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Theoretical article

Synchronous Virtual Learning in Ubiquitous Learning Paradigm and Effective Mathematics Teaching

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Abstract

Learning generally has taken a new dimension in this present era. Virtual learning has become increasingly popular recently due to technological advancement. Learning has moved from didactic pedagogy characterized by a teacher-centered approach where knowledge is transmitted from the instructor to the learner to a virtual, mobile, blended/ hybrid, e-learning mode of instruction. Learning is now a form of a Transformative approach to teaching and learning that goes beyond acquiring knowledge and skills only to create profound changes in individuals' beliefs, attitudes, values, and behavior. To obtain the necessary skills required for learning, the learners should have access to learning, and learning should be flexible and occur anywhere anytime through virtual instruction. The study emphasizes the ubiquitous (u-learning) paradigm, synchronous virtual learning in particular, and teachers' role in mathematics teaching and learning. This research has contributed valuable insights into how synchronous virtual learning can improve mathematics teaching and learning, support diverse learners, and inform instructional practices in digital environments. The implication of using synchronous virtual learning is to promote active engagement, social interaction, and peer collaboration, enhancing student comprehension and problem-solving skills. Since learning cannot be limited to didactic instruction, virtual learning should be considered for effective mathematics learning.

Keywords:
Synchronous Virtual Learning, didactic pedagogy, e-learning, u-learning, m-learning, mathematics

Zusammenfasung

Lernen hat in der heutigen Zeit allgemein eine neue Dimension angenommen. Virtuelles Lernen erfreut sich in letzter Zeit aufgrund des technologischen Fortschritts immer größerer Beliebtheit. Das Lernen hat sich von der didaktischen Pädagogik, die durch einen lehrerzentrierten Ansatz gekennzeichnet ist, bei dem Wissen vom Ausbilder an den Lernenden weitergegeben wird, zu einem virtuellen, mobilen, gemischten/hybriden E-Learning-Unterrichtsmodus entwickelt. Lernen ist heute eine Form eines transformativen Lehr- und Lernansatzes, der über den Erwerb von Wissen und Fähigkeiten hinausgeht und nur tiefgreifende Veränderungen in den Überzeugungen, Einstellungen, Werten und Verhaltensweisen des Einzelnen herbeiführt. Um die für das Lernen erforderlichen Fähigkeiten zu erwerben, sollten die Lernenden Zugang zum Lernen haben, und das Lernen sollte flexibel sein und überall und jederzeit durch virtuellen Unterricht erfolgen. Diese Studie betont das allgegenwärtige (U-Learning-)Paradigma, insbesondere das virtuelle Lernen und die Rolle der Lehrer beim Lehren und Lernen von Mathematik. Da sich das Lernen nicht auf didaktischen Unterricht beschränken kann, sollte für ein effektives Mathematiklernen virtuelles Lernen in Betracht gezogen werden.

Schlüsselworte:
Virtuelles Lernen, E-Learning, U-Lernen, Ich lerne, Mathematik

1. Introduction

Mathematics plays a significant role in human lives and forms the basis of all human activities. This is the main reason why society cannot exist and function properly without mathematics. Mathematics teaching and learning should be handled in ways of making learning easy for every individual. This paper explores the various roles teachers play in the effective teaching and learning of mathematics. Due to the complexity of the whole world situation (Akinoso, 2015) which calls for immediate solutions for learning to continue coherently, this calls for immediate intervention. The study evaluates the role of teachers in promoting student engagement, knowledge acquisition, classroom management, and assessment practices. An extensive literature review was conducted to examine current research on the role of teachers in effective mathematics instruction. Results from the literature review suggest that teachers' roles in effective teaching and learning of mathematics include providing students with relevant and structured learning experiences, creating a positive learning environment, utilizing appropriate assessment strategies, and engaging in meaningful collaboration with students and colleagues.

