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# An Approach towards Online Mathematics: Students' Perspective

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**ABSTRACT**

This study examined students' practices towards teaching and learning mathematics online at Ifugao State University (IFSU) Potia Campus. Specifically, it aimed to identify the learning resources used, challenges encountered, and the potential development of Information, Education, and Communication (IEC) materials to address these challenges. Employing a mixed-methods approach, the research included a quantitative survey of 300 respondents and qualitative semi-structured interviews. A single-stage cluster sampling technique was used to ensure a representative sample of the student population. The findings revealed that YouTube was the most utilized online resource, highlighting its accessibility and user-friendly nature. However, significant challenges, such as unstable internet connectivity, limited real-time interaction, and software malfunctions, hindered students' learning experiences. The qualitative data provided deeper insights into additional obstacles faced by students, such as geographical limitations affecting internet access. Based on these findings, the study proposed the development of an IEC material titled "Digital Math Mastery: Navigating the Online Learning Landscape," which aims to inform students about available resources and address the challenges encountered. The study also recommended implementing awareness programs, enhancing communication strategies, and conducting further research to explore additional challenges and resources in online mathematics education.

**Keywords:** Online Math, Learning Resources, Challenges, IEC Material

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## Introduction

The shift to online learning, driven by the COVID-19 pandemic and advancements in educational technology, has reshaped the traditional classroom experience at Ifugao State University Potia Campus. Despite the growing use of digital tools and platforms, students face persistent challenges in adapting to this new mode of learning, particularly in subjects like mathematics that require structured interaction and immediate feedback.

Existing solutions to address online learning difficulties, such as access to various learning resources (websites, applications, etc.), have been implemented. However, the effectiveness and appropriateness of these resources for teaching mathematics remain largely unexamined. While digital platforms offer new opportunities, students still report difficulties in navigating these tools effectively.

This study filled this gap by identifying the learning resources students utilize and the challenges they face in their online mathematics education. By examining these factors, the research hopes to provide insight into the current state of online mathematics learning and highlight areas where improvements are needed. Furthermore, the development of Information, Education, and Communication (IEC) materials based on the findings addressed identified challenges, offering practical solutions to improve the learning experience for students in this digital environment.

This study determined the student's practices towards teaching and learning mathematics online. The study used a Descriptive Quantitative and Qualitative Research Design which determined the students' practices in teaching and learning mathematics online. It was conducted at Ifugao State University Potia Campus. This study also discussed the challenges encountered by the respondents and other learning resources they utilized. The study figured the awareness of the students in using various learning resources.

Since students at Ifugao State University (IFSU) Potia Campus are not well informed about the resources available online, the current solutions to the challenges of online learning have proven insufficient. While there are various digital platforms and learning tools accessible, many students lack awareness of how to effectively utilize these resources for their mathematics education. Additionally, existing support mechanisms have not adequately addressed specific difficulties, such as unstable internet connections, lack of suitable devices, and limited interaction with instructors and peers. The absence of comprehensive strategies to ensure equitable access to online learning for students in rural or disadvantaged areas further exacerbates these issues. This study identified these gaps in resource awareness and accessibility, ultimately proposing tailored Information, Education, and Communication (IEC) materials to enhance students' online learning experience in mathematics.

## Statement of the Problem

The analysis of the current situation revealed that online learning, particularly in mathematics, presented significant challenges for students at Ifugao State University (IFSU) Potia Campus. Despite the widespread adoption of digital platforms, many students faced persistent issues such as unstable internet connections, lack of access to proper learning devices, and environmental distractions, which severely hindered their learning experiences. Additionally, the complexity of mathematical problem-solving methods and the lack of immediate support further complicated students' ability to understand difficult concepts in an online setting.

These problems were critical because they directly impacted students' academic performance and their ability to effectively engage with the subject matter. Mathematics, in particular, required high levels of interaction, feedback, and practical application, which were often lacking in the online environment. Furthermore, inequitable access to resources and reliable internet disproportionately affected students in rural or economically disadvantaged areas, widening the digital divide and creating barriers to learning.

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Addressing these issues was essential to ensure that all students, regardless of their circumstances, had a fair opportunity to succeed in their studies. The study aimed to identify these gaps and challenges to propose solutions that could improve the online learning experience and create a more inclusive educational environment.

## Objectives

This study determined the student's practices towards teaching and learning mathematics online. Specifically, the study sought to answer the following questions:

1. What are the learning resources used online (website, applications, etc.) in learning mathematics?
2. What are the challenges encountered by the respondents in online learning?
3. What are other challenges encountered by the respondents in online learning?
4. What Information, Education and Communication (IEC) Material can be developed to address the challenges met by the respondents in learning mathematics online?

