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Effects of Students' Competency in using CEHRD Learning Portal and Technology integration in Mathematics on Academic Performance

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Abstract
The aim of this research was to examine how different aspects of technology use, including students' competency in using CEHRD learning portal, types of activities, content areas, and time spent using devices, affect their performance in mathematics. This study employed a cross-sectional survey design within a quantitative framework, involving a sample of 704 students from 13 schools in the Kathmandu district of Nepal using stratified random sampling technique. Data were collected using questionnaire and analyzed using frequency, percentage, ANOVA, and path analysis to examine the effects of various aspects of technology use on students' mathematics achievement. Findings indicates that the students with higher competency in using the CEHRD learning portal performed significantly better in mathematics, with highly competent students achieving the highest scores. However, there was no significant difference in achievement based on the type of technology use for learning activities or the mathematical content most frequently studied, though some positive trends were noted in areas like Algebra and learning new mathematical knowledge. Additionally, students who used mobile phones and laptops for less than one hour showed better performance than those who used them for longer periods or not at all, suggesting that moderate use of technology may be more effective for learning mathematics.

Keywords: academic performance, mathematics learning, CEHRD learning portal, digital resources, technology integration

1. Background

Alternative teaching and learning methods, as well as instructional technologies, have emerged in the twenty-first century due to technological advancements. These trends become more widely used in all subjects including mathematics education. Various studies demonstrate that utilizing technology in math instruction can significantly improve student engagement and academic outcomes (Chapai, 2023; Joshi et al., 2025). Technology can integrate in mathematics education in different forms. In mathematics classrooms, digital tools such as dynamic geometry software, interactive whiteboards, learning management systems, and AI-driven platforms offer students opportunities for active engagement and academic success in mathematics teaching and learning (Ali et al., 2023). Mobile learning is one of the notions that have emerged as a result of such advances (Güler et al., 2022). Mobile devices have been shown to improve students' mathematical thinking in a variety of learning environments, including network, virtual, and interactive settings (Açıkgül & Şad, 2021; Borba et al., 2016). Furthermore, the widespread use of technology has influenced day-to-day tasks such as finding, analyzing, communicating, or creating information for work or personal use (Hatlevik et al., 2015) demonstrating that the incorporation of online learning platforms has become an essential component of effective teaching and learning processes. Numerous studies have shown that students benefit from using digital devices such as mobile, tablet, and laptop/computers for multitasking (Kay & Lauricella, 2016) such as note-taking, access to academic software, collaboration, organizational skills, engagement and focus (Hyden, 2005), and the ability to follow multimedia-based lectures (Debevec et al., 2006). Effective uses of technology develop high level of motivation towards mathematics learning and create positive perception about homework, self-practice, learning new knowledge (Valdez & Maderal, 2021).

Recognizing the pivotal role of technology in modern education, the Government of Nepal has introduced several policies and strategic plans to promote digital education. The Information and Communication Technology (ICT) Policy 2015 emphasizes digital literacy and sets a vision to ensure internet access for all citizens and schools by 2020. Building upon this, the National Education Policy 2019 mandates the strengthening of ICT infrastructure in schools and the provision of ICT training for teachers, with a focus on integrating digital literacy into education. Similarly, the School Sector Development Plan (SSDP) 2016/17-2022/23 had taken ICT in education as a long-term goal of education. SSDP outlines several strategies to enhance ICT integration in education, including the establishment of ICT-enabled learning environments and model school ICT centers, incorporation of ICT into the secondary curriculum, development of inclusive digital materials for students with disabilities, creation of e-libraries and educational portals, teacher training in ICT-based pedagogy, development of online and offline resources in core subjects, provision of subject-specific e-learning materials with centralized repositories, and the strengthening of school governance and management through improved EMIS and implementation of the Computerized Government Accounting System (CGAS) (Ministry of Education(MoE), 2016). School Education Sector Plan, 2022/23-2031/32, prioritizes the development of digital learning materials and the transformation of selected schools into ICT hubs (MoEST, 2022).

Similarly, Digital Nepal Framework 2019 identifies eight priority sectors for the integration of digital technologies, with education being a key focus (MoICT, 2019). This framework envisions enhanced teaching and learning through digital tools and aims to produce tech-savvy human resources. Its significant components include: investment in digital literacy education; development of digital skills among human resources; promotion of innovation and talent; support for research and development; and bridging the skill gap between industry and education through the establishment of Finishing Schools. Various initiatives under this framework include the establishment of smart classrooms, implementation of online learning programs, provision of laptops, deployment of the Education Information Management System (EIMS), biometric attendance systems, installation of CCTV cameras, and promotion of mobile learning in rural areas. Additionally, the Student Learning Facilitation through Alternative Modes Guideline 2020 underscores the use of online and alternative learning methods to ensure continuity of education during disruptions, such as those experienced during the COVID-19 pandemic. Complementing this, the Teacher Professional Development through Distance Education System (SOP-2020) outlines provisions for continuous professional development of teachers through online, face-to-face, and blended learning modes, based on contextual needs and circumstances.