The teachers should take an active role in the teaching and learning process. It is clear that when teachers take an active role in the classroom, students are more engaged, knowledgeable, and successful in

mathematics learning. Teachers play a significant role in teaching and learning procedures either human or artificial teacher. The role of the teacher in learning cannot be ignored. The role of the teacher is to mold the learners' future. For teaching and learning to be effective, modern pedagogy involving active learning should be incorporated through ubiquitous learning (u-Learning) that encourages learning anywhere, anytime with digital technology. This active learning leads to active knowledge making which is made possible through a ubiquitous learning environment which might not be possible in didactic environment. Ubiquitous learning known as u-learning is the learning with mobile devices. This type of learning utilizes mobile and wireless technologies to support seamless and connected learning. In ubiquitous learning, the learning is extended beyond the four walls of the classroom and the cells of the timetable. The concept of u-learning is anytime, anywhere. This study is exploring the optimal integration of real-world contexts and digital tools to enhance student engagement and conceptual understanding in mathematics.

2. Ubiquitous Learning Environment

Ubiquitous learning is a learning approach that takes advantage of the pervasive presence of technology and access to information in various environments. It emphasizes the integration of learning into everyday activities, making learning accessible anytime and anywhere. U-learning leverages ubiquitous technology, such as smartphones, tablets, or wearable devices, to enable learners to engage in learning experiences beyond the confines of a traditional classroom. It aims to seamlessly integrate learning into the learner's daily life and surroundings, blurring the boundaries between formal and informal learning. The key features of U-learning include:

- Contextual Learning: U-learning focuses on learning experiences that are contextually relevant and applicable to real-life situations. It emphasizes the connection between learning and the learner's immediate environment.
- Seamless Learning: U-learning enables continuous learning experiences by seamlessly integrating learning opportunities into the learner's daily routines and activities. Learning can occur at various locations and times, facilitated by the ubiquity of technology.
- Personalization: U-learning supports personalized learning experiences, allowing learners to customize their learning pathways and pace. It leverages technology to provide adaptive and tailored learning content based on individual needs and preferences.

Fekos (2013) averred that ubiquitous computing is a model of human and computer interaction in daily activities and integrated into objects humans interact with routinely. One of the objects people interact with regularly is a mobile phone. Instead of using it for calls, chats, and playing games only, mobile phones could also be used for learning. Invariably, u-learning makes personal and interpersonal computing with a degree of visibility and transparency. Ubiquitous learning concepts include mobile learning, cloud computing, virtual schools, learning management systems, blended learning, station rotation, and other mediums of learning with technology or mobile devices outside the four walls of the traditional classroom. The u-learning is an innovative pedagogy that makes learning easier and continuous.

Mobile learning in particular is the online learning facilities with the use of mobile devices that learners can learn from anytime anywhere. The mobile devices possessed by learners are not restricted to making calls, chats, shopping, or advertising products only, but allow learning outside the classroom setting.

Mobile learning or m-learning is the online facilities that the learners can learn from. The learners can enroll in a course, study the lessons assigned, watch the video lectures, attend live classes, and take examinations from their mobile devices. What makes mobile learning different from e-learning is the use of mobile devices to access content. The learners can access learning with mobile phones, tablets, iPads, and other portable mobile devices. The mobile device replaces the use of books, CDs, and DVDs, and replaces with portable devices learners can access easily for learning anywhere. Teachers should be able to use a variety of teaching methods to ensure effectiveness. A virtual learning environment is one of the ubiquitous learning environments that encourages online discussion, reading, have access to assignments, allows students to interact with colleagues, and offers input. Synchronous virtual learning is the major variable considered in this write-up which is one of the environments for teaching in ubiquitous learning and e-Learning ecology.

3. The Downside of Ubiquitous Learning

While u-learning (ubiquitous learning) and virtual learning offer numerous benefits, they also come with certain disadvantages, some of the disadvantages are considered. Whatever value affects ubiquitous

learning also affects virtual learning the subset of ubiquitous learning.

Technological Challenges: U-learning and virtual learning heavily rely on technology, which can present challenges for both students and teachers. Limited access to technology or unreliable internet connectivity can hinder the learning experience, particularly for students in underserved areas or with limited resources. Technical issues such as software glitches or compatibility problems may also arise, causing disruptions to the learning process.

Lack of Face-to-Face Interaction: U-learning and virtual learning often lack the face-to-face interaction found in traditional classroom settings. This reduced physical presence and absence of immediate feedback can lead to a sense of isolation for some students. The lack of direct interaction may also limit the ability to ask spontaneous questions, engage in meaningful discussions, or benefit from non-verbal cues that facilitate understanding.

