess the internal consistency of the multi-item measures. For the Perceived Cognitive Offloading measure, alpha-if-item-deleted values were also examined to determine whether removing any item improved internal consistency. Cronbach's alpha was interpreted as an indicator of internal consistency, while recognising that reliability estimates may be influenced by the number of items, item characteristics, and sample size [21], [22]. A p-value below 0.05 was considered statistically significant.

RESULTS

Calculator Use Profile

Students reported frequent use of calculators when solving quantitative problems. A total of 24 students (43.6%) reported that they always used a calculator, while 22 students (40.0%) reported that they often used a calculator. Another 9 students (16.4%) reported using a calculator sometimes. No respondent selected "rarely" or "never".

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Most students used a scientific calculator. Specifically, 52 students (94.5%) reported using a scientific calculator, 2 students (3.6%) reported using a combination of calculator types, and 1 student (1.8%) reported using a graphing calculator.

Table 2. Calculator Use Profile

Variable	Category	n	%
Frequency of calculator use	Always	24	43.6
Frequency of calculator use	Often	22	40
Frequency of calculator use	Sometimes	9	16.4
Type of calculator	Scientific calculator	52	94.5
Type of calculator	Combination of calculator types	2	3.6
Type of calculator	Graphing calculator	1	1.8

These results show that calculator use was common among the respondents.

Internal Consistency of the Multi-Item Measures

The Calculator Reliance measure showed good internal consistency, with Cronbach's alpha of 0.805. The Computational Self-Efficacy measure showed acceptable internal consistency, with Cronbach's alpha of 0.796. The Perceived Cognitive Offloading measure showed limited internal consistency, with Cronbach's alpha of 0.632. For the Perceived Cognitive Offloading measure, removing any individual item did not improve the coefficient. All four items were therefore retained, but findings from this exploratory measure were interpreted cautiously.

Table 3. Internal Consistency of the Main and Supporting Measures

Measure	Number of items	Cronbach's alpha	Interpretation
Calculator Reliance	6	0.805	Good
Computational Self-Efficacy	6	0.796	Acceptable
Perceived Cognitive Offloading	4	0.632	Limited; exploratory use only

Calculator Reliance

The overall mean score for Calculator Reliance was 3.75, with a standard deviation (SD) of 0.73. The item-level means (M) and SD values are presented in Table 4. The highest item mean was recorded for the statement "I feel more confident when I have a calculator with me during problem solving" (M = 4.40, SD = 0.83). This was followed by "I use a calculator to confirm almost every numerical step in my solution" (M = 4.02, SD = 1.01) and "I prefer to use a calculator rather than performing calculations manually" (M = 3.93, SD = 0.98).

The lowest item mean within the calculator reliance measure was "I rely on a calculator even for simple numerical operations" (M = 3.07, SD = 1.15). Responses were higher for the confidence and confirmation items than for calculator use in simple numerical operations.

Table 4. Calculator Reliance Item Means

Item	Mean	SD
I feel uncomfortable solving quantitative problems without a calculator.	3.58	1.08

I rely on a calculator even for simple numerical operations.	3.07	1.15
I prefer to use a calculator rather than performing calculations manually.	3.93	0.98
I find it difficult to start solving a problem if a calculator is not available.	3.53	1.09
I use a calculator to confirm almost every numerical step in my solution.	4.02	1.01
I feel more confident when I have a calculator with me during problem solving.	4.4	0.83
Overall Calculator Reliance	3.75	0.73

Computational Self-Efficacy

The overall mean score for Computational Self-Efficacy was 3.22 (SD = 0.57). Students reported the highest confidence in working with scientific notation (M = 3.64, SD = 0.91). However, lower confidence was observed for solving quantitative problems accurately without relying heavily on a calculator (M = 2.85, SD = 0.78) and solving fraction-based calculations without using a calculator (M = 2.95, SD = 0.83).

Table 5. Computational Self-Efficacy Item Means

Item	**Mean**	**SD**
I am confident in performing basic arithmetic operations manually.	3.31	0.74
I can solve fraction-based calculations without using a calculator.	2.95	0.83
I am comfortable working with scientific notation.	3.64	0.91
I can manipulate algebraic expressions confidently.	3.27	0.87
I believe I can solve quantitative problems accurately without relying heavily on a calculator.	2.85	0.78
I feel capable of handling numerical computations in engineering courses.	3.27	0.71
Overall Computational Self-Efficacy	3.22	0.57

Reported confidence varied across computational tasks and was lower for items involving reduced calculator support.

