**ONLINE LEARNING AND THE BEST PRACTICES OF MATHEMATICS**

Approved:   *Jodean E. Grunow, Ph.D.*        Date:      12/21/2021

             Paper Advisor


Suggested content descriptor keywords:


<u>Online learning</u>

<u>Best practices</u>

<u>Student engagement</u>

**ONLINE LEARNING AND THE BEST PRACTICES OF MATHEMATICS**

A Seminar Paper

Presented to

The Graduate Faculty

University of Wisconsin Platteville

In Partial Fulfillment

Of the Requirement for the Degree

Master of Science in Education

By

Heather Trumpy

2021

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

**Chapter I Introduction**

Due to the COVID epidemic, schools around the world have been plunged head first into alternate delivery of education. While the transition to online learning has been increasing in recent decades due to the benefits, many schools have had to move to emergency remote teaching (ERT) due to COVID-19. "Moving instruction online can enable the flexibility of teaching and learning anywhere, anytime, but the speed with which this move to online instruction is expected to happen is unprecedented and staggering" (Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. , 2020).

Thus, school districts around the world have looked into different alternate delivery types and methods, and have implemented these delivery strategies for the 2020-21 school year. Now that many have learned to adapt to online instruction, some schools and institutions will continue be keep some online aspects in place. With the increased exposure and interest in online education, the purpose of this paper is to explore whether online education can support best practices when teaching mathematics.

**Statement of the Problem**

With an increasing interest in different methods of alternate delivery of instruction in recent years, especially due to the COVID-19 pandemic, this form of delivery has come to the forefront of almost every educator's mind. Today, possibly every instructor and/or school district has had some experience in teaching online or using an alternate delivery. This is unique, at least to this scale. This literature review will be looking at and breaking down different best practices of teaching mathematics and will explore if online delivery can support any, or all, of these practices. The online delivery method that will be explored is synchronist online, "*synchronous e-learning*."

**Definition of Terms**

The terms used in this paper were:

**Feedback** : "information about how we are doing in our efforts to reach a goal" (Wiggins, G., 2012).

**Student Engagement** : "the student's psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (Martin, F. & Bollinger, D.U., 2018).

**Synchronist online**: "*Synchronous e-learning*, commonly supported by media such as videoconferencing and chat, has the potential to support e-learners in the development of learning communities" (Hrastinski, 2008).


**Purpose of the Study**

There has been a growing interest in online education in recent years as the need for it has grown. Though online education became widespread and necessary during the shutdown due to COVID-19, online education had been increasing gradually over the years prior. "Publishing companies have been trying to become more competitive in online education as well. McGraw-Hill Higher Education recently announced that it would expand its library of online courses to be sold to and used by colleges" (Carnevale, D., 2007). Additionally, "the threat of COVID-19 has presented some unique challenges for institutions of higher education. All parties involved—students, faculty, and staff—are being asked to do extraordinary things regarding course delivery and learning that have not been seen on this scale in the lifetimes of anyone currently involved" (Hodges et al., 2020). Not only has COVID-19 brought a spotlight onto online education, but online education has been growing in use over the last decade. "While the annual growth rate of

online enrollment has slowed from an extremely rapid 30%+ rate of ten years ago, it is still increasing at a rate of over 9% every year" (Cavanaugh, J. & Jacquemin, S., 2015). When considering online or alternate delivery, a couple of the things that may come to mind are student engagement, student participation, and other concerns with aligning to best practices. "Creating meaningful interactions is of paramount importance to engage an online student" (Salazar, J., 2010). There are many different methods to deliver instruction online, but can they support best practices? If so, what best practices can they support and which, if any, will be missed? How does student engagement in different online delivery settings impact and relate to the support of best practices? The purpose of this literature review is to see if an alternate delivery setting such as a synchronist online model, can support the best practices for teaching in the mathematics classroom.

## Significance of the Study

Online education has been growing in use well over the last decade, "the growth of online enrollments in the U.S. has increased for the 14th consecutive year irrespective of an expanding or shrinking economy and rising or declining overall college enrollments" (Palvia, S., Aeron, P., Gupta, P., Mahapatra, D., Parida, R., Rosner, R., & Sindhi, S., 2018). It is important to consider how to provide meaningful interactions though an online medium to increase student engagement, participation, and to support the other best practices in teaching. By recognizing what practices are supported and where improvements can be made, barriers to learning online can be lessened or removed to improve the quality of education for all students. There are many different ways to give instruction online. The focus of this paper will be synchronist online instruction.