Self-Motivation and Discipline: U-learning and virtual learning require students to take more responsibility for their own learning and time management. Without the physical presence of a teacher or peers, students may struggle with self-motivation and self-discipline. Some students may find it challenging to stay engaged and focused in a self-paced online environment, potentially leading to a decline in academic performance.

Limited Hands-On Experiences: Certain subjects, including mathematics, often involve hands-on activities, manipulatives, or group work. U-learning and virtual learning environments may have limitations in providing these tactile or collaborative experiences, which can impact students' understanding and engagement. Although virtual simulations and interactive tools can partially address this limitation, but may not fully replicate the benefits of hands-on learning.

Potential for Distractions: U-learning and virtual learning can expose students to various distractions, such as social media, unrelated websites, or personal electronic devices. These distractions can divert students' attention away from the intended learning activities and negatively impact students' focus, productivity, and overall academic performance.

Inequitable Access and the Digital Divide: U-learning and virtual learning rely on access to technology and internet connectivity, which may not be readily available to all students. This creates a digital divide, where students from disadvantaged backgrounds or rural areas may face barriers to accessing virtual learning resources. The lack of equitable access to technology can exacerbate existing educational inequalities and widen the achievement gap.

Teacher-Student Interaction and Support: In virtual learning environments, the level of teacher-student interaction may be reduced compared to traditional classrooms. Students may have limited opportunities to directly interact with teachers, ask questions, or seek clarifications. This reduced interaction can hinder the personalized support and guidance that teachers provide, potentially affecting students' comprehension and progress.

Limited Social Development: U-learning and virtual learning may limit students' opportunities for social interaction and the development of social skills. Students miss out on the social dynamics of a physical classroom, such as collaborating with peers, engaging in group activities, or participating in extracurricular events. The absence of these social interactions can impact students' social-emotional development and ability to work effectively in teams.

To mitigate these disadvantages, it is important to address technological infrastructure issues, ensure equitable access to technology, provide clear guidelines for self-regulated learning, foster virtual communities for collaboration and support, incorporate strategies to promote student engagement and motivation in virtual learning environments. Additionally, a balanced approach that combines virtual learning with in-person interactions whenever possible can help mitigate some of the drawbacks associated with u-learning and virtual learning. Virtual learning is the aspect of u-learning considered in this paper since the learning environment contributes immensely to mathematics learning.

4. Virtual Learning and Mathematics Teaching

The learning environment for mathematics teaching determines how instruction is handled and the effect it has on students whether positive or negative. A ubiquitous learning environment will go a long way and yield positive effects on learning. It's important to note that u-learning and virtual learning can overlap to some extent, as virtual learning can be a component of u-learning. U-learning encompasses a broader concept that goes beyond virtual learning by emphasizing the integration of learning into everyday life and leveraging technology ubiquitously, whereas virtual

learning specifically refers to learning in digital environments.

Virtual learning refers to the use of digital technologies to create learning environments that simulate or replicate aspects of a traditional classroom. It typically involves online platforms, educational software, or virtual classrooms that enable learners and teachers to interact remotely. In short, the online learning environment is where students study in a digital-based forum taught by instructors through online lectures via video or audio. Virtual learning entails more interaction between the students and teachers, unlike online or e-learning which is more self-paced. Virtual learning is taught online through a learning management system or other educational platform. This type of learning is flexible and makes learning easy for learners who enjoy self-learning and those who want to learn without attending physical classes.

Virtual learning can take place in fully online settings, blended learning environments, or as a supplement to traditional classroom-based learning.

The key features of virtual learning include:

- Online Learning Environments: Virtual learning primarily occurs in digital environments, where learners access learning materials, complete assignments, engage in discussions, and interact with teachers and peers through online platforms or educational software.
- Remote Instruction: Virtual learning allows for remote instruction, with teachers delivering lessons and facilitating learning experiences through video conferencing, pre-recorded lectures, or online discussions. Students can participate in learning activities from their locations using their devices.
- Synchronous and Asynchronous Learning: Virtual learning can be both synchronous, where learners and teachers interact in real-time, and asynchronous, where learners engage with pre-recorded materials or complete tasks independently at their own pace.
- Multimedia Resources: Virtual learning often incorporates multimedia resources, such as videos, interactive simulations, or virtual labs, to enhance the learning experience and provide alternative modes of instruction.
- Digital Assessments and Feedback: Virtual learning platforms allow for digital assessments, quizzes, and assignments, often with automated grading features. Teachers can provide feedback through digital means, offering timely guidance and support to students.