Perceived Cognitive Offloading and Related Indicators

The overall mean for Perceived Cognitive Offloading was 3.59 (SD = 0.62). The highest mean was recorded for the statement “Using a calculator reduces the mental effort required to solve problems” (M = 3.98, SD = 0.95). Students also reported that calculators allowed them to concentrate more on concepts rather than numbers (M = 3.62, SD = 0.80). The item “I sometimes rely on the calculator output without questioning it deeply” had a mean of 3.47 (SD = 0.79), indicating that the average response was above the midpoint of the five-point scale.

Table 6. Perceived Cognitive Offloading Item Means

Item	**Mean**	**SD**
Using a calculator reduces the mental effort required to solve problems.	3.98	0.95
When I use a calculator, I focus less on the calculation process.	3.29	1.05
I feel that calculators allow me to concentrate more on concepts rather than numbers.	3.62	0.8
I sometimes rely on the calculator output without questioning it deeply.	3.47	0.79
Overall Perceived Cognitive Offloading	3.59	0.62

Two additional items were analysed separately because they represented related but distinct perceptions of manual computation and were not combined into a composite measure. Students reported that they felt mentally more engaged when solving problems manually (M = 3.60, SD = 0.74) and that solving problems without a

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calculator required more concentration (M = 4.04, SD = 0.96). These responses indicate that students viewed manual calculation as requiring more concentration while also making them feel more mentally engaged.

Correlation Analysis

The normality assessment indicated statistically significant departures from normality for the Calculator Reliance and Computational Self-Efficacy composite scores, whereas the Perceived Cognitive Offloading score did not show a statistically significant departure from normality. Spearman's correlation analysis was conducted to examine relationships among the main variables.

Table 7. Spearman's Correlations among Selected Study Variables

Relationship	Spearman's ρ	p-value	Interpretation
Calculator Reliance and Computational Self-Efficacy	0.173	0.206	Not significant
Calculator Reliance and Perceived Cognitive Offloading	0.384	0.004	Significant positive relationship
Computational Self-Efficacy and Self-Perceived Analytical Accuracy	0.372	0.005	Significant positive relationship

The results show that calculator reliance was not significantly related to computational self-efficacy. This suggests that students who relied more on calculators did not necessarily report lower confidence in their computational ability. However, calculator reliance was significantly and positively associated with the exploratory measure of perceived cognitive offloading ($\rho = 0.384$, $p = 0.004$). This indicates that students with stronger calculator reliance were also more likely to perceive calculators as reducing mental effort or shifting attention during problem solving.

Computational self-efficacy was significantly associated with self-perceived analytical accuracy. This suggests that students who felt more capable of handling computations were also more likely to believe that their final numerical answers were accurate.

DISCUSSION

Calculator Use as a Common Learning Practice

Calculator use was common among the students in this study. More than four-fifths reported using a calculator always or often when solving quantitative problems. This is expected in engineering technology courses that involve frequent calculations.

However, the results also show that calculator reliance is not limited to practical convenience. The highest Calculator Reliance item was related to confidence. Students reported feeling more confident when a calculator was available. This suggests that a calculator may provide reassurance in addition to performing calculations. The study did not test whether this confidence improved actual performance.

Students may view calculators as reducing mental effort during numerical work. Because actual computational performance was not assessed, calculator reliance should not be treated as evidence of poor mathematical ability.

Computational Self-Efficacy among the Respondents

Students reported an overall computational self-efficacy mean of 3.22 (SD = 0.57). They reported the highest confidence in working with scientific notation (M = 3.64, SD = 0.91), while lower confidence was observed for solving fraction-based calculations without a calculator (M = 2.95, SD = 0.83) and solving quantitative problems without heavy calculator reliance (M = 2.85, SD = 0.78). This pattern is educationally important because engineering technology students frequently encounter fractions, ratios, exponents, units, and formula rearrangement in technical subjects.

This finding is consistent with the broader self-efficacy literature, which suggests that students' confidence in mathematics-related tasks may be shaped by prior experiences, perceived competence, and learning context [23]. Self-efficacy is also relevant because students' beliefs about their capability can influence academic persistence and engagement with challenging tasks [24]. However, self-efficacy should still be interpreted as perceived capability rather than direct evidence of actual performance [25]. In STEM-related contexts, confidence and performance may not always align perfectly, which supports the need to distinguish computational self-efficacy from actual computational accuracy [26].