Despite the introduction of progressive educational policies in Nepal aimed at promoting digital learning, the practical implementation of these initiatives remains limited and inconsistent particularly in rural and resource-constrained regions (Joshi et al., 2023). Many schools continue to struggle with inadequate infrastructure, unreliable internet connectivity, and a shortage of trained personnel (Adhikari et al., 2022; Khanal et al., 2022), all of which hinder the meaningful integration of technology into everyday classroom instruction. In the context of virtual mathematics learning, students face numerous barriers, including lack of access to digital devices, the unaffordable cost of acquiring such devices, insufficient training in digital skills, difficulties in submitting assignments online, and limited overall digital literacy (Joshi et al., 2024). Furthermore, in Nepalese context both teachers and students often keep only basic digital competencies (Joshi, 2016; Joshi et al., 2022), obstructing their ability to effectively utilize educational technologies. Although national policy frameworks underscore the importance of digital transformation in education, a substantial disconnect persists between policy intentions and the actual conditions in classrooms.

Traditional teaching methods are increasingly seen as outdated in today's era of globalization. Conventional approaches can lead to student boredom and lack of motivation (Sharp et al., 2017). As an alternative, learning portals offer a promising solution by providing educational content through a mix of media formats such as text, animation, graphics, audio, and video which helps sustain student interest and enhance academic performance (Abdulrahaman et al., 2020). Moreover, these portals not only support effective knowledge delivery by teachers but also foster a more active and engaging learning environment for students. In this context, the Center for Education and Human Resource Development (CEHRD) learning portal by the Government of Nepal to enhance teaching and learning processes through digital means (Joshi et al., 2025). It is designed primarily to support school-level education, the portal provides a centralized access point for curriculum materials, digital textbooks, interactive learning resources, teaching materials for teachers and SEE exam materials for students. It aims to bridge gaps in educational equity by making high-quality educational content accessible to students and educators across different regions, including remote and underserved areas. The CEHRD portal plays a pivotal role in promoting digital literacy and integrating information and communication technology (ICT) into the national education system, supporting a more engaging and self-directed learning environment for students.

Although international studies have examined the positive influence of digital skills and technology integration on students' academic performance, there is a limited research in the Nepalese context—especially focused on mathematics learning outcomes. Few studies have explored how digital competencies among students and teachers, along with the degree of technology integration, actually impact learners' performance in mathematics. This gap becomes more critical given the government's strong emphasis on ICT based education as a catalyst for national development. Therefore, this study aims to investigate the effects of digital competency and technology integration on mathematics learning outcomes among students in Nepal. To fulfill the mentioned objectives the following research questions were formulated.

- How does students' competency in using the CEHRD learning portal influence their mathematics achievement?
- Is there a significant difference in mathematics achievement based on the type of technology use for learning activities (e.g., homework, self-practice, learning new knowledge)?
- Does the mathematical content area most frequently studied with technology impact students' achievement scores?
- What is the relationship between the amounts of time spent using mobile devices for mathematics learning and students' achievement?
- How does the duration of laptop use for mathematics learning affect students' performance in mathematics?