5. Types of Virtual Learning

Virtual learning can be categorized into different types, which include synchronous, asynchronous, blended, and massive Open Online Courses (MOOCs).

Synchronous Learning: This type of virtual learning occurs in real-time, where instructors and students interact simultaneously. It often involves live video conferences, webinars, or virtual classrooms. Synchronous learning allows for immediate feedback and active participation. For example, Zoom and Microsoft Teams are popular platforms for synchronous learning.

Asynchronous Learning**:** Asynchronous learning refers to self-paced learning, where students access pre-recorded lectures, videos, and online materials at their convenience. It provides flexibility in terms of time and location. Discussion boards and email communication are often used to facilitate interaction between students and instructors.

Blended Learning**:** Blended learning combines traditional face-to-face instruction with online learning components. It allows for a mix of in-person interactions and virtual activities. This approach provides the benefits of both traditional and online learning, promoting flexibility and engagement.

Massive Open Online Courses (MOOCs): MOOCs are free online courses available to a large number of participants. They often incorporate video lectures, interactive quizzes, and discussion forums. MOOC platforms like Coursera, edX, and Udemy offer a wide range of courses from top universities and institutions.

These recent literature references provide valuable insights into the types of virtual learning and their significance in educational contexts. The study presented below emphasizes different aspects of virtual learning, highlighting the importance of appropriate digital resources, game-based learning, scaffolding and autonomy support, and virtual mobility.

6. Synchronous Virtual Learning

Synchronous virtual learning allows the instructors and students to interact. This type of learning often includes live video conferences, webinars, or virtual classrooms. Synchronous learning

involves the active participation of the learners leading to immediate feedback. The platforms for synchronous virtual learning include Zoom and Microsoft Teams.

The study conducted by Chang et al. (2021) focuses on synchronous online learning and its impact on student's motivation. The researchers found that synchronous online classes have the potential to increase students' motivation. By analyzing students' experiences through experience sampling, they discovered that synchronous online classes provided immediate feedback, increased social interaction, and facilitated active participation. These factors contributed to higher levels of motivation among students. The real-time nature of synchronous online learning allows for more engaging and interactive experiences, creating a sense of presence and connectedness among students and instructors.

Synchronous virtual learning is highly effective in teaching and has a greater advantage over other types of virtual learning. This statement is in support of Means et al. (2010) research which suggests that synchronous virtual learning can be as effective as traditional face-to-face instruction when designed properly, particularly in terms of student outcomes and satisfaction. A study by Bernard et al. (2014) found that synchronous virtual learning environments can facilitate interaction and collaboration among students, leading to higher levels of engagement and learning. The best practices of synchronous virtual learning must involve active engagement. Picciano (2017) emphasizes the best practices for synchronous virtual learning, including clear communication, active engagement strategies, and leveraging technology effectively to enhance learning experiences. Meanwhile, the acquisition of the learning experience is the major target of any instruction. To acquire great outcomes in teaching, the students must be satisfied with the mode of instruction. Martin et al. (2021) examine student satisfaction and learning outcomes in synchronous virtual learning environments. It identifies factors such as instructor presence, course organization, and interactive activities as significant predictors of student satisfaction and success. The instructors must possess adequate knowledge of synchronous virtual instruction to carry out mathematics teaching successfully. Archambault et al. (2016) explore the role of teacher professional development in enhancing instructional practices for synchronous virtual learning and emphasize the importance of training and support for educators to effectively facilitate online synchronous sessions. As effective as the synchronous virtual learning mode of instruction, there are some challenges in reducing the use of this mode of instruction. These include digital equity, technology access, and engagement in synchronous virtual learning (Hodges et al., 2020). These challenges can be addressed through inclusive teaching practices and providing support for both students and instructors.