## Conceptual Framework

Authors, researchers, theorists, and educators have defined online earning in different ways based on the angles of various perspectives and disciplines. On one hand, Means, Toyama, Murphy, and Baki (2013) defined OL as learning that occurs ertirely (purely online learning) or partially (blended learning) through the Internet. On the other hand, Bakia, Shear, Toyama, and Lasseter (2012) viewed online learning as "instructional environments supported by the Internet. Albrahim (2020) referred online learning as a learning experience that allows for growing. acquiring knowledge, and constructing personal meaning by providing access to learning materials through the Internet; interacting with the content, instructor, and other learners; and obtaining support during the leaning process.

Alman and Tomer (2012) noted that teaching online may provide opportunities for online instructors to learn about the principles of instructional design and technology, online pedagogies, and emergent technologies. Online teaching. therefore, would help faculty members to expand their professional community, exchange best practices and feedback, and enhance their teaching and career portfolios.

With all the researches and evidences in the advantage of online learning, Concerns about the problems that might emerge in online environments have grown. According to Pallof, et. al., (2013), it is important to note that online learning is not a replacement for face-to-face education. Generally speaking, faculty members receive very little training and preparation for teaching in higher education. Having said that, the impact of this lack of preparation is magnified in online learning environments.

The fast shifting of learning platforms motivated the researcher to study the students' preferences in learning mathematics online, to understand how the students dealt with online learning, and to come up with a generalization on what intervention program should be developed in order to improve learning mathematics online.

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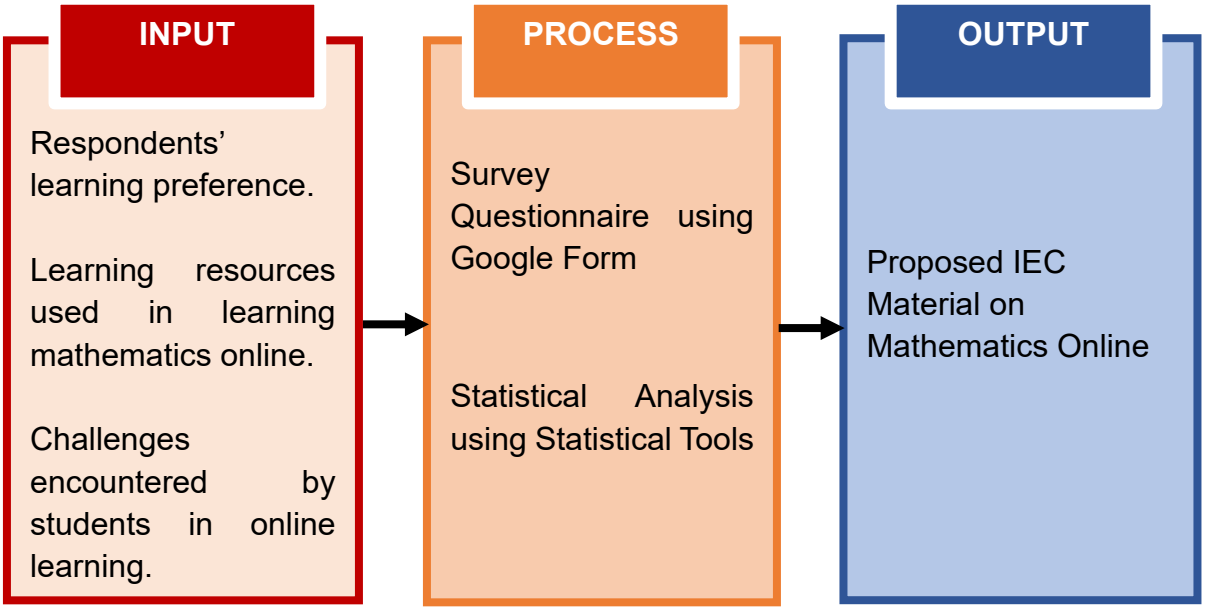


**Paradigm of the Study**

## Review of Related Literature

The sudden shift of the pedagogical processes of schools around the world to online platform is the result of the onset of the COVID-19 pandemic as well as the transformation of the world into technological society (Li & Lalani, 2020). Using this teaching-learning mode, technology substitutes almost all face-to-face interactions since lessons are delivered online. Everyone is adjusting in this learning platform. Students and teachers are used to have a face-to-face interaction, however, in the online learning, teaching-learning is delivered virtually. This poses challenges to the academic sectors. Cries against it and support for it are all over the news and social media.

Over time, the definition of online learning has evolved. "E-learning, virtual learning, cyber learning, Internet learning, distributed learning, web-facilitated learning, web-based learning, distance learning, computer-based learning, resource- based learning, and technology-based learning" are some of the most commonly used terms to describe it (Anohina et.al, 2015). Online learning is relative to distance education. It is an education that takes place over the internet (Caruth GD & Caruth DL, 2013). It is where education happens outside the traditional classroom setting by means of modern technology.