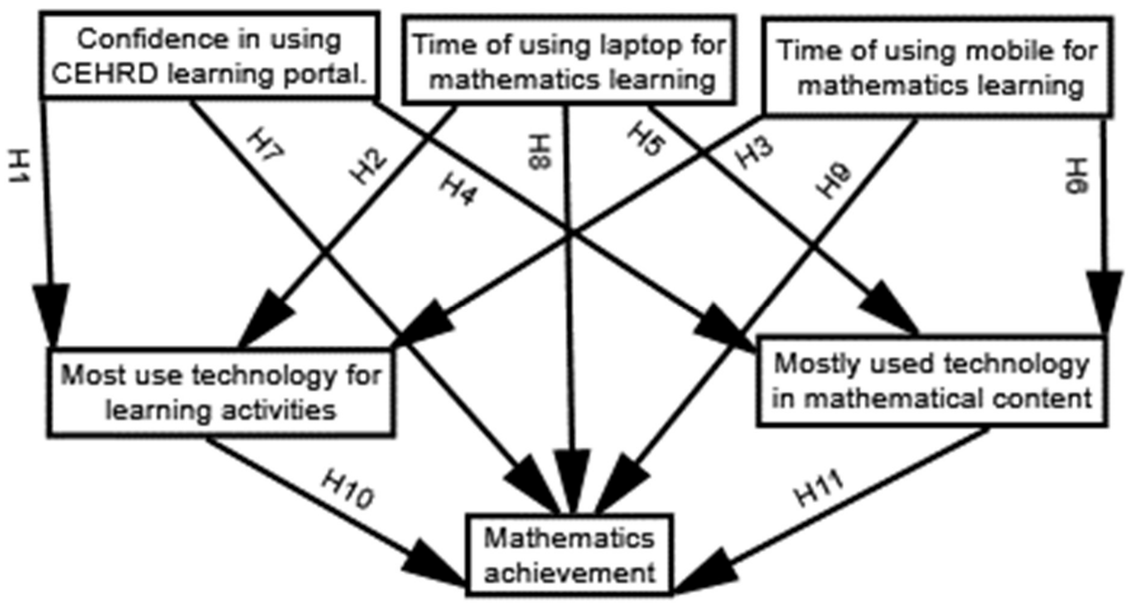
1.1 Literature Review

This section includes relevant literature to the current investigation. It is structured and explains about students' competency in using learning portal, technology utilization for learning activities, effect of time spent in technology on students' achievement. Technology-enhanced education as one that using ICT as mediating devices to facilitate student learning through diverse applications such as web-based learning, computer-based learning, and learning management systems (Yu, 2022). Hence, it is necessary to know students Digital competency to evaluate the effectiveness of educational technology integration. Ali et al.(2019) studied to identify the effect of using Design and technology subject (DST) learning portal on students' achievement compared with using conventional teaching method with quasi-experimental research design and found that the competency level of usability of the learning portal was very high. Further their findings show that learning portal has a very high level of usability and the use of portal significantly improve students' achievement in DST subject. Zhao et al. (2021) found that digital competencies of students' in terms of information and data literacy, communication and collaboration, and safety were positive. Significant differences were observed based on gender, grade level, residence, and prior training. The study emphasized promoting skills such as digital content creation and addressing everyday tech challenges. It also highlighted the need for ICT training, support for female students in specific digital areas, and assistance for younger and rural students in developing digital competence. Joshi et al.(2024) investigates the complications faced by students in learning mathematics in virtual platform of Nepal and found that access of digital devices, training on digital skills, assignment submission skills and digital literacy as major complications. Additionally, these complications to learning mathematics negatively affect students' academic performance. Upadhayaya et al. (2021) studied on the perception of online and distance learning among postgraduate students in Nepal. Their result shows that quality, opportunity, relevance, and support plays significant role to use learning portal across their homes. However, there was no significant difference in their views across the variables gender, ethnicity, school type, and device use in relation to other criteria.

A result of the meta-analysis conducted by Güler et al.(2022) revealed that mobile learning has a moderate positive effect on students' mathematics performance. The moderate positive effect may be considered as logical, as mobile learning is not fully a remedy however its considerable positive impact (Criollo-C et al., 2018). In addition, studies show that a positive effect of mobile learning on students’ self-efficacy and motivation (Ciampa, 2014). Moreover, the increment of this effect students’ self- efficacy and motivation can resulting a positive impact on their achievement (Castillo-Merino & Serradell-López, 2014).

Students' proficiency with learning portals is also impacted by how much time they spend learning mathematics on digital devices. According to the study of Lin et al. (2023), incorporating digital games into math instruction greatly enhances students' learning performance and engagement. The study assesses how well tablet-based digital games can increase students' learning of mathematics. Joshi, Chapai, et al. (2025) revealed that greater mathematics proficiency is significantly predicted by the usage of digital resources both within and outside of the classroom, including during free time. Similarly, Kayumova et al. (2021) and Lemke and Schifferstein (2021) found a positive correlation between students' performance in mathematics and their use of digital resources. After reviewing the literature and based on the research questions the conceptual framework shown in the Figure 1 is developed.

Figure 1: *Conceptual framework (Hypothesized model)*



2. Methodology

This research utilized a cross-sectional survey approach within a quantitative framework involving school students in the Kathmandu district of Nepal. A sample size of 384 was sufficient for representativeness based on a 95% confidence level, a 5% margin of error, and a 50% population proportion (https://www.calculator.net/sample-size-calculator.html) for the population 75021 (MoEST, 2020). However, researchers took 836 sample for the research ensuring representation of each category of school types (community and institutional), gender (boys and girls), and study level (Basic and secondary) using stratified random sampling technique. However, 132 sample were excluded by missing cases in each considered variables in this research hence 704 is the actual sample utilized in this research. The researchers applied the random number table technique to choose 13 schools (five community and eight institutional) while students were selected randomly. After selecting schools, 42 students (21 girls and 21 boys) from the eighth and tenth grades were picked from community schools, while 26 students (13 girls and 13 boys) from the same grades were chosen from institutional schools.

2.1 Variable information

Six variables as competency of using CEHRD learning portal (CCLP), most use of technology for learning activities (MUTLA), most use of technology in mathematical content (MUTMC), time of using mobile for mathematics learning (TUMML), time of using laptop for mathematics learning (TULML), and mathematics achievement score (reported from school record) were used in this research. The competency of using CEHRD learning portal was measured in four-point rating scale as no competent, low competent, somehow competent, and highly competent whereas the most use of technology for learning activities have four categories as homework, self-practice, learning new knowledge, and others. Similarly, most use of technology in mathematical content have eight categories as Set, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, and Probability. Additionally, time of using mobile and laptop for mathematics learning have three categories as no time given, less than one hour, and more than one hour.

2.2 Data Collection

The survey data were collected by field visit as face-to-face mode from October 2024 to January 2025 using the survey questionnaire translated in Nepali whereas the achievement score was taken from official record of the institution. The participant consent was obtained during the data collection period. The ethical approval was obtained from Institutional Review Committee, Research Management Cell, Mahendra Ratna Campus Tahachal, Tribhuvan University, Nepal (Ref. No. 001-2081/2082, Approval Number RNC-IRC/001-2081-2082) in this research.