7. Virtual Learning and Mathematics Achievement

Virtual learning can have a significant impact on mathematics achievement when implemented effectively. It can contribute to students' mathematics achievement in the following ways:

Flexibility and Individualization: Virtual learning allows for flexible scheduling and self-paced learning, which can benefit students with different learning styles and paces. Students can access mathematics lessons and resources at their convenience, review content as needed, and progress at a pace that suits their individual needs. This individualization promotes a deeper understanding of mathematical concepts and can lead to improved achievement.

Engaging Multimedia and Interactive Tools: Virtual learning platforms often incorporate multimedia elements, such as videos, animations, and interactive simulations, to make mathematics more engaging and accessible. These multimedia tools can provide visual representations, real-life examples, and interactive activities that enhance students' understanding and retention of mathematical concepts, ultimately leading to improved achievement.

Personalized Instruction and Feedback: Virtual learning platforms can provide personalized instruction and immediate feedback tailored to students' individual needs. Adaptive learning systems can adjust the level of difficulty based on students' performance, provide targeted practice exercises, and offer customized feedback. This personalized approach helps address students' specific areas of weakness, reinforce learning, and support their mathematical achievement.

Collaborative Learning Opportunities: Virtual learning environments can facilitate collaborative learning experiences in mathematics. Students can engage in online discussions, group projects, and problem-solving activities with peers. Collaborative learning promotes active engagement, critical thinking, and the exploration of multiple perspectives, leading to a deeper understanding of mathematical concepts and improved achievement.

Access to a Variety of Resources: Virtual learning provides access to a vast array of digital resources for mathematics, including interactive textbooks, online tutorials, educational apps, and virtual manipulatives. Students can explore diverse resources, access supplemental materials, and engage with interactive tools that support their learning. This access to a wide range of resources can enhance students' conceptual understanding, problem-solving skills, and overall mathematics achievement.

Data-Driven Instruction and Monitoring: Virtual learning platforms generate data on students' progress, performance, and engagement in mathematics. Teachers can analyze this data to gain insights into students' strengths, weaknesses, and learning patterns. By using data analytics, teachers can identify areas where students may be struggling, track their progress over time, and provide targeted interventions or additional support to improve their mathematics achievement.

Continuous Support and Remediation: Virtual learning platforms can provide ongoing support and remediation for students who are struggling in mathematics. Students can access additional practice exercises, tutorials, or interactive resources to reinforce their understanding of challenging concepts. Virtual learning offers opportunities for targeted interventions, differentiated instruction, and individualized support, which can help struggling students improve their achievement in mathematics.

The effectiveness of virtual learning in mathematics achievement depends on various factors, including the quality of instructional design (Means et al., 2009); Puentedura, (2011), teacher-student interaction (Bernard et al., 2009), technological infrastructure (Watson et al., 2013), and students' access to technology and internet connectivity (Becker et al., 2017). Effective implementation of virtual learning strategies, along with appropriate support and monitoring, can contribute to improved mathematics achievement for students in virtual learning environments.

8. Role of Teachers in Effective Teaching of Mathematics

Teachers play a crucial role in the effective mathematics teaching and learning which directly impacts students' academic performance. This implies that teachers' role in effective teaching and learning mathematics is instrumental in shaping students' academic performance. Walshaw (2008) and Doig et al. (2003) have checked research to seek evidence about the kinds of pedagogical practices that contribute to desirable learning outcomes. The teachers must employ appropriate instructional strategies, providing clear explanations, offering scaffolding support, differentiating instruction, providing feedback, fostering a positive learning environment, and promoting collaboration and communication, teachers can enhance students' mathematical learning and help them achieve better academic outcomes. No matter how good the teacher's teaching intentions are, the teacher has to work out how best the students are helped to grasp core mathematical ideas (Hill et al., 2005). Some of the roles are considered below.

Instructional Strategies: Teachers have the responsibility of selecting appropriate instructional strategies that engage students and promote conceptual understanding. Teachers should employ a variety of techniques such as hands-on activities, problem-solving tasks, group work, and technology integration to cater to diverse learning styles and abilities. Using effective instructional strategies, teachers can help students grasp mathematical concepts more effectively and improve academic performance.

Clear Explanation and Demonstration: Mathematics can be challenging for many students, so teachers need to provide clear explanations and demonstrations of mathematical concepts and procedures. Teachers should break down complex ideas into smaller, more manageable parts and use visual aids, real-world examples, and concrete materials to make abstract concepts more accessible. Clear explanations help students develop a solid foundation of understanding, leading to improved performance.