The use of online learning has been a subject of debate in the academic world. Bernier and Stenstrom (2016), both technological optimists and skeptics, questioned the effectiveness of online learning especially when compared to the traditional face- to-face classroom interactions. Despite the criticism against it, OL is seen as a popular "substantial component at the majority of higher education institutions" (Allen & Seaman, 2014). Allen, et. al., (2014) further posited that almost 75% of academic leaders believe that the learning outcomes of online learning are similar to or better than those of face-to-face education. Remarkably, the trends in online learning research have shifted to determining how various elements and features of online learning influence its effectiveness.

Online instructors can also benefit from online learning. Johnson, et. al., (2016) enumerated some of the benefits of OL to instructors. Accordingly, OL offers flexibility with regards to teaching location and hours. Instructors can work according to their comfortable place and convenient time. They would be able

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to reuse and immediately update the learning materials. It also allows them to increase the number of ways to individually communicate, supervise, and direct learners. Finally, it improves their capacity to identify the educational needs of learners and create specialized learning experiences in accordance with those needs.

Though all teachers are affected by the sudden shift to OL, instructors in higher education encounter difficulties, due to the aforementioned developments and situations. When dealing with technology-rich classrooms and associated difficulties, they could feel uneasy. Albrahim (2020) argued that some of the issues that might deter faculty members from teaching online include: (a) wondering if they are qualified to teach online, (b) how they would maintain their identities and attributes as instructors, (c) what the learners' demographic might be, (d) how they could meet discipline-related demands, (e) what kind of training they would need, (f) how do they could be successful online instructors, (g) how would they assess änd evaluate learning outcomes, and (h) how would they deal with stress and feelings of frustration while making the transition to online learning environments. Instructors are forced to make adjustments and to adopt pedagogical practices that more compatible with the integration of technology at the postsecondary level in order to adapt to the online and technology- enriched courses. Schimd, et.al., (2014) proposed that classrooms, though virtually, should be learner-centered. They further stated that instructors should practice the principles of feedback, andragogy, constructivism, and transformative learning. Online instructors must then pay attention to what they need to create, develop, and manage their online courses and how to effectively communicate with the learners in the absence of physical presence and interaction.

Teaching mathematics posed challenges as students may find it difficult to understand, hence uninteresting. Teaching math using online doubles the challenges. Mathematics teachers need to think ways or tools to teach and to actively engage students. Roschelle, et.al., (2017) highlighted three important research- based categories of effective learning digital tools: (a) tools like graphing calculators that can do some of the detail work and students can focus on concepts, (b) tools for providing guidance and feedback to students as they practice mathematics, and (c) tools that help students visualize concepts and develop understanding. Teachers need teacher professional development in order to properly appreciate the benefits of digital tools given their rapid rate of development. Although teachers may be aware of the technology, this knowledge alone is insufficient to help pupils use the technologies to learn mathematics. Now recognizing twenty-first century learning. teachers must engage their students in developing four key skills (the 4 C's) in preparation for effectively connecting with a global society: Critical thinking, Communication, Collaboration and Creativity (Partnership for 21st Century Learning, 2015; Thoughtful Learning Organization, 2016). Students will thus be equipped with these skills to function well in the more complicated social, cultural, and educational environments that depend on the benefits provided by the reliance on a variety of technological resources.

Integrating technologies to mathematics teaching necessitates teachers to determine how the technologies support learning the mathematics. They must also consider which pedagogical strategies effectively engage students in learning the subject with the tools as they incorporate the 4 C's. Teachers must identify, orchestrate, and manage different pedagogical strategies and learning tasks for integrating the technologies in new and perhaps different mathematical topics. However, the challenge involves far more than their understanding of the mathematics content (Roschelle, et. al., 2017). The experience ultimately challenges their technological pedagogical content knowledge and reasoning (TPACK) with an array of technologies as "quality teaching requires developing a nuanced understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations" (Hervey, 2015).

On one hand, for teachers' professional development, online or blended learning is a setting that is becoming more and more accepted in education. It can allow teachers more choices about how, when and

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where they learn, reduce cost, and provide increased access for many more teachers across a broader geographical area (Murphy, et.al., 2013). Yet, the primarily asynchronous nature of online learning poses additional challenges for the design of these needed educational experiences.

COVID-19 has become a global health crisis. Based from the Worldmeter (2020), as of October 6, 2020, almost 36 million people have been infected and over one million have died. In the Philippines, this translates into almost 325,000 infected and 6,000 deaths. To avoid the spread of COVID-19, most governments have opted to employ quarantine protocols and temporarily shut down their educational institutions. As a consequence, more than a billion learners have been affected woridwide. Among this number are over 28 million Filipino learners across academic have to stay at home and comply with the Philippine government's quarantine measures (UNESCO, 2020).