2.3 Data Analysis

Different data analysis techniques were applied in the research as frequency, percentage, analysis of variance (ANOVA), and path analysis. Test of significant difference in mathematics achievement based on the type of technology use for learning activities (e.g., homework, self-practice, learning new knowledge), competency of students in using CEHRD learning portal, use of technology in different mathematical content, and time of using laptop and laptop for mathematics learning was measured by ANOVA. Similarly, effect of type of technology use for learning activities (e.g., homework, self-practice, learning new knowledge), competency of students in using CEHRD learning portal, use of technology in different mathematical content, and time of using laptop and laptop for mathematics learning on mathematics achievement was measured by path analysis and Flexplot methods. Additionally, the effect of these variables also measured on the achievement categories as not graded (<35%), basic (35-40%), acceptable (40-50%), satisfactory (50-60%), good (60-70%), very good (70-80%), excellent (80-90%), and outstanding (90-100%).

3. Result

The table presents the effects of various factors on students' mathematics achievement scores, measured by mean scores and standard deviations, along with significance levels (p-values). Among the variables, competency in using the CEHRD learning portal (CCLP) showed a statistically significant effect on achievement ($p = 0.03$), with Highly Competent (HC) students achieving the highest mean score ($M=60.12$), notably above those with lower competency levels. In contrast, the most frequent use of technology for learning activities (MUTLA) and mathematical content focus (MUTMC) did not show significant effects ($p=0.32$ and $p=0.80$, respectively), although students using technology for "Other" purposes or focusing on "Algebra" had relatively higher mean scores. Regarding device usage, time spent using a mobile device (TUMML) for math learning approached significance ($p=0.07$), with those not using mobile devices at all slightly outperforming others. Similarly, time spent using a laptop (TULML) showed a marginally significant effect (p=0.05), where students using laptops for less than an hour had the highest mean score (M=56.21), suggesting that moderate use may be more beneficial than extended usage. Overall, the findings suggest that higher competency in using the CEHRD portal is meaningfully associated with better mathematics achievement, while the frequency and nature of technology use have mixed or less significant impacts.

Table 1: *Mean difference of mathematics achievement score based on sample characteristics* (n=704)

Variables	N	Mean	SD	P-Value
Competency of using CEHRD learning portal (CCLP)				
No competent (NC)	383	52.23	22.27	0.03
Low competent (LC)	118	52.07	21.15	
Somehow competent (SC)	127	51.72	20.43	
Highly competent (HC)	76	60.12	22.48	
Most use of technology for learning activities (MUTLA)				
Homework (HW)	207	51.34	21.51	0.32
Self-practice (SP)	59	53.10	20.84	
Learning new knowledge (LNK)	372	53.10	22.15	
Other	66	57.11	22.37	
Most use of technology in mathematical content (MUTMC)				
Set	128	51.09	20.81	0.80
Arithmetic	70	51.91	26.87	
Mensuration	58	52.76	17.44	
Algebra	92	56.29	22.09	
Geometry	188	52.78	20.83	
Trigonometry	116	53.77	23.63	
Statistics	41	53.12	21.10	
Probability	11	48.64	22.80	
Time of using mobile for mathematics learning (TUMML)				
No time given	199	54.27	20.96	0.07
< 1 hour	329	53.92	21.75	
>1 hour	176	49.69	22.94	
Time of using laptop for mathematics learning (TULML)				
No time given	396	52.87	22.14	0.05
< 1 hour	150	56.21	21.46	
>1 hour	158	50.11	21.36	

Figure 2_a presents the categorical effects of students' competencies in using the CEHRD learning portal (CCLP) on their mathematics achievement scores (MathP). The four levels of competency—no competent (NC), low competent (LC), somewhat competent (SC), and high competent (HC)—are compared across performance categories. The results show that students with *High Competency* in using the portal tended to achieve higher scores, particularly those in the *Excellent* and *Very good* categories, indicating a strong positive

correlation between advanced portal use and performance. On the other hand, students with *Some Competency* display mixed outcomes, with those in the *Basic* category experiencing notable negative effects. Interestingly, even among students with *No* or *Low Competency*, a few positive gains were observed in the *Basic* and *Acceptable* categories, though these gains are modest. Overall, the figure suggests that proficient use of the CEHRD learning portal is associated with better mathematical achievement.

Figure 2_b illustrates the categorical effects of students' use of technology in various learning activities—Homework (HW), Self-practice (SP), Learning new knowledge (LNK), and Other—on their mathematics achievement (MathP). The graph reveals that the impact of technology use varies across both activity type and performance level. For Homework, the effects are generally neutral to slightly positive, with minor negative impacts observed in the "Basic" and "Outstanding" categories. In contrast, Self-practice shows the widest variation, where students categorized as "Very good" and "Excellent" experience strong positive effects, while those in the "Basic" and "Outstanding" categories face notable negative impacts. For Learning new knowledge, technology use appears beneficial, especially for students rated as "Very good" and "Outstanding," though a negative impact was seen for "Basic" users. The "Other" category presents mixed results, with positive effects for higher-performing students and negative effects for those in the "Basic" group.

Figure 2_c illustrates the categorical effects of students' most used technology in mathematics content (MUTMC) on their achievement scores (MathP). The results reveal varied impacts depending on both the domain and the level of technology engagement. In domains such as Trigonometry and Probability, performance outcomes were highly polarized—students categorized under "Basic" show strong positive gains, whereas those labeled "Outstanding" sometimes show significant declines, particularly in Probability. Conversely, domains like Mensuration, Algebra, and Geometry tend to benefit from moderate levels of technology use, with students in the "Acceptable," "Satisfactory," and "Good" categories generally showing positive achievement effects. Interestingly, over-reliance on technology, as seen in the "Very good" and "Outstanding" groups, is associated with reduced performance in fundamental areas like Arithmetic, suggesting possible drawbacks of excessive technology use.