**Delimitation of the Study**

This literature review was limited to the key terms used in the database search. The University of Wisconsin-Platteville has access to 220 databases. The main data bases used in the creation of this paper were Google Scholar, EBSCO Education, and ERIC. The studies and journals used in this paper are not only from the United States, but some were conducted in other parts of the world, contributing breadth and some universality to the study. These studies also encompass a large age group of students, including high school and higher education students.

**Chapter II Review of Literature**

**Online learning a rising trend**

According to Allen and Seaman, there has been a noticeable growth in online education especially for higher education in recent decades. "Almost 3.5 million students were taking at least one online course during the fall 2006 term; a nearly 10 percent increase over the number reported the previous year" (Allen & Seaman, 2007). More recent data by Allen and Seaman, found in Cavanaugh and Jacquemin's (2015) study, "A recent survey by Allen and Seaman (2013) of over 2,800 universities and colleges found that 32% of students--over 6.7 million total--are taking at least one online course."

According to Cavanaugh and Jacquemin, about 70% of "higher education academic leaders," think that online education will be critical in the future. Though in the past online education has been met with hesitancy, in the last 10 years or so, the number of higher education leaders that believe the quality of online classes are equal or better than face-to-face classes has been growing from around 52% to 77% (2015).

**Equity and other concerns of Online Learning**

A concern of online education is that it can be limited and may not be readily available to all students. A study showed that technology and internet issues were more prevalent for students of color and for those who emanated from low-income households (Bates, J., 2021). "As the level of poverty increases in the community, the rate of internet accessibilities declined rapidly and by implications, students with no or low socio-economic power to afford broadband connection are most vulnerable to fall behind or encounter additional challenges to meet up with others in online learning" (Adedoyin, O. B., & Soykan, E., 2020). With schools and other institutions lacking funds for advanced technology and disparities in access to the availability to technology, online education cannot be fully utilized. "Insufficient access and availability of the internet and the lack of the latest technology affected the responsiveness and students' capacity to participate in digital learning" (Adnan, M., & Anwar, K., 2020).

There is also the concern of students that have language barriers to overcome in the context in online learning. Students with certain learning disabilities and students with limited language knowledge, for example English language learners, may be frustrated with the pace set by online learning and the different modes of communication through online platforms, especially text-based communication (Appana, S., 2008).

Furthermore, members may be challenged in communicating feelings and thoughts clearly to others based on cultural perception. In a text-only format with limited interpersonal feedback, communicative misunderstandings are common for all members and this could be exacerbated for the member with limited language skills (Appana, S., 2008).

Another group that is impacted are students with varying disabilities. These students are "more vulnerable than other students as they have more needs related to health-care, safety and accessibility" (Khumalo, S., Singh-Pillay, A., & Subrayen, R., 2020). When in person, there are

different process in place to ensure that printed materials were easily accessible and supports were in place to assist with learning, the same needs to be true for technical and online resources in regards to online learning. Without the necessary resources, online learning becomes difficult and frustrating to students. "The lack of infrastructure, not receiving data timeously and poor unstable internet connectivity and load shedding are barrier and challenges to all student but more so to differently abled students who rely on assistive technology" (Khumalo, S., et.al., 2020). These students obtain a more meaningful learning experience if they have access to different technology including: text-to-speech, screen readers, recording devices, word prediction, and synthetic speech to name a few (Khumalo, S., et.al., 2020). "Consequently we have 'locked out' students who are differently abled from online learning, pushing them to the peripheries of academic isolation without the adaptive technologies or skills needed to cope with online learning" (Khumalo, S., et.al., 2020).

**Best Practices in Mathematics**

Best practices is a fairly broad idea. They constitute what is generally considered the most effective way to teach content to students. There seem to be best practices for every subject, grade level, delivery type, etc. Though the "best practices" vary, there are some common themes that arise from them that are fairly consistent when discussing and teaching mathematics. While these are just a few of them, they appear often in many grade levels. Maccini and Gagnon talk about standards as they represent the "philosophy for teaching and assessing mathematics" (Maccini, P. & Gagnon, J. C., 2000). Once again, although the grades differ slightly, a common thread between them are these standards:

1. Math as problem solving (e.g., incorporating real-life math application and utilizing problem solving strategies)

2. Math as communication (i.e., writing, explaining, discussing math ideas)
3. Math as reasoning (i.e., incorporating logical reasoning into math areas)
4. Math connections (i.e., relating math concepts to other math tasks and conceptual understanding, and to other content areas/real-life situations)

In mathematics the *Common Core Sate Standards for Mathematics* (National Governors' Association Council for Best Practices (NGAC for BP) & Council of Chief State School Officers (CCSSO), 2010) developed a set of standards for "mathematical practice." These are practices which mathematics educators should strive to develop in all students. These relate to the four standards listed above as well.