Remote online learning, which blends synchronous and asynchronous activities, has been adopted by De La Salle University. There are flexible solutions available for meeting course requirements all year long for students who are unable to participate in online learning (DLSU, 2020). According to Villarin (2020), to allow "all students to learn at their own pace," ADMU has halted synchronous online classes but kept up asynchronous online learning. Similar to DLSU, University of Santo Tomas (UST, 2020) has chosen to keep using synchronous and asynchronous online classrooms, as well as variable grading of student outputs and assessments. Other private colleges and universities have continued to offer online courses, including STI College, St. Scholastica's College, Adamson University, Far Eastern University, the University of the East, Ateneo de Davao University, and the University of San Carlos.

Possibly, the HEls' revolve to modified forms of online learning attempts to Concretize the government's stance to continue learning despite the pandemic. As the Philippine's Department of Education (DepEd) Secretary, Leonor Briones quipped, "Education must continue even in times of crisis whether it may be a calamity, disaster, emergency, quarantine, or even war". The Philippines' Commission on Higher Education (CHEd, 2020), on the other hand, advised HEls to continue the "deployment of available flexible learning and other alternative modes of delivery in lieu of on-campus learning". These pronouncements aim to encourage the continuance of learning.

It would seem that online learning is the only practical way to continue learning at a distance during times of quarantines and viral outbreaks. But this appears to be predicated on false information. It should be emphasized that online learning is just one mode of distance education.

In the time of COVID-19, Ali (2020), said that for students and educators everywhere, distance learning has become essential. Flores (2018) noted that some have suggested using cell phones and (SMS) texting technology to facilitate learning. In addition, Punzalan (2020) stated that others urge to employ TV programs, radio broadcasts, and other non-internet-based media. Perhaps, some teachers might go back to basics and distribute annotated physical textbooks to their students through courier services. Education will go on in one form or another as long as the education sector is active, teachers and students have plenty of support, the curriculum and content of the learning modules are clearly defined and personalized, technological limitations are acknowledged, and there are user-friendly and enjoyable materials available. Such assistance assumes that educators, policymakers, and authorities will work together to create pertinent related programs.

Notwithstanding, according to Kim (2020), the various stresses it brings, the outbreak of COVID-19 not only forced us to think about the technologies for delivering education, it also compelled us to rethink the very nature of education itself.

Several months after the initial backlash in March 2020, CHEd Chairperson Prospero De Vera qualified the idea of flexible learning as "more encompassing than online learning." De Vera explains that while online learning requires internet access, flexible learning does not necessarily require connectivity.

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Instead, it "focuses on the design and delivery of programs, courses, and learning interventions that address the learners' unique needs in terms of pace, place, process, and products of earning (Parrocha, 2020).

Not only the Philippines but other nations to deal with same issues. Its Southeast Asian counterparts have reacted ingeniously to the same difficulties and have begun to change course toward a new era of education. As of May 2020, Indonesia, Thailand, and Vietnam have started some kind of distance education program. Thailand's Education Ministry originally planned to implement a learning program using a Distance Learning Television (DLTV) platform. Seventeen television channels were set up to broadcast educational courses, vocational education, non- formal and informal education (Praphornkul, 2020). The approach combines television or on-air learning and online learning. The rollout, however, was met with criticisms due to broadcasting problems and poor connectivity (Bangkok Post, 2020). The ministry adjusted its plan and focused instead on preparing for schools to reopen nationally after a survey found that 60-70% of students are not ready for TV education (Bangkok Post, 2020).

The Ifugao State University has also developed its Learning Management System (LMS) in order to facilitate online teaching-learning process. Faculty members underwent series of webinars in order to master navigating the LMS. The Office of the Vice President for Academic Affairs initiated Workshop on Scholarly Works Development and the use of IFSU LMS. However, they are using other online media in delivering instruction such as Google Meet and Zoom. This was constituted by IFSU Executive Order No. 33, series of 2020 on the adoption of flexible learning in delivering instruction.

## Methodology

This study employed both quantitative and qualitative research designs to address the research objectives. It was conducted at Ifugao State University (IFSU), Potia Campus, Alfonso Lista, Ifugao, with 300 respondents from different colleges on the campus. The quantitative approach was used for the first two objectives, while the qualitative method was employed for the third objective.

A single-stage cluster sampling technique was utilized to select the respondents. According to Taherdoost (2016), this method involves selecting a simple random sample of clusters and collecting data from every unit within the sampled clusters. Clusters represent natural groupings of individuals, such as classrooms or academic departments. In this study, a sampling frame listing all clusters (e.g., specific student groups) in the population was constructed, and a fixed number of clusters were randomly selected. Each cluster had an equal probability of being chosen, ensuring that the sample was representative of the student population (Abadie et al., 2017).