Figure 1_d presents the categorical effect of students' time spent using mobile devices for mathematics learning (TUMML) on their achievement scores in mathematics (MathP), divided into three groups: No Time Given (NTG), less than 1 hour, and more than 1 hour. The chart reveals differing impacts based on the duration of mobile use and students' performance levels. In the NTG group, the "Basic" category shows a strong positive effect, while "Not graded" indicates a moderate negative effect. For students using mobile devices for less than 1 hour, most performance categories show minimal impact, with slight positive effects for "Acceptable," "Satisfactory," and "Excellent." However, when usage exceeds 1 hour, the "Not graded" and "Basic" categories show negative effects on achievement, while "Good" and "Very good" display moderate to strong positive impacts. In summary, the figure suggests that moderate mobile use (less than 1 hour) is generally neutral or slightly beneficial, whereas excessive use may hinder achievement for lower-performing students but can still support improvement among higher achievers.

Figure 2_e illustrates the categorical effect of students' time spent using laptops or computers for mathematics learning (TULML) on their mathematics achievement scores (MathP), categorized into three-time groups: No Time Given (NTG), less than 1 hour, and more than 1 hour. The results show varied impacts depending on both usage time and performance levels. In the NTG group, students classified as "Basic" show a moderate positive effect, while others remain close to neutral. For those using laptops/computers for less than 1 hour, the impact is mixed: the "Basic" category experiences a significant negative effect, whereas "Very good," "Excellent," and "Outstanding" students exhibit positive gains, especially "Very good," which shows the highest positive effect in the entire chart. Among students who used laptops/computers for more than 1 hour, performance effects range from mildly negative (in categories like "Very good" and "Outstanding") to positive for "Acceptable," "Satisfactory," and "Good." Overall, the data suggest that brief, focused use of laptops/computers (less than 1 hour) was particularly beneficial for higher-performing students, while prolonged use may have diminished or negative returns, especially for lower-performing students.

Figure 2_f illustrates the categorical effect of students' competencies in using the CEHRD learning portal on their most frequent uses of technology in mathematics learning activities. The competency levels—No Competent (NC), Low Competent (LC), Somehow Competent (SC), and Highly Competent (HC)—show varied patterns across four main usage categories: Homework (HW), Self-Practice (SP), Learning New Knowledge (LNK), and Other. Students identified as Highly Competent (HC) demonstrated a strong positive association with self-practice and moderate engagement in other uses, while showing a negative association with using technology for homework. Those who were Somehow Competent (SC) tended to use technology more for homework but less for self-practice and learning new knowledge. Low Competent (LC) students showed negative associations with self-practice and other uses, indicating limited and less diverse engagement. Meanwhile, No Competent (NC) students showed minimal to no significant effect across all categories. Overall, the data suggests that higher competency in using the CEHRD portal is linked to more autonomous and varied uses of technology in mathematics learning.

Figure 2_g displays the categorical effect of students' competency in using the CEHRD learning portal (CCLP) on their most frequent use of technology across various mathematical content areas. The chart includes content categories such as Set Theory, Arithmetic, Mensuration, Algebra, Geometry, Trigonometry, Statistics, and Probability. Students with No Competency (NC) show minimal variation, with only slight engagement across topics. Low Competent (LC) students exhibit notable negative associations with Probability, Trigonometry, and Mensuration, but a positive association with Mensuration and Algebra. In contrast, Somehow Competent (SC) students demonstrate diverse usage, including strong negative associations with Probability and Mensuration, and a positive trend in Geometry. Highly Competent (HC) students display a pronounced positive association with Probability, as well as moderate usage of Set Theory and Statistics, while showing reduced emphasis on Arithmetic and Mensuration. This suggests that students with higher competency are more likely to engage with abstract and data-related mathematical content using technology, whereas those with lower competency lean toward foundational or concrete topics, often with less consistency.

Figure 2_h illustrates the distribution of students across various mathematics achievement categories. The largest portion of students, 23.6%**,** falls into the "Not graded" category, suggesting a significant number either did not participate in assessment or their performance was not formally evaluated. Following this, 17.6% of students achieved a "Satisfactory" level, and 15.9% reached the "Acceptable" level. 14.9% demonstrated "Good" performance, while 9.5% achieved a "Very good" status, and 7.8% attained an "Excellent" rating. Smaller proportions were noted in the "Outstanding" (6.5%) and "Basic" (4.1%) categories. This distribution indicates that while a fair number of students are performing at satisfactory to good levels, a substantial proportion remains either ungraded or only marginally meeting achievement standards, highlighting potential gaps in assessment participation or learning outcomes.