Scaffolding and Differentiation: Effective teachers provide scaffolding support to students as the students learn new mathematical concepts and skills. Scaffolding involves breaking down tasks into manageable steps, providing prompts and guidance, and gradually reducing support as students gain confidence and proficiency. Teachers should also differentiate instruction to meet the diverse needs of students, providing additional support or enrichment based on students' abilities and learning styles.

Formative Assessment and Feedback: Regular formative assessment is vital for teachers to gauge students' understanding of mathematical concepts and identify areas that require further attention. Through ongoing assessments, teachers can provide timely and

specific feedback to students, helping them understand their strengths and areas for improvement. Feedback should be constructive, encouraging, and actionable, guiding students toward academic growth and enhancing their performance in mathematics.

Creating a Positive Learning Environment: A positive classroom environment is essential for effective teaching and learning of mathematics. Teachers should foster a safe and supportive atmosphere where students feel comfortable asking questions, making mistakes, and taking risks. Encouraging a growth mindset, emphasizing the importance of effort and perseverance, and celebrating students' achievements can boost their confidence and motivation in learning mathematics.

Collaboration and Communication: Teachers should encourage collaborative learning experiences, such as group work and peer discussions, where students can engage in mathematical discourse and share their ideas. Collaborative activities promote critical thinking, problem-solving, and communication skills, which are crucial for success in mathematics. Teachers should also maintain open lines of communication with students, parents, and colleagues to address any concerns, provide support, and foster a collaborative learning community that contributes to improved academic performance.

9. Role of Teachers in Effective Use of Synchronous Virtual Learning

In the context of a ubiquitous learning environment, where virtual learning is prevalent, teachers play a crucial role in facilitating the effective use of virtual learning tools and technologies for mathematics education. Some of the teachers' roles are given below.

Technological Proficiency: Teachers need to be proficient in the use of virtual learning tools and technologies specific to mathematics education. This includes being familiar with online platforms, educational software, virtual manipulatives, interactive simulations, and digital resources relevant to teaching mathematics. Having a sound understanding of these tools, teachers can effectively integrate them into their instructional practices and help students navigate the virtual learning environment.

Curriculum Design and Adaptation: Teachers should design or adapt the mathematics curriculum to align with the virtual learning environment. Teachers need to identify appropriate online resources, interactive activities, and multimedia materials that support the learning objectives and engage students effectively. Adapting traditional instructional materials for online delivery requires careful consideration of sequencing, pacing, and scaffolding to ensure a smooth transition to the virtual setting while maintaining the integrity of the mathematics content.

Facilitating Online Discussions and Collaboration: Teachers play a critical role in facilitating online discussions and collaborative activities among students. Teachers can create virtual spaces where students can engage in mathematical discourse, share their ideas, and collaborate on problem-solving tasks. Through effective moderation and guidance, teachers can encourage active participation, critical thinking, and constructive interactions among students, thereby enhancing students understanding and performance in mathematics.

Providing Timely Feedback and Assessment: Teachers should establish mechanisms for providing timely feedback and assessment in the virtual learning environment. This can include using online quizzes, assignments, and interactive assessments to gauge students' understanding of mathematical concepts. Teachers can also leverage technology to provide immediate feedback on students' responses and offer personalized guidance for improvement. Timely feedback helps students identify areas of strength and weakness, enabling them to make necessary adjustments and improve their academic performance.

Monitoring and Supporting Individual Progress: In a virtual learning environment, teachers need to closely monitor students' progress and provide the necessary support. Teachers can track students' engagement, participation, and performance in online activities and assignments. By identifying students who may be struggling or falling behind, teachers can offer personalized interventions, additional resources, or one-on-one support to address their specific needs. Regular communication with students through virtual platforms is also essential to maintain a supportive learning environment.

Digital Citizenship and Online Etiquette: Teachers should educate students about digital citizenship, online etiquette, and responsible use of virtual learning tools. Teachers can promote responsible behavior, ethical use of information, and respectful online interactions among students. By fostering a positive online culture, teachers create a

conducive environment that enhances learning and collaboration while minimizing distractions and inappropriate behaviors, ultimately supporting students' academic performance.