Upon receiving approval for the study, the researcher sought permission from the Campus Executive Director to conduct the research. The details of the study were discussed with all potential respondents to ensure they understood the research objectives before participating. The researcher emphasized that participation was voluntary, and confidentiality would be maintained throughout the process. Respondents were provided with an acceptance question to acknowledge their understanding of the study before answering the questionnaire.

For the quantitative aspect, a structured questionnaire was the primary tool for gathering data. The data collected were tallied, tabulated, and analyzed using frequency, percentage, and rank. Frequency and percentage distributions were used to describe the respondents' demographic profiles (e.g., age, gender, academic level) and other relevant data. Ranking was applied to prioritize the identified challenges, where ordinal values were replaced by ranks to indicate the order of importance or frequency of certain issues (Sullivan, 2013).

For the third objective, which sought to explore additional challenges encountered by the respondents in online learning, a qualitative approach was employed through semi-structured interviews. Respondents were asked open-ended questions to gain deeper insights into the difficulties they faced beyond those

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identified in the quantitative data. Thematic analysis was used to analyze the interview responses. The researcher transcribed the interviews, coded the data, and identified recurring themes or patterns related to the challenges in online mathematics learning. These qualitative findings complemented the quantitative results, offering a richer understanding of the respondents' experiences and providing a foundation for developing Information, Education, and Communication (IEC) materials tailored to address these challenges.

## Results and Discussion

### The External Resources used in Teaching and Learning Mathematics Online

The data presented in Table 1 provides a thorough overview on the use of external resources used in teaching and learning mathematics online.

**Table 1: External Resources used in Teaching and Learning Mathematics Online**

| Indicators | YES | | NO | | DOES NOT MATTER | |
|---|---|---|---|---|---|---|
| | *f* | % | *f* | % | *f* | % |
| External resources help in dealing with teaching/learning mathematics online. | 294 | 82.58% | 52 | 14.61% | 10 | 2.81% |
| **YouTube** is utilized for online teaching/learning. | 284 | 79.78% | 70 | 19.66% | 2 | 0.56% |
| **Pinterest** is sought for online teaching/learning purposes. | 104 | 29.21% | 240 | 67.42% | 12 | 3.37% |
| **LinkedIn** is used as a platform for online teaching/learning. | 92 | 25.84% | 254 | 71.35% | 10 | 2.81% |
| **Scribd** is made use of for teaching/learning. | 132 | 37.08% | 212 | 59.55% | 12 | 3.37% |
| **Facebook** is considered as an external resource for online learning. | 206 | 57.86% | 142 | 39.89% | 8 | 2.25% |
| **Khan Academy** is sought for research purposes. | 112 | 31.46% | 230 | 64.61% | 14 | 3.93% |
| **Academia** is used as a reference source. | 176 | 49.43% | 174 | 48.88% | 6 | 1.69% |
| **FOLD** is utilized as a source of information. | 98 | 27.53% | 244 | 68.54% | 14 | 3.93% |
| **Microsoft Math Solver** is utilized for online teaching/learning. | 108 | 30.34% | 236 | 66.29% | 12 | 3.37% |
| **Wolfram Alpha** is operated for online teaching/learning. | 64 | 17.98% | 282 | 79.21% | 10 | 2.81% |
| **Desmos** is utilized for online teaching/learning. | 80 | 22.47% | 264 | 74.16% | 12 | 3.37% |
| **Photomath** is used for online teaching/learning. | 122 | 34.27% | 224 | 62.92% | 10 | 2.81% |
| **Mathway** is sought for online teaching/learning purposes. | 106 | 29.77% | 240 | 67.42% | 10 | 2.81% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GeoGebra/GeoGebra** Classic is made use of for online teaching/learning. | 90 | 25.28% | 260 | 73.03% | | 1.69% |
| **OpenStax** is utilized for online teaching/learning. | 40 | 11.24% | 304 | 85.39% | 12 | 3.37% |
| **Purplemath** is used for online teaching/learning. | 54 | 15.17% | 292 | 82.02% | 10 | 2.81% |
| **Kahoot** is used for online teaching/learning. | 46 | 12.92% | 300 | 84.27% | 10 | 2.81% |
| **Quizzizz** is used for online teaching/learning. | 122 | 34.27% | 226 | 63.48% | 8 | 2.25% |
| **Prezi** is made use of for online teaching/learning. | 76 | 21.35% | 270 | 75.84% | 10 | 2.81% |

Most of the respondents, accounting for 82.58%, expressed satisfaction with the assistance provided by external resources in the teaching and learning of mathematics. Into the bargain, YouTube emerged as a widely embraced platform, with 79.78% of participants utilizing it for online education. Additionally, Facebook is considered an external resource by 57.86% of respondents, indicating its perceived relevance in the educational landscape. Correspondingly, the survey also annotated the varied adoption of specific platforms, such as Academia, Scribd, Photomath, Quizzizz, Khan Academy, Microsoft Math Solver, Mathway, Pinterest, FOLD, LinkedIn and Geogebra/Geogebra Classic which are employed by a significant portion of the participants. Notably is the observation that while certain platforms like Desmos, Prezi, Wolfram Alpha, Purplemath, Kahoot, and OpenStax which showed comparatively lower adoption rates.