More recent engineering education studies provide additional context for these findings. Hunsu et al. found that self-efficacy remained a significant predictor of achievement in an undergraduate statics course even after prior knowledge and regular class attendance were considered [15]. Power et al. also highlighted the relevance of self-efficacy to academic performance, motivation, and progression in undergraduate engineering education [16]. These studies do not directly address calculator-supported computation, but they reinforce the importance of self-efficacy as a relevant student belief in engineering learning.

Lower confidence in selected computational tasks may affect how students approach calculation-heavy activities. However, this study did not directly examine whether self-efficacy affected checking behaviour or the decision to use a calculator.

Relationship between Calculator Reliance and Computational Self-Efficacy

Calculator reliance and computational self-efficacy were not significantly correlated. In this sample, greater calculator reliance was not associated with lower reported computational confidence.

There are several possible explanations. First, some students may be confident in computation but still prefer calculators for efficiency and error reduction. Second, calculator use is common in engineering learning environments, so students may use calculators even when they feel capable of performing the calculations. Third, students may separate procedural confidence from practical tool use. They may believe that they can perform computations, but still choose calculators as the preferred problem-solving tool. These explanations are tentative because the study did not directly ask students why they chose to use calculators.

Another possibility is that calculator reliance and computational self-efficacy represent relatively distinct dimensions rather than opposite ends of a single continuum. Calculator reliance reflects students' preference for or dependence on external computational support, whereas computational self-efficacy reflects their perceived capability to perform computational tasks. Recent studies in broader digital technology contexts also suggest that self-efficacy and technological dependence may not always have a simple direct inverse relationship [17], [18]. Therefore, students may feel capable of performing computations while still preferring to use an external tool for convenience, reassurance, or efficiency. However, the non-significant relationship found in the present study should not be interpreted as evidence that the two constructs are fully independent or orthogonal. Further studies with larger samples and stronger construct validation are needed to examine whether calculator reliance and computational self-efficacy are empirically distinct.

This finding suggests that educators should be cautious when interpreting calculator use. Frequent calculator use should not be interpreted as direct evidence of weak computational ability, particularly because actual computational performance was not assessed in this study. The more important pedagogical question is whether the student understands the process, can estimate the reasonableness of the answer, and can explain the meaning of the numerical result.

Calculator Reliance and Perceived Cognitive Offloading

Calculator reliance was positively associated with perceived cognitive offloading. Students with greater calculator reliance were more likely to report that calculators reduced mental effort, shifted attention away from calculation procedures, and allowed greater focus on concepts. Because the Perceived Cognitive Offloading measure showed limited internal consistency, this association should be interpreted cautiously.

Recent work on digital cognitive offloading also suggests that reliance on digital tools may be associated with broader learning behaviours, including task persistence, critical thinking, and depth of engagement [27]. Although calculators are more limited than general digital tools, this comparison may help explain why students use external support during numerical work.

This relationship has both positive and negative implications. Calculators may reduce perceived mental effort and allow students to focus more on concepts. In engineering problem solving, this can be useful because students must interpret formulas, select correct parameters, apply units, and evaluate technical meaning. However, frequent calculator use may become a concern if students accept outputs without checking the units, magnitude, or reasonableness of the answer. This is particularly important in engineering contexts, where numerical errors can affect design decisions, troubleshooting, and safety-related judgments.

Therefore, the issue is not whether calculators should be used, but how calculator use can be balanced with computational awareness. Students should be encouraged to use calculators as support tools while still practising estimation, unit checking, and reasonableness checking.

Computational Self-Efficacy and Self-Perceived Analytical Accuracy

Computational self-efficacy was positively associated with self-perceived analytical accuracy. Students who reported greater confidence in computation also tended to report greater perceived accuracy of their final numerical answers. Both variables were self-reported and concerned students' own judgments. The association may therefore partly reflect overlap between the two measures.

However, self-perceived accuracy is not the same as actual accuracy. A student may feel confident but still make computational or conceptual errors. Therefore, future studies should include actual performance measures, such as problem-solving test scores, calculation tasks, or error analysis. This would allow researchers to examine whether computational self-efficacy predicts actual accuracy, and whether calculator reliance strengthens or weakens that relationship.