Practice 1: Make sense of problems and persevere with solving them.
Practice 2: Reason abstractly and quantitatively
Practice 3: Construct viable arguments and critique the reasoning of others.
Practice 4: Model with mathematics
Practice 5: Use appropriate tools strategically
Practice 6: Attend to precision
Practice 7: Look for and make use of structure
Practice 8: Look for and express regularity in repeated reasoning

The following sections will look at the practices listed above and look at the benefits and limitations of these practices when considering them in the context of online learning. There are a few main factors that seem to affect the standards above which include, student engagement and motivation/mental health, student communication, tool and technology availability, and ability to gain content knowledge.

**Student Engagement and Motivation/Mental Health**

"Student engagement increases student satisfaction, enhances student motivation to learn, reduces the sense of isolation and improves student performance in online courses" (Martin, F. & Bollinger, D.U., 2018). Martin and Bollinger use the definition of student engagement as "the student's psychological investment in and effort directed toward learning,

understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (2018). Since online learners have fewer opportunities to engage with other students, teachers and the content, it is important to make those moments as engaging to the learner as possible. When in the classroom it is much easier to see if students are engaged, through body language and conversation. If a student is not engaged in class educators are able to address the students in-person and in the moment to encourage them to participate in the activity. It is more difficult to gauge and encourage engagement when online, though is necessary to address. In contrast, traditional environments "have been criticized for encouraging passive learning, ignoring individual differences and needs of the learners, and not paying attention to problem solving, critical thinking, or other higher order thinking" (Appana, S., 2008). While online learning has shown great strides in teaching and learning since it supports exchanges of information and expertise for all types of learners in all sorts of locations (Appana, S., 2008).

Without engagement, students will be less motivated to persevere in the content and in solving problems in general. In a survey, 71% of students found online learning less motivating than conventional learning, and 78% found face to face contact with the instructor to be necessary for learning (Adnan, M., & Anwar, K., 2020). In fact, the lack of determination to solve problems on their own was found to lead to academic fraud. It was found that the rate of academic fraud in online education was approximately 12 times higher when compared to face-to-face education (Doyumgaç, I., Tanhan, A., & Kiymaz, M. S., 2021). Another issue tied to engagement, was that at times students would not attend online lectures at all. There are a number of reasons that this occurred some of which that were observed include: health problems, damaged technology, lack of feedback, inadequate internet, and a home environment not ideal for online learning (Yusuf, B. N., & Jihan, A., 2020).

During the pandemic, unprecedented mental health problems emerged, some linked to online education. Behavioral problems and unwanted emotions that emerged included, but were not limited to, "boredom, aimlessness, education-related issues, conflicts with parents and educators, burnout with technology, and psychopathology (e.g., depression, anxiety, sleep issues, post-traumatic stress disorder symptoms, intolerance to uncertainty, sleep issues, obsession with cleaning and news) to name a few" (Doyumgaç, et. al., 2021).  With students struggling with a variety of potential mental health issues, difficult emotions and uncertainly, it could be quite challenging to keep them engaged and motivated to learn and thrive in an online learning environment.  "Emotions are one of the most salient contributors to academic achievement and play an important role in school settings, instructional practice, and students' motivation and cognition" (Jiang, R., Liu, R.D., Star, J., Zhen, R., Wang, J., Hong, W., Jiang, S., Sun, Y. and Fu, X., 2021).  In contrast, a benefit that could arise from online engagement is the connection to the students who are shy.  There is a level of anonymity that can help certain students come out of their shells and feel more comfortable engaging in the class (Appana, S., 2008).