These findings revealed the preferences and utilization trends of the external resources for the online teaching and learning of mathematics among the respondents. Hence, these imply that the popularity of the platforms YouTube and Facebook suggests the need for educators to integrate multimedia and interactive elements into their online teaching strategies (Ezparza & Aguilar, 2023). In addition, Das (2021) stated that the recognition of the other external resources also points to the potential collaborative and networking opportunities within the mathematics education community. Conversely, platforms with lower usage might require further exploration in order to raise awareness of students towards it. Consequently, Alikhani, et.al., (2023) suggest a need for adaptability and support for a diverse preference and a strategic approach in incorporating external resources into online mathematics education. Additionally, Maiya and Aithal (2023) stated that institutions should consider a subtle approach to integrating these platforms in the curriculum, ensuring an excellent and enriched online learning experience.

Table 2 outlines the ranking of external resources employed by students and teachers in the extent of online learning.

**Table 2. Other External Resources Utilized in Teaching/Learning Mathematics**

| Indicators | Rank |
|---|---|
| Chat GPT/Other AI websites | 1 |
| Coursera | 2 |
| Google | 2 |
| Gauthmath | 2 |

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| | |
|---|---|
| Quick Math | 2 |
| Tiktok Tutorials | 2 |
| Wordtune | 2 |

At the top of the list are Chat GPT and other AI websites, indicating a conventional reliance on artificial intelligence platforms for educational support. Hence, Coursera, Google, Gauthmath, Quick Math, Tiktok Tutorials, and Wordtune all share the second rank, showcasing a diverse array of widely utilized resources. Coursera, a prominent online learning platform, stands out alongside the prevalent Google services, emphasizing their significance in the educational landscape. Specialized tools like Gauthmath and Quick Math suggest a specific focus on mathematical assistance, while the presence of Tiktok Tutorials underlines the emerging trend of integrating short-form video content from social media into the educational realm. Wordtune, known for its language and writing assistance, specifically in researches linked to mathematics, also holds a significant position, reflecting the multifaceted nature of external resources leveraged for online learning. Overall, the data showed the varied and evolving nature of tools and platforms employed in the digital education sphere. This implies that students and teachers are determined to acknowledge these platforms other than traditional resources. Songkram, et. al., (2023) said that the reliance of the different platforms suggests a growing acceptance and utilization in education. Moreover, the inclusion of these platforms gives a potential benefit of engaging and easily digestible content in enhancing the learning experience (Purwanto, et. al., 2023). Therefore, incorporating these are a recognition of the need for a tailored and engaging educational materials in learning mathematics online (Yusufjanovna, 2023). However, Lind and Jakobsson (2022) suggest that though these platforms point a flexible and adaptive approach, students and teachers are still encouraged to highly perceive a reliable and relevant information for mathematics online learning.

## The Challenges Encountered by Students and Teachers in Online Learning

Table 3 provides comprehensive views into the challenges encountered by both students and teachers in online learning.

A significant majority, of 84%, identify the lack of communication and time delays in answering questions as prominent challenges. These emphasized the particular role that effective communication plays in the success of online education. The challenged rooted with communication may point to a need for enhanced communication tools, strategies and training for both students and teachers in the online learning environment. In addition, time delays in responding to questions specifies a plausible need for real-time interaction and feedback in online learning. As well addressing this concern may help in implementing more responsive collaborative interaction. This implies that educators and course developers should have to consider strategies that enhance communication and minimize delays to create a more interactive and engaging online learning environment (Elumanai, et. al., 2021).

In particular, over 81% of respondents believe that the lack of interaction with classmates makes learning math online difficult. This is anchored with the study of Davis, et. al., (2022), which states that participants find it difficult to learn mathematics if students and teachers are lack of social interaction during online math classes. This finding indicates that there is a need to prioritize interactive teaching methods, imposing collaborative activities and peer-to-peer interactions to enhance the learning experiences of the students in online math classes (Budde, 2023).