Professional Development and Learning Communities: Teachers need continuous professional development to enhance their knowledge and skills in utilizing virtual learning for mathematics education. Teachers should actively participate in professional learning communities, attend webinars, explore online courses, and collaborate with peers to stay updated on emerging technologies and effective practices. Ongoing professional development empowers teachers to leverage the full potential of virtual learning tools and improve students' academic performance in mathematics.

Customizing Instruction: Teachers can use virtual learning platforms to customize instruction based on student's individual needs and learning styles. Teachers can provide differentiated assignments, activities, and resources to cater to diverse abilities, interests, and paces of learning. By leveraging the flexibility of virtual learning, teachers can offer personalized instruction that addresses students' specific strengths and challenges, leading to improved academic performance.

Engaging Multimedia and Interactive Content: Virtual learning offers opportunities to incorporate multimedia elements such as videos, animations, and interactive simulations into mathematics lessons. Teachers can curate or create engaging multimedia content that illustrates abstract concepts, provides real-life applications, and enhances students' understanding. By using interactive tools and visualizations, teachers can make mathematics more accessible and engaging, which can positively impact students' learning and academic performance.

Promoting Self-Regulated Learning: In a virtual learning environment, teachers can foster self-regulated learning skills in students. The teachers can guide students in setting goals, planning their learning, monitoring their progress, and reflecting on their performance. Teachers can encourage students to take ownership of their learning, make use of self-assessment tools, and seek resources independently. By promoting self-regulated learning, teachers empower students to become independent learners.

Building Online Communities and Collaboration: Teachers can create online communities where students can collaborate, share ideas, and learn from one another. Virtual learning platforms offer opportunities for students to work in groups, engage in peer-to-peer discussions, and provide feedback to their peers. Teachers can facilitate online collaborations, assign group projects, and encourage students to solve problems collectively. By fostering collaborative learning experiences, teachers promote deeper understanding, critical thinking, and improved performance in mathematics.

Addressing Technical Challenges and Providing Support: In a ubiquitous learning environment, technical issues may arise that can hinder students' learning experiences. Teachers play a vital role in troubleshooting technical challenges and providing support to students. The teachers should be available to address students' questions, assist with technical difficulties, and ensure smooth access to virtual learning resources. By promptly addressing technical issues, teachers create a supportive learning environment that minimizes disruptions and supports students' academic performance.

Continuous Monitoring and Evaluation: Teachers need to continuously monitor students' progress and evaluate the effectiveness of virtual learning strategies. Teachers can use data analytics tools and learning management systems to track students' engagement, performance, and growth in mathematics. By analyzing data, teachers can identify areas where students may need additional support, adapt instructional strategies, and make data-informed decisions to improve students' academic performance.

Collaboration with Parents and Guardians: Teachers should maintain regular communication and collaboration with parents or guardians in the virtual learning environment. The updates on students' progress are shared, provide guidance on supporting mathematics learning at home, and address any concerns or questions parents may have. Collaborating with parents creates a strong home-school partnership that supports students' learning and contributes to academic success in mathematics.

Flexibility and Adaptability: In a ubiquitous learning environment, teachers need to be flexible and adaptable to changes and challenges that arise. Teachers should be open to exploring new virtual learning tools, adapting instructional strategies based on feedback and student needs, and making adjustments to accommodate different learning situations. By embracing flexibility and adaptability, teachers can ensure that virtual learning environments are dynamic, effective, and conducive to student's academic performance in mathematics.

The learning environment contributes either positively or otherwise to student learning outcomes. This is the reason the environment should be considered and made rich enough to promote students' learning outcomes. Teaching mathematics in the abstract contributes to the student's mathematics learning difficulties. Teaching mathematics should be done by applying different strategies to meet the needs of individuals especially. The opportunity to enrich the teaching environment with this use of technology in this present era is germane. Mathematics learning with the advantage of virtual learning in ubiquitous learning environments is of great benefit and the teacher's concern must play a significant role in making learning possible and smooth. For teachers to teach in the virtual learning environment, teachers must possess certain characteristics to demonstrate adequate knowledge of expertise in the area of virtual learning. This will go a long way to enhance learning and improve learning outcomes. Synchronous virtual learning one of the virtual learning types enhances effective mathematics teaching by promoting interactive engagement, leveraging digital resources, and integrating real-world contexts, thus facilitating deeper conceptual understanding and problem-solving skills.