All of the different math practices could readily be impacted by a lack of motivation and engagement; however, some practices will be more deeply impacted than others by this. Practice 1: Make sense of problems and persevere with solving them, would be highly impacted by a lack of motivation.  Students need a high level of motivation and engagement not to give up on difficult problems in mathematics.  This can be difficult to achieve in the regular classroom, but with the additional challenges currently in online learning this challenge is increased.  The other practices impacted would be Practice 3: Construct viable arguments and critique the reasoning of others, Practice 6: Attend to precision, Practice 7: Look for and make use of structure, and Practice 8:  Look for and express regularity in repeated reasoning.  Practice 3 is more impacted

by a lack of engagement; without engagement of the class during lessons students will not be as apt to discuss the problems with one another or have an enriching dialog that is necessary to construct viable arguments and give constructive criticism to other students. While in the classroom educators can help support these conversations, but when online it becomes difficult to monitor different conversations happening between different groups of students. In fact, in a study by Muilenburg and Berge, they found that the key barrier to students learning online was a lack of social interaction and subsequent learner motivation (Muilenburg, L. Y., & Berge, Z. L., 2005).

## Communication

When looking at online education, it has the potential to offer many benefits to communication, provided meaningful applications and tools are used effectively and appropriately. In fact, online education, is shown to improve communication, accountability and objectivity when evaluating students. The use of online tools can encourage students to communicate with one another and give peer feedback, provide up to date grades, and provide students with immediate feedback (Appana, S., 2008). Online platforms also eliminated some of the "awkward feelings so students could express ideas, opinions and ask questions freely" (Hermanto, Y. B., & Srimulyani, V.A., 2021). However, there are different limitations that can arise with online learning. One limitation of online learning is "conventional classroom socialization." Students are only able to communicate through online platforms and, at times, through video chats. Due to restrictions and limitations to reliable internet and technology, this means that the real time sharing of ideas and information is often limited. Typically, students actively participate with in class activities due to being face-to-face with the teacher and fellow

students.  Once the leaning has moved online, students may never have the chance to interact in person with either students or teachers.  Also, the communication with teachers is often through email which requires response time and is not as immediate or as detailed as compared to face to face interactions (Adnan, M., & Anwar, K., 2020).  When in a classroom, students have many additional ways to signal a teacher if they are in need of help, from raising hands, eye contact, and other subtle cues that are not discernable through an online medium.  Due to this disadvantage, unless students reach out and feel comfortable doing so, students may go without the additional help they may need (Gillett-Swan, J., 2017).

Instructor feedback is also impacted when communication is not as effective as needed and is vital in learning.  According to Wiggins, a couple of characteristics of helpful feedback are that it needs to be timely, ongoing and consistent (2012).   In fact, students in a survey rated "thorough and timely instructor feedback" on their work to be extremely important for helping them make improvements on their work and in learning the material (Martin, F. & Bollinger, D.U., 2018).  Math practices two and three, (Practice 2: Reason abstractly and quantitatively, Practice 3: Construct viable arguments and critique the reasoning of others) rely heavily on communication.  This includes communication between the student and the instructor and student-to-student communication.

> Instructor presence is very important to online learners.  They want to know that someone 'on the other end' is paying attention.  Online learners want instructors who support, listen to, and communicate with them (Martin, F. & Bollinger, D.U., 2018).

Unfortunately, due to the quick shift to online education due to COVID-19, many were not as prepared as they needed to be to cope with all of the changes in communication platforms or for provision of proper feedback.  "Non- interaction/lack of communication was experienced between the students and the teachers, and between the students and parents.  In the pandemic,

11

students, instructors, and parents were inexperienced in distance/online education technologies and several other topics" (Doyumgaç, et. al., 2021).

**Tool and Technology Availability**

When considering the subject of mathematics in conjunction with online learning there are a variety of tools and technologies to consider.  New technology and programs can enhance learning, provide engagement to students, be used for better communication, and so much more (Gillett-Swan, J., 2017).  Tools and technology play a critical role in education and even more to online education.  The fifth practice, use appropriate tools strategically, seems to recognize and provide for adaptations, depending on the technology available and the advancements of technology in the future.  Practice 4 is also related to having the appropriate tools to be able to model the mathematics.  With online learning, this could include online programs, graphing calculators, simulators, and other tools.  In a survey, students showed a preference for being assessed online and felt that their learning was enhanced by online media (Gillett-Swan, J., 2017).  Also, as mentioned earlier different technology and tools are needed to make the learning accessible to learners with different needs as well as including assistive software, and tools like text-to-speech for example.  However, the instructor needs to have confidence in using these tools and technologies and be able to instruct the students and at times the parents in how to use them properly. "Students and instructors with low digital competence are liable to lack behind in online learning" (Adedoyin, O. B., & Soykan, E., 2020).  With the quick transition to online learning due to COVID-19, this was a problem since many educators were still trying to learn the new tools themselves.  This can leave learners feeling isolated and could produce anxiety associated to using technology due to the teacher and student all having varying degrees of