Hence, computer literacy is recognized as a hindrance by 71% of participants, while a slightly lower percentage (73%) find online classes more challenging than traditional and on-site learning. In addition to what has been said, Nurhikmah, et. al., (2023) states that in blended learning, there is a significant effect

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of computer self-efficacy towards learning outcome. Khalil, et. al. (2020) also added that the sudden transition to synchronized online learning has been a great challenge to students and teachers. This signify that integrating interactive online resources is important in order for the students to be more involved in the discussion or activities (Tang, 2023). Also, Huda, et. al. (2023) asserts that students may participate in online problem-solving activities and teachers on the other hand should undergo trainings on digital math software, attend webinars, and join online math challenges to enhance their own skills.

Additionally, a majority (around 71%) do not believe that everyone is technologically ready for online classes. This is supported by the study of Coman, et. al. (2020) which claims that technical issues are one of the most important to consider in online teaching. Accordingly, Nguyen and Habók (2023), they specified that teachers and students must be technologically literate and must have training sessions to enhance basic technological skills, covering areas such as computer literacy and specific software usage.

Besides, the ease of communication, user-friendliness of the platform, and the impact on motivation vary among the respondents. Hence, this emphasizes that there is a need for tailored approaches to enhance the satisfaction of the users and their individual preferences (Ying & Hui, 2023).

A significant portion (61%) feels that online learning diminishes their motivation, and a majority (67%) is struggling to adapt to the online learning platform. Technically, educational platforms can introduce interactive and engaging contents which incorporates gamification and provide regular positive feedback to boost motivation (Pramesworo, et.al., 2023).

**Table 3: Challenges Encountered by Students/Teachers in Online Learning**

| Indicators | YES | | NO | | DOES NOT MATTER | |
|---|---|---|---|---|---|---|
| | *f* | % | *f* | % | *f* | % |
| Lack of communication is a challenge in online classes. | 298 | 83.71% | 54 | 15.17% | 4 | 1.12% |
| Time delay in answering questions is a challenge in online classes. | 300 | 84.27% | 52 | 14.17% | 4 | 1.12% |
| Lack of interaction with classmates or students makes learning math online challenging. | 290 | 81.46% | 64 | 17.98% | 2 | 0.56% |
| A high level of computer literacy becomes a challenge in online classes. | 252 | 70.79% | 102 | 28.65% | 2 | 0.56% |
| Online classes make learning or teaching mathematics more difficult than on-site learning. | 260 | 73.03% | 90 | 25.28% | 6 | 1.69% |
| Everyone is technologically ready for online classes. | 252 | 70.79% | 104 | 29.21% | 0 | 0 |
| Online classes do not always facilitate easy communication with teachers, classmates, or students. | 162 | 45.51% | 192 | 53.93% | 2 | 0.56% |
| Online learning is not always perceived as a user-friendly platform. | 166 | 46.63% | 186 | 52.25% | 4 | 1.12% |
| Online learning reduces motivation to learn or teach. | 218 | 61.24% | 132 | 37.07% | 6 | 1.69% |

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| Adapting to the online learning platform is challenging. | 238 | 66.85% | 110 | 30.90% | 8 | 2.25% |

## Other Challenges Experienced by Students and Teachers in Online Learning

In the course of the interviews, respondents highlighted a variety of challenges that extended beyond the common difficulties associated with online learning, revealing deeper issues that had significant impacts on their educational experience. Through thematic analysis, several key themes emerged, each reflecting distinct obstacles that students faced in their efforts to learn mathematics online.

One of the most prominent themes was the frustration caused by unstable internet connections. Many respondents shared stories of having to travel to remote locations, such as mountains, to find areas with better signal strength. Some even built campsites in these locations to ensure a stable connection during class sessions. This not only disrupted their learning routines but also added to their mental and physical strain. The pervasive issue of internet instability indicates the need for improved infrastructure or alternative solutions for students in rural areas.

Another recurring theme was the issue of environmental distractions, particularly background noise. Students who lived in crowded or noisy environments struggled to concentrate, which adversely affected the quality of their work. This theme highlights the need for quiet, conducive study spaces that many students lack in online learning setups, especially in shared living conditions.

Technical difficulties with hardware and software also emerged as a common challenge. Respondents reported unreliable resources, such as malfunctioning computers or outdated software, which hampered their ability to engage fully in online learning. Additionally, the complexity of understanding problem-solving methods in mathematics was amplified in an online environment, where immediate feedback and hands-on support were not readily available.

A theme that compounded these technical and environmental challenges was the lack of access to personal computers. Many students relied on shared devices or mobile phones, which are not ideal for engaging with complex mathematical content. This issue was exacerbated by a perceived lack of transparency in the transition to online learning, where respondents felt that clear communication and guidance from educators were sometimes insufficient.