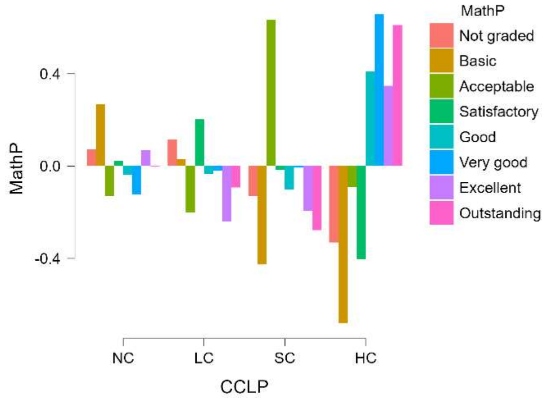


Figure 2_a: *Categorical effect of students' CCLP on achievement score*

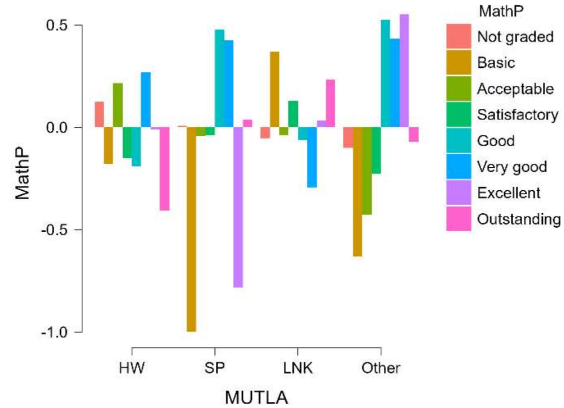


Figure 2_b: *Categorical effect of students' MUTLA on achievement score*

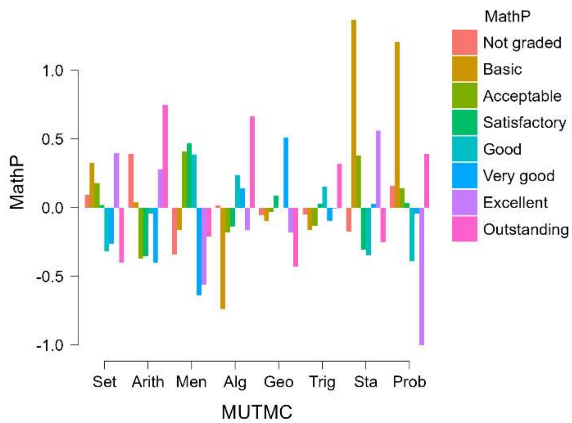


Figure 2_c: *Categorical effect of students' MUTMC on achievement score*

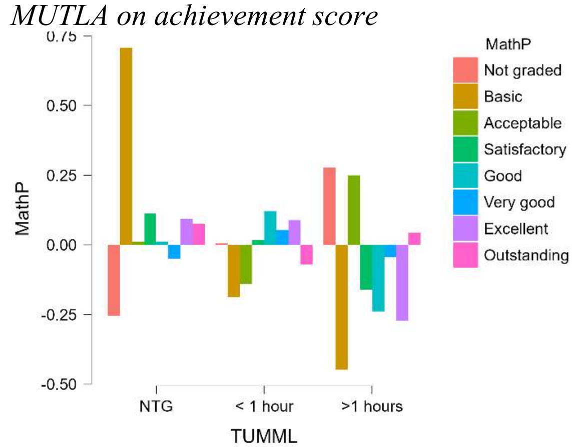


Figure 2_d: *Categorical effect of students' TUMML on achievement score*

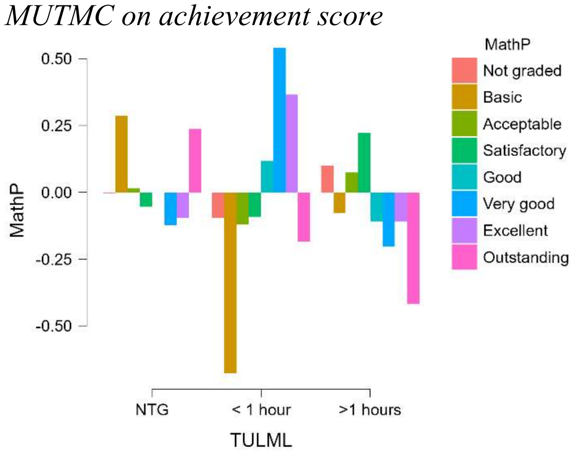


Figure 2_e: *Categorical effect of students' TULML on achievement score*

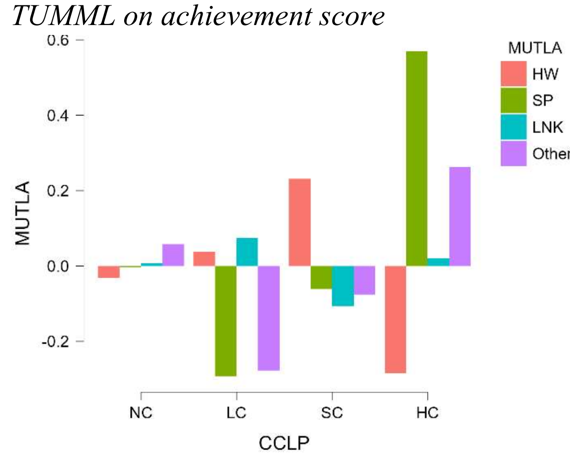


Figure 2_f: *Categorical effect of students' CCLP on MUTLA*

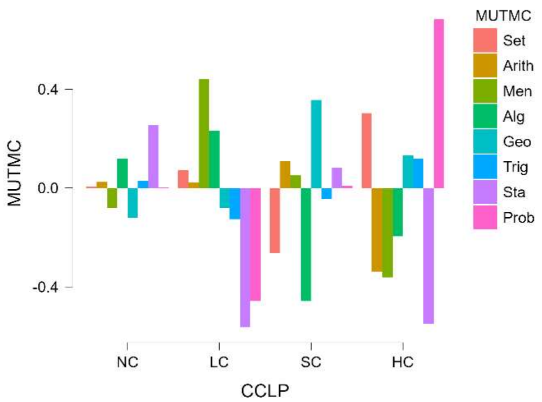


Figure 2_g: *Categorical effect of students' CCLP on MUTMC*

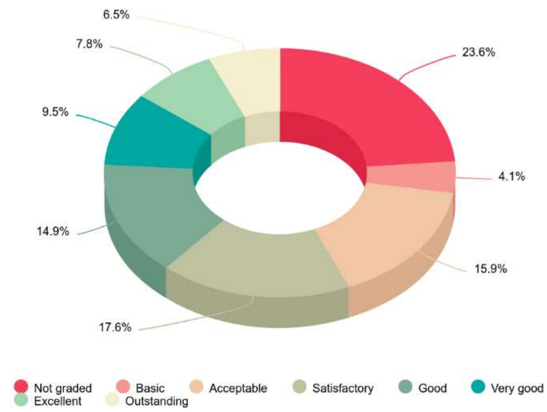
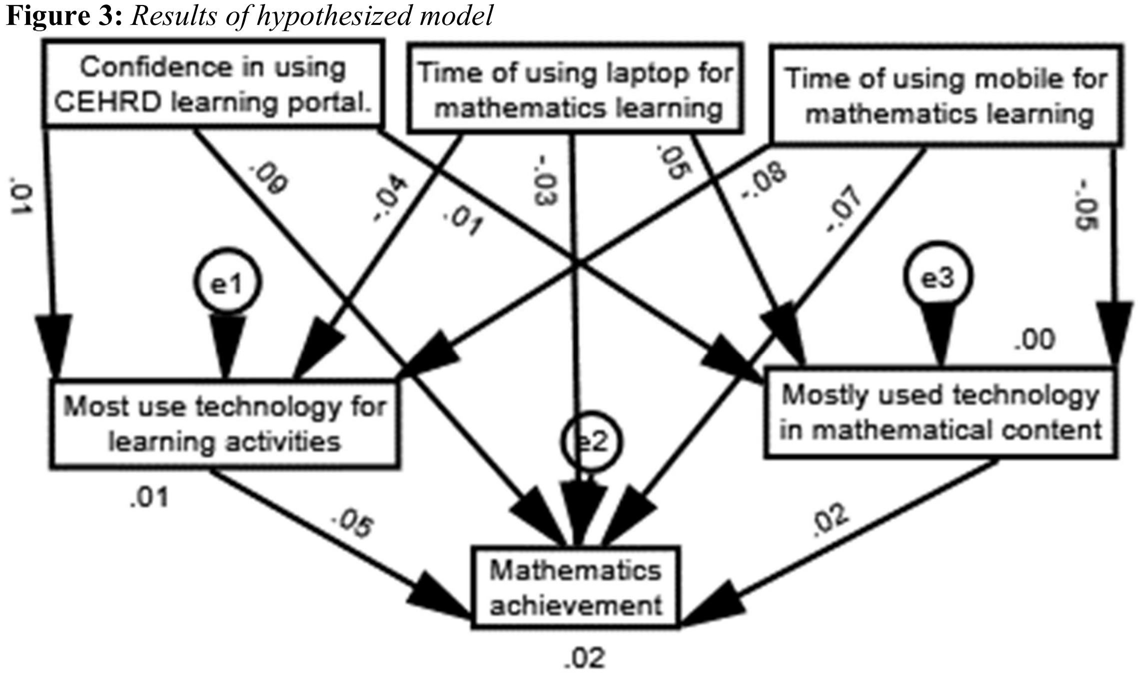


Figure 2_h: *Status of students on mathematics achievement categories*

Figure 3 presents a path analysis model illustrating the relationships among various factors influencing students' mathematics achievement. Key predictors include confidence in using the CEHRD learning portal**,** time spent using a laptop and mobile devices for mathematics learning, and two mediating variables: most used technology for learning activities and most used technology in mathematical content. The results indicate that while some paths (e.g., from time of using laptop to mathematics achievement at 0.08 and from time of using mobile to mathematics achievement at 0.02) show slightly positive standardized regression weights, most relationships are weak and statistically non-significant. Notably, confidence in using the CEHRD portal has a minimal direct effect (0.01) on the use of technology for learning activities, and ultimately, a negligible impact on mathematics achievement. Additionally, both mediators—most used technology for learning activities and content—demonstrate minimal influence on achievement (0.05 and 0.02 respectively). Overall, the model suggests that while these technological and behavioral factors are conceptually linked to mathematics achievement, their actual explanatory power in this study is quite limited.

Figure 3: *Results of hypothesized model*



4. Discussion

This study investigated how students’ digital competencies and patterns of technology use influence their achievement in mathematics, particularly within the context of Nepal’s national digital education initiatives. The findings offer nuanced insights into how competency in using digital learning platforms and the nature and duration of technology use affect mathematics performance.