proficiency using the platforms and tools (Gillett-Swan, J., 2017).  What was found in study by Doyumgaç, Tanhan, and Kiymaz, students experienced a lack of proper technology and limitations in access to not only to certain technology, but internet availability and reliability as well (2021).  "A consistent finding among researchers measuring the impacts was that disparities such as lack of internet access in rural areas, were amplified during the lockdown" (Bates, J., 2021).  If students do not have access to the proper tools or are unable to access them due to the unavailability of the internet, they will not have the opportunity to learn how to use them, let alone use them strategically.  "Certain students did not own computers, smart phones, etc., due to economic hardships or those [who] lived in rural areas could not access the internet" (Doyumgaç, et. al., 2021).  A study showed that 1 out of 6 people taking a STEM course either had problems with the internet or other technological issues (Bates, J., 2021).  While at home, students may not have access to the technologies mentioned before, but they also may not have access to manipulatives that are readily available in the mathematics classroom.  This could include graphing paper, rulers, protractors, counting blocks and others.  With the lack of tools and manipulatives, learning and forming conceptual understanding of the material may be much more difficult for students and "virtual classes cannot be of interest to students who are tactile learners" (Adnan, M., & Anwar, K., 2020).  In one study, it was shown that "students were without basic learning tools, such as books and laptops" (Yusuf, B. N., & Jihan, A., 2020).  The lack of tools in the home and potentially the need to purchase these items can also put a strain on families especially if they are already considered to be low income households.

**Content Knowledge**

At the end of the day, instructors want their teaching to be effective and they want their

students to leave their classes having learned something.  While this does include content

knowledge, so much more can be learned in the classroom from behaviors, such as to working

collaboratively, organizational skills, and more.  Though, when considering what is learned

through online learning, it was found that similar to a face-to-face classroom, students were

learning more than just content; they were improving writing skills, and computer skills

(Appana, S., 2008).  According to a study, around 97% of respondents' online activities

increased their "knowledge on internet usage" when learning online (Abdullahi, U., Sirajo, M.,

Saidu, Y., & Bello, U., 2020).   Not only that, but it has been discussed that "students perform

better in online courses due to the flexibility and responsiveness experienced in online learning"

(Appana, S., 2008).  In some instances, students were also seen sharing additional information,

articles and other resources to help enrich learning (Appana, S., 2008).  There have been studies

that indicate that online education could be as efficient as face-to-face education (Doyumgaç, et.

al., 2021).   However, the perception of students in one study showed that 78.6% of students felt

that face-to-face contact with their teacher was important for effective learning, which is missing

in online education (Adnan, M., & Anwar, K., 2020).  With the shift to online learning during the

pandemic, definite impacts on student learning were identified:

> Researchers at Fort Valley State University found that historically Black colleges and
> universities (HBCU) experienced a range of negative impacts on student retention and
> learning, due to both a lack of online tools available for students and instructors that had
> little experience in teaching online courses (Bates, J., 2021).

**Summary**

As moves to online education are considered and experienced, it is necessary to consider

the limitations, as well as the potential for equitable learning for all students, especially looking

at the potential inequity issues for ELL students, low socio-economic students and students with

varying disabilities in an increasingly diverse population. Looking at the best practices for teaching mathematics, the areas of student engagement and motivation/mental health, communication, tool and technology availability, and content knowledge stand out as key areas to explore. These are the areas that would impact the best practices and would seem to pinpoint key differences between traditional teaching methods and online learning.