These findings suggest that a multifaceted approach is necessary to address the various barriers students face in online learning. Educators and institutions must prioritize the development of interactive strategies that can make online learning more engaging and accessible, regardless of a student's circumstances. This includes exploring alternative resources for both synchronous and asynchronous learning, ensuring that students who lack stable internet connections or quiet study spaces are not left behind. As Gu and Zhang (2023) emphasize, providing equitable learning opportunities is essential, especially in the rapidly evolving landscape of online education.

## Proposed Information, Education and Communication (IEC) Material to address the Challenges Encountered by the Teachers and Students in Online Learning

Regardless of the devastating effects of pandemic on education, it also provided a great opportunity for learning. The COVID-19 brought a shocking effect on education which includes learning disruptions, decreased access to education and research facilities and increased student debts (Onyema, et. al., 2020).

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Thus, this led to the shift of traditional teaching into blended learning directed for educational institutions to grow and adopt new technologies, digitizing challenges to overcome the threat of it (Suegay, 2022). Additionally, Ifugao State University is also one of the institutions that endeavored through the challenges brought by the pandemic. As a result, the challenges and the external resources encountered by the students and teachers were examined and researchers developed an Information, Education and Communication Material (IEC), specifically a Pamphlet to address it. Abogaa and Capada (2016) states that IEC materials play an important role in education by enhancing understanding, promoting active learning, improving retention, facilitating communication, creating awareness and supporting distance learning.

The developed pamphlet titled "Digital Math Mastery: Navigating the Online Learning Landscape" aimed to present the challenges encountered by the students and teachers and the learning resources available in online learning.

On the first part which is the front page presents the challenges encountered by students and teachers in online learning. It also carries the things that can be done to mitigate the challenges presented. Additionally, some external resources are also enumerated in this part. Thus, the second part specifically outlines a variety of external resources to enhance the learning experience in the field of mathematics. In addition, these resources include educational apps, interactive websites, and online forums where students can seek additional search engines.

Also, this developed material aims to bridge the gap between the posed challenges and the tools available to overcome them. Additionally, it encourages students and teachers to explore these external aids to foster a proactive approach to navigating the complexities of online mathematics education.

A study by Lehtonen, et. al., (2023) state that flyers or pamphlets focusing in promoting and distributing apps, flyers serve as tangible and visually compelling tools that can strategically place in educational institutions. Additionally, Barrientos (2021) states that math apps significantly affect the performance of the students and it's recommended that students must secure different apps to improve their number intelligence. Furthermore, Kay (2020) concluded that students and teachers both rated the engagement and learning value of mathematics apps in a flyer high and learning performance is increased significantly after using them for remembering, understanding, applications and analysis-based tasks.

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## Conclusions

Based on the findings drawn, the following conclusions were formulated:

1. Among the given external resources used in teaching and learning mathematics online, YouTube is the most utilized platform. It indicates that the popularity of the website is suggestive of its accessibility and familiarity, offering a user-friendly platform for both educators and students in mathematics.
2. Due to the restricted real-time interaction, poor internet connectivity and software malfunctions implicit in online learning hindering the immediate clarification of doubts and impeding student's understanding of complex subjects. Most of the respondents identified the lack of communication and time delays in answering questions as the most distinguished challenge encountered by students and teachers in online learning. In this regard, these difficulties may hinder the students' understanding and may impact the timely progression of the virtual educational experience.
3. Apart from the given challenges, unstable internet connection also frustrates the students because of their geographical location where some of the respondents even go to mountains to have a stronger internet connection. As a result, it hampers students' access to learning resources, blocking their ability to fully engage with online classroom experience, leading to possible gaps in understanding and less effective learning environment.
4. The proposed Information, Education and Communication (IEC) Material is a pamphlet titled with Digital Math Mastery: Navigating the Online Learning Landscape which presents the challenges encountered by the students and the learning resources available that can be used in online learning. It offers a concise, visually and engaging platform which allow clear communication of

key information about mathematical websites. Given the difficulty of mathematical concepts, the incorporation of visual elements such as graphics and on the flyers becomes instrument in making the content more accessible for the target audience.

## Recommendations

Based on the findings and conclusions, the following are recommended by the researcher:

1. Implementing an awareness program to inform students and teachers about all possible learning resources, including educational websites, applications, and tools, will ensure that they are well-equipped to enhance their learning experiences.
2. To enhance communication, institutions may establish a clear and accessible medium for both students and teachers. The strategic use of technology, including video conferencing and collaborative platforms can be establish to enhance online interaction. Also, instructors must strive to keep in touch with the students and involve them during online discussions.
3. Synchronous and asynchronous learning may be implemented that will allow students to engage with learning materials at their pace, reducing the dependency on continuous internet connectivity. In addition, students must also be resourceful in searching to better understand the lessons given to them.
4. A more detailed Information, Education, and Communication (IEC) Material is suggested; and
5. Further studies to investigate other challenges and external resources encountered by students and teachers.

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