4.1 Influence of CEHRD learning portal competency on mathematics achievement

The results clearly demonstrate a significant positive relationship in between highly competent students in the use of CEHRD learning portal with mathematics achievement. This finding aligns with previous research by Ali et al. (2019), who noted that learning portals with high usability contribute positively to academic performance. Similarly, Zhao et al. (2021) emphasized the value of developing students' digital competencies—such as data literacy, communication, and content creation—which this study suggests are essential for effective portal use. Furthermore, students with higher portal competency engaged more autonomously in self-practice and learning new knowledge, rather than relying solely on teacher-directed activities like homework. This supports the idea that digital competency fosters independent learning behaviors, which are associated with improved academic performance. However, the path analysis indicated that while competency had a direct statistical association with achievement, its indirect influence through mediating variables was limited, suggesting that other contextual or instructional factors may moderate this relationship.

4.2 Type of technology use for learning activities and its impact on achievement

Students’ mathematics achievement varied by type of technology use—homework, self-practice, learning new knowledge, or other however the result is not significant indicates patterned differences across performance levels and activities. Students who used technology for self-practice and learning new knowledge—particularly those in the "Very Good" and "Excellent" categories—tended to perform better. These findings are consistent with prior studies (e.g., Ciampa, 2014; Castillo-Merino & Serradell-López, 2014), which showed that technology use for active, student-driven tasks enhances motivation and self-efficacy, thereby improving achievement. In contrast, technology use for routine or passive tasks like completing homework had more neutral or inconsistent effects. The results highlight the importance of promoting engaging and exploratory uses of technology, rather than treating it merely as a tool for completing assignments.

4.3 Impact of mathematical content focused on during technology use

Content areas like Algebra, Geometry, and Mensuration showed moderate gains with technology use, particularly among mid-level achievers. However, overuse or exclusive focus on certain domains, such as Probability and Arithmetic, appeared to result in diminished performance among higher achievers. This supports findings from Lin et al. (2023), who emphasized the value of context-appropriate digital tools, and suggests that the effectiveness of technology integration may depend on both the mathematical content and the level of student proficiency. Students with stronger foundational knowledge may not benefit equally from heavy tech use in simpler content areas, perhaps due to redundancy or distraction.

4.4 Relationship between time spent using mobile devices and mathematics achievement

Students using mobile devices for less than an hour generally saw neutral to slightly positive outcomes, while excessive use (>1 hour) was associated with negative impacts for low-performing students, though it showed moderate benefits for high achievers. This finding aligns with Güler et al. (2022), who reported a moderate positive effect of mobile learning, and Criollo-C et al. (2018), who cautioned against viewing mobile learning as a panacea. In Nepal's context, where digital access and supervision vary, these results underscore the importance of regulated and purposeful use of mobile devices for learning. Overuse may lead to cognitive overload or non-academic distractions, especially for students with weaker self-regulation.

5. Conclusion

This study examined the influence of digital competency and technology integration on mathematics achievement among students in Nepal. The findings highlight that student with high competency in using the CEHRD learning portal performed significantly better in mathematics. However, the frequency and nature of technology use—such as type of activity or content focus—had mixed effects, with moderate use generally more beneficial than prolonged use. Notably, moderate engagement with laptops and self-directed learning activities like self-practice and learning new knowledge yielded better outcomes than routine uses like homework. These findings underscore the nuanced role of technology in learning, where digital competence and purposeful use matter more than mere access or frequency.

The findings of this study offer several practical implications for educators, school leaders, and policymakers. First, the significant association between students' digital competency—particularly in using the CEHRD learning portal—and their mathematics achievement highlights the need for targeted digital literacy training. Schools should integrate structured digital skill-building programs into the curriculum, with a focus on fostering self-directed learning through educational platforms. Teachers should also be equipped with professional development opportunities to incorporate technology meaningfully into their pedagogy, moving beyond basic use for assignments to more interactive and concept-focused strategies. At the policy level, while infrastructure development is important, equal emphasis must be placed on ensuring the effective use of technology, especially in rural and under-resourced areas. This includes creating inclusive digital content, improving access to devices, and providing contextualized support to students who may lack prior exposure to technology-based learning.

Despite the valuable insights, this study has several limitations. The use of a cross-sectional design restricts the ability to establish causal relationships between technology use and mathematics achievement. Data collected through self-reported surveys may be affected by recall bias or social desirability, potentially influencing the accuracy of reported technology usage patterns. Additionally, the study sample may not fully represent all socio-economic, geographic, or linguistic groups across Nepal, particularly those in remote areas with limited internet access. The weak explanatory power of the path analysis suggests that other critical factors—such as teacher effectiveness, parental involvement, or the quality of instructional materials—were not captured in the current study. This study is limited to self-reported perception of the students regarding the measured independent variables. These limitations indicate the need for further research using longitudinal and mixed-method approaches to explore the deeper mechanisms through which digital tools and competencies influence learning outcomes.

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Data Availability

The data will be available with reasonable request of first author (Principal Investigator of the project).

Declaration of Generative AI in Scientific Writing

While preparing this manuscript, the authors employed AI tools to enhance the language however these tools were not applied to generate content.

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