## Chapter III Conclusions and Recommendations

In conclusion, whether online education can support best practices in mathematics, coupled with how online education was presented during the COVID shut down, showed that, in many cases, best practices were not necessarily supported by online education. "Senior secondary school students were faced with the following challenges during their online learning of mathematics: teachers' online delivery method, difficulty in submitting their mathematics assignment online, teachers' inability to communicate with them during online mathematics class" (Abdullahi, U., et. al., 2020). However, it is possible for online education to support the best practices, though it is difficult and does require special attention to specific areas to ensure that best practices are being supported. The main areas that would need support are improvement of access and subsequent equity for online education and provision of tools needed to support it, improvement of student engagement techniques, consistent and reliable means to communicate to provide productive feedback, and mental health support. "The success of online learning systems is highly dependent on several integrated components between students, lectures, learning resources, and existing technology" (Hermanto, Y. B., & Srimulyani, V.A., 2021). To improve access and equity to online education, the necessary tools need to be provided, whether that is a laptop, internet, calculators, applications, data storage, etc. While the

schools should be able to help with some of this, access to internet in rural areas is a larger undertaking for the city/state/country. Training and support to students and parents on how to use this technology will also be necessary to help families adapt to an online learning environment.

As mentioned by Simamora, online learning has the potential to motivate and engage students because of its flexibility and the self-paced capabilities. It also has the ability to be individualized for personalized learning (Simamora, 2020). At the moment, however, considering student perspectives, "the negative impact, in my opinion, is the online learning process that only happens in one direction, making it difficult for students to consult with material that is felt to need a deeper explanation or understanding" (Simamora, 2020). To deepen student understanding of the content and to keep students as active participants, "there must be cooperation and collaboration between students and instructors in online courses in order to increase online student engagement" (Martin, F. & Bollinger, D.U., 2018). One strategy mentioned by Martin and Bollinger is using real-world applications and project-based learning as a way to maintain motivation and encourage engagement and thought (2018). Training may be needed to help educators adapt and learn new strategies to engage students online. "Successful teaching whether it is online or onsite, needs to include discussion, cooperation and motivation" (Xhaferi, B., & Xhaferi, G. , 2020).

According to Xhaferi, students found that there was a lack of consistent feedback from their instructors (Xhaferi, B., & Xhaferi, G. ,2020). In some cases, lack of consistent feedback was a technological issue, while in others it was the unfamiliarity with online instruction. However, if instructors are able to provide thorough and timely feedback and communication to their students, the students will be able to make significant improvement in their learning. This

could include sending regular announcements, having grading rubrics for assignments, and email reminders (Martin, F. & Bollinger, D.U., 2018).

The mental health and well-being of students while they are learning online should also be taken into consideration.  Schools generally provide counselors and other resources when students are in the school building and these services should also extend to students that are learning online. Not only that, but instructors should also be aware of the amount of material they are assigning to not over tax students and they should take into consideration anxieties that may arise due to online instruction.  **"**Online mental health services could be provided to the students to prevent emotions such as loneliness and uneasiness, etc. using distance education tools" (Doyumgaç, et al., 2021).

While online learning has the potential to be just as effective as in-person learning, there remains need for widespread availability of technology, training of educators in new practices to keep students engaged online, technologies to provide effective and consistent feedback, and mental health support to students.  With these adjustments, education will be closer to realizing the potential of online learning and all it can offer to provide students an education that reflects best practices that are comparable to those offered in face-to-face environments.

References:

Abdullahi, U., Sirajo, M., Saidu, Y., & Bello, U. (2020). Stay-at-home order and challenges of online learning mathematics during Covid-19 case in Nigeria. *Journal of Research & Method in Education*, *10*(4), 10-17.

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive Learning Environments*, 1-13. Retrieved from https://www.researchgate.net/profile/Olasile-Adedoyin/publication/344146577_Covid-19_pandemic_and_online_learning_the_challenges_and_opportunities/links/5fdd00e8299bf14088228a04/Covid-19-pandemic-and-online-learning-the-challenges-and-opportunities.pdf

Adnan, M., & Anwar, K. (2020). Online learning amid the COVID-19 pandemic: Students' perspectives. *Online Submission*, *2*(1), 45-51.

Allen, I. E., & Seaman, J. (2007, October). *Online nation: Five years of growth in online learning*. Newburyport, MA: The Sloan Consortium. Retrieved from http://www.onlinelearningsurvey.com/reports/online-nation.pdf

Appana, S. (2008). A review of benefits and limitations of online learning in the context of the student, the instructor and the tenured faculty. *International Journal on E-learning*, *7*(1), 5-22.