Implications for Engineering Technology Education

The findings have several implications for engineering technology education.

First, educators should avoid treating calculator use as a simple sign of weakness. The positive association between calculator reliance and perceived cognitive offloading suggests that students who report greater calculator reliance also tend to perceive calculators as reducing mental effort or shifting attention during problem solving. Such offloading may be useful when it allows more attention to be given to concepts and interpretation, although this possibility was not directly tested in the present study.

Second, students still need opportunities to strengthen computational self-efficacy. Since confidence was lower for fraction-based calculations and solving without heavy calculator reliance, instructors may consider short manual computation exercises, estimation tasks, and calculator-free warm-up activities. These activities do not need to replace calculator use, but may provide opportunities for students to practise basic numerical skills alongside calculator-supported problem solving.

Third, calculator use may be accompanied by checking strategies. Instructors may encourage students to consider whether an answer is reasonable, whether the unit is correct, whether the magnitude makes sense, and whether the calculator input was entered correctly. Such practices may help discourage uncritical acceptance of calculator outputs while maintaining the practical benefits of calculator use.

Fourth, teaching should distinguish between computation and interpretation. A calculator may produce an answer, but students must still understand what the answer means in an engineering context. This distinction is especially important in electrical engineering technology, where numerical values often represent voltage, current, resistance, power, frequency, or other technical quantities.

The results also suggest that selected concepts from educational psychology, particularly self-efficacy and perceived cognitive offloading, may help engineering educators interpret students' calculator-use behaviour. In this study, these concepts are used as supporting perspectives rather than as a new psychological model. The implications presented here should therefore be viewed as pedagogical considerations arising from the observed patterns rather than as effects of interventions tested in this study.

Limitations and Future Research

This study has several limitations. First, the sample size was relatively small and was drawn almost entirely from one programme at one institution. The sample size may also have limited the ability to detect small associations among the study variables. Therefore, the findings should be interpreted as exploratory and context-specific rather than generalisable to all engineering technology students.

Second, the study relied on self-reported data. Students' reported confidence, reliance, and perceived accuracy may not fully reflect their actual computational performance. Future research should supplement self-reported measures with at least one objective computational performance task, such as a manual calculation test, calculator-supported problem-solving task, or error-detection activity. This would allow direct comparison between students' perceived computational capability and their actual performance, and would help clarify whether calculator reliance is associated with objective computational outcomes.

Third, the Perceived Cognitive Offloading measure showed limited internal consistency and was therefore treated as exploratory. Future studies should refine and validate this measure more carefully, possibly by separating beneficial cognitive offloading from uncritical overreliance.

Fourth, this study did not examine numerical sense, checking behaviour, or self-regulated learning. Future studies may include these variables to provide a broader understanding of calculator use and computational confidence.

Fifth, self-perceived analytical accuracy was measured using a single item, which may not have captured the construct comprehensively.

Sixth, the questionnaire was developed specifically for this study and did not undergo formal pre-administration validation. Its measurement quality was assessed mainly through internal consistency analysis in the present sample. Future studies should further examine its content validity, construct validity, and factor structure.

Finally, future studies with larger and more balanced samples may examine whether calculator reliance and computational self-efficacy vary across engineering technology programmes and years of study. Year of study could also be considered as a potential control variable, together with a more direct measure of prior mathematics preparation, to reduce possible confounding when examining relationships among the main study variables. Pre-university background may provide useful contextual information, but it should not be treated as equivalent to prior mathematics preparation.

CONCLUSION

This exploratory study examined calculator reliance and computational self-efficacy among 55 Electrical Engineering Technology students. Calculator reliance was not significantly related to computational self-efficacy. This suggests that calculator reliance should not be assumed to indicate lower computational confidence. However, calculator reliance was significantly and positively associated with the exploratory measure of perceived cognitive offloading. Computational self-efficacy was also significantly and positively associated with self-perceived analytical accuracy. These results describe students' perceptions and should not be interpreted as evidence of actual computational performance.

For teaching, calculators should remain available for suitable quantitative tasks. At the same time, students should continue to practise estimation, manual calculation, unit checking, and interpretation of numerical results. Considering calculator reliance together with reported confidence and perceived mental effort may help educators support appropriate calculator use while maintaining independent checking practices.

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