10. Conclusion

Teachers play a pivotal role in the effective use of virtual learning for mathematics in a ubiquitous learning paradigm. By being technologically proficient, designing and adapting the curriculum, facilitating online discussions, providing timely feedback, monitoring individual progress, promoting digital citizenship, and engaging in professional development, teachers can create engaging and meaningful virtual learning experiences that support students' mathematical learning and contribute to their academic performance. Other roles played by the teacher in leveraging virtual learning for mathematics in a ubiquitous learning environment are customizing instruction, incorporating multimedia content, promoting self-regulated learning, fostering collaboration, addressing technical challenges, monitoring progress, collaborating with parents, and being flexible and adaptable. This study considered how synchronous virtual learning, within the ubiquitous learning paradigm, can foster effective mathematics teaching by seamlessly integrating digital resources, real-world contexts, and interactive engagement strategies to promote deeper conceptual understanding and problem-solving skills among students. Therefore, it was concluded that, synchronous virtual learning enhances effective mathematics teaching by promoting interactive engagement, leveraging digital resources, and integrating real-world contexts, thus facilitating deeper conceptual understanding and problem-solving skills among students.

Authors note:

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References

Akinoso, S. O. (2015). Teaching Mathematics in a volatile, uncertain, and ambiguous (VUCA) world: The use of Concrete-Representation-Abstract instructional strategy. *Journal of International Society for Teacher Education, 19*(1), 97-107.

Archambault, L., Kennedy, K., Bender, S., & Flora, K. (2016). Outcomes From a Teacher Professional Development Program in Virtual Schooling. *Journal of Technology and Teacher Education, 24*(1), 5–30.

Becker, S. A., Cummins, M., Davis, A., Freeman, A., Hall, C. G., & Ananthanarayanan, V. (2017). *NMC Horizon Report: 2017 K-12 Edition*. The New Media Consortium.

Bernard, R. M., Abrami, P. C., Borokhovski, E., Wade, C. A., Tamim, R. M., Surkes, M. A., & Bethel, E. C. (2009). A Meta-Analysis of Three Types of Interaction Treatments in Distance Education. *Review of Educational Research, 79*(3), 1243-1289.

Bernard, R. M., Borokhovski, E., Schmid, R. F., Tamim, R. M., & Abrami, P. C. (2014). A Meta-Analysis of Blended Learning and Technology Use in Higher Education: From the General to the Applied. *Journal of Computing in Higher Education, 26*(1), 87–122.

Chang, Y., Zhang, J., & Chen, J. (2021). How synchronous online classes can increase students' motivation: An experience sampling study. *Computers & Education, 164*, 104-140.

Doig, B., McCrae, B., & Rowe, K. J. (2003). *A good start to numeracy: Effective numeracy strategies from research and practice in early childhood*. Australian Council of Educational Research.

Fekos, N. (2013). *What is Ubiquitous Learning*? https://clwb.org/2013/06/10/what-is-ubiquitous-learning/

Hill, H., Rowan, B., & Ball, D. (2005). Effects of teachers' mathematical knowledge for teaching on student

achievement. *American Education Research Journal, 42*, 371-406.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. *Educause Review, 27*.

Martin, F., Parker, M. A., & Deale, D. F. (2021). Examining Student Satisfaction and Achievement in Synchronous Online Courses. *Online Learning, 25*(1), 205-224.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009). *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*. U.S. Department of Education, Office of Planning, Evaluation, and Policy Development.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*. U.S. Department of Education.

Picciano, A. G. (2017). Theories and Frameworks for Online Education: Seeking an Integrated Model. *Online Learning, 21*(3), 166-190.

Puentedura, R. (2011). SAMR: Moving from Enhancement to Transformation. *Learning & Leading with Technology, 39*(5), 10-14.

Walshaw, M. & Anthony, G. (2008). The role of pedagogy in classroom discourse: A review of recent research into mathematics. *Review of Educational Research, 78*, 516-551.

Watson, J., Murin, A., Vashaw, L., Gemin, B., & Rapp, C. (2013). *Keeping Pace with K-12 Online Learning: An Annual Review of Policy and Practice*. Evergreen Education Group.