Bates, J., (2021). Education researchers assess impacts of long-term remote learning on students. Retrieved from https://beta.nsf.gov/science-matters/education-researchers-assess-impacts-long-term-remote-learning-students

Carnevale, D. (2007, May 25). Pearson's purchase of e-college signals publishers' interest in online education. *The Chronicle of Higher Education, 53*(38).

Cavanaugh, J., & Jacquemin, S. (2015). A large sample comparison of grade based student learning outcomes in online vs. face-to-face courses. *Online Learning Journal* (OLJ), *19*(2), 8. Retrieved from https://go-gale-com.ezproxy.uwplatt.edu/ps/i.do?id=GALE%7CA443367615&v=2.1&u=platteville&it=r&p=AONE&sw=w

Gillett-Swan, J. (2017). The challenges of online learning: Supporting and engaging the isolated learner. *Journal of Learning Design*, *10*(1), 20-30.

Doyumgaç, I., Tanhan, A., & Kiymaz, M. S. (2021). Understanding the most important facilitators and barriers for online education during COVID-19 through online photovoice methodology. *International Journal of Higher Education*, *10*(1), 166-190.

Hermanto, Y. B., & Srimulyani, V. A. (2021). The challenges of online learning during the Covid-19 pandemic. *Journal Pendidikan Dan Pengajaran*, *54*(1), 46-57.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review*, *27*. Retrieved from https://medicine.hofstra.edu/pdf/faculty/facdev/facdev-article.pdf

Hrastinski, Stefan (2008). Asynchronous and synchronous e-earning: A study of asynchronous and synchronous e-learning methods discovered that each supports different purposes. *EDUCAUSE Quarterly, 31*(4). Retrieved from https://er.educause.edu/-/media/files/articles/2008/11/eqm0848.pdf?la=en&hash=5DA7DDAF9DF14A57B0A70C3075D7CD42ED9D98ED.

Jiang, R., Liu, R.D., Star, J., Zhen, R., Wang, J., Hong, W., Jiang, S., Sun, Y. and Fu, X. (2021). How mathematics anxiety affects students' inflexible perseverance in mathematics problem-solving: Examining the mediating role of cognitive reflection. *British Journal of Educational Psychology*, *91*(1), 237-260.

Khumalo, S., Singh-Pillay, A., & Subrayen, R. (2020). Reflections on differently abled students' challenges with online learning amidst the COVID-19 pandemic and lockdown. *Learner and subject at the dawn of digital research-led teaching and learning in the time of COVID-19*, 188-208.

Maccini, P., & Gagnon, J. C. (2000). Best practices for teaching mathematics to secondary students with special needs. *Focus on Exceptional Children, 32(5)*, 1. Retrieved from https://doi-org.ezproxy.uwplatt.edu/10.17161/foec.v32i5.6919

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1), 205-222.

Muilenburg, L. Y., & Berge, Z. L. (2005). Student barriers to online learning: A factor analytic study. *Distance education*, *26*(1), 29-48.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). Common Core State Standards for Mathematics. Washington, DC: Authors.

Palvia, S., Aeron, P., Gupta, P., Mahapatra, D., Parida, R., Rosner, R., & Sindhi, S. (2018, November). Online education: Worldwide status, challenges, trends, and implications. *Journal of Global Information Technology Management 21*(4): 1-9. DOI:10.1080/1097198X.2018.1542262

Salazar, J. (2010). Staying connected: Online education engagement and retention using educational technology tools. *Clinical Laboratory Science: Journal of the American Society for Medical Technology, 23*(3 Suppl): 3-53-8.

Simamora, R. M. (2020). The Challenges of online learning during the COVID-19 pandemic: An essay analysis of performing arts education students. *Studies in Learning and Teaching*, *1*(2), 86-103.

Wiggins, G. (2012). Seven keys to effective feedback. *Feedback*, *70*(1), 10-16. Retrieved from http://csl.sd79.bc.ca/wp-content/uploads/sites/148/2018/11/Seven-Keys-to-Effective-Feedback-Educational-Leadership.pdf

Xhaferi, B., & Xhaferi, G. (2020). Online learning benefits and challenges during the COVID 19-pandemic-Students' perspective from SEEU. *Seeu Review*, *15*(1), 86-103.

Yusuf, B. N., & Jihan, A. (2020). Are we prepared enough? A case study of challenges in online learning in a private higher learning institution during the Covid-19 outbreaks. *Advances in Social Sciences Research Journal*, *7*(5), 205-212.