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The Perception of Digitally Disadvantaged Students towards Virtual Cooperative Learning

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This study examines the emotional attitudes and opinions of digitally disadvantaged students undergoing emergency online learning in Malaysia, as well as the impact of virtual cooperative learning towards their learning experience. The data was collected through one-on-one interviews with nine digitally disadvantaged students undertaking the Chemical Process Engineering Undergraduate Program at a university in Peninsular Malaysia. The scope of the interviews focused on the students' emotional responses and their opinions about online learning. The impact of virtual cooperative learning as an intervention strategy was also scrutinized. The results of this study can be used for pedagogical considerations for online learning so that the learning experiences of digitally disadvantaged students during an emergency can be improved.

Key words: Digital divide, emergency online learning, cooperative learning, engineering education

Introduction

The lockdown situation, to control the spread of Covid-19 in many countries, forced emergency shifting from face-to-face to online learning to continue educational services. This situation exposed some inequalities and challenges for equal educational access, especially in developing countries (Lembani, Gunter, Breines, & Dalu, 2020;). Yap and Tan (2022) recently showed that the characteristics of goal setting, locating information, and applying knowledge and skills influenced undergraduate students' adaptability to new learning strategies. Students with poor internet access were found to have lower satisfaction towards their learning experiences due to difficulty accessing online learning (Unger & Meiran, 2020). In Malaysia, students undertaking undergraduate degree programs have been on emergency online learning modes since the first lockdown in middle of March 2020. To date, the transition back to full face-to-face (physical) learning methods remain uncertain. Online learning can benefit students because it allows them to learn at their own pace and in any location they choose. However, online learning can be difficult for disabled, underprivileged, and marginalized students who have limited resources and access to online learning. These students are referred to as digitally disadvantaged students. To enhance the effectiveness of online learning, it is crucial to identify the emotional attitudes of digitally disadvantaged students so that educators can adopt or design the appropriate pedagogies to improve students' online learning experiences.

Digital divide is defined as the gap in material access to digital tools (Mathrani, Sarvesh & Umer, 2021), connectivity quality, software, hardware and autonomy of use (Mwendia, Wagacha & Oboko, 2016). When the research on digital divide started at the end of the 20th century (Chipeva, Cruz-Jesus, Oliveira, & Irani, 2018; El-Bawab, 2020; Muruli & Kumar, 2012; van Deursen, van Dijk, & ten Klooster, 2015; van Dijk, 2006), studies on its impact on education grew in tandem. However, the focus was more on the impact of the digital divide in the landscape of conventional online learning (Adhikari, Mathrani, & Scogings, 2016; Zhonggen, 2018). The spotlight on the impact of digital inequality towards the education sector intensified in the past year due to the emergency online learning method devised to address issues created by the Covid-19 pandemic. While it is crucial for governments and other policymakers

worldwide to close the gap through improved digital facilities in communities (Vassilakopoulou & Hustad, 2021), educators can play a role by designing an online learning experience, (Murtiningsih, Hastanti Widy, & Ahmad, 2020) which can reduce the gap of the digital inequalities among students. This is expected to enhance student motivation to persevere under the emergency online learning methods.

Previous research has shown that student collaboration promotes academic literacy in subject content (Moore, Boardman, Smith, & Ferrell, 2019), and a greater appreciation for learning complex subjects such as fundamental science (Gould, Gilbert, Pike, & Menzies, 2019) and neuroanatomy (de Back, Tinga, Nguyen, & Louwerse, 2020). Cooperative learning via a small group learning approach (Davidson & Major, 2014) was found to be effective in promoting learners' cognitive ability and social development as well as improving their subject matter competence (Loh & Ang, 2020).

A study by Cicuto & Torres (2016) found that an active learning environment was effective in increasing students' motivation in learning biochemistry. On the other hand, a strong student-instructor relationship could promote student motivation in an emergency, remote teaching environment (Gares, Kariuki, & Rempel, 2020). A positive correlation between collaboration and students' sense of community was found to exist even in online learning environments (Chatterjee & Correia, 2020). All these elements can be advanced using cooperative learning approaches. Felder & Brent (2007) define cooperative learning as students working in teams on an assignment or project while adhering to predefined constraints that must be met. This instructional strategy allows students to improve their problem-solving abilities and serves as an effective learning method for both students and lecturers. However, some issues, such as the impact of limited internet access when integrating virtual, cooperative learning must be addressed. The computer-supported collaborative learning (CSCL) framework advocated by Jeong and Hmelo-Silver (2016), which is commonly used to support student collaboration for blending learning or online learning modes, was adopted for this study. According to the framework, technology afforded students opportunities to (1) work with each other towards a shared goal, (2) communicate, (3) share resources, (4) engage in a productive process, (5) engage in co-construction, (6) monitor and regulate the learning process, as well as (7) build group and community. Since the effectiveness of virtual cooperative learning for students who are digitally disadvantaged is not well understood, the purpose of this research is to understand the emotional attitudes and opinions of digitally disadvantaged students towards emergency online learning, as well as the impact of virtual cooperative learning on their learning experiences.

Research Design & Methods

A qualitative research method for this study used a one-on-one interview approach. The interview was conducted in March 2021. The participants for the interview were selected from 53 second-year students majoring in the Chemical Process Engineering Undergraduate Program at a university in Peninsular Malaysia. This group of students experienced virtual cooperative learning in one of the core chemical engineering subjects taken during their recently concluded semester. Under the cooperative learning approach, the students were required to watch pre-recorded lecture videos before the live class. During the live class, they were required to solve problems in a group using a collaborative tool i.e., Google Jamboard. The course instructor monitored their progress, and feedback was provided to them. Thereafter, the students were required to explain the solution by submitting a recorded video presentation as a group assignment.

This group of students voluntarily responded to a preliminary survey on their digital access conditions during the emergency online learning. With consent from participants, some were contacted for further interviews. Formal ethical approval was not needed because the respondents' and interviewees' information were kept anonymous.
The data collection in this study involved a semi-structured interview with nine second-year students, who expressed that they had unstable internet connections. These students had participated in the preliminary survey on their digital access conditions. They were informed that the participation in the survey was voluntary. They were also informed that they could provide their name in the survey form if they consented to be selected for interview. The interview was conducted through the Cisco WebEx Meetings platform for eight participants and WhatsApp voice messaging for one participant.

Thematic content analysis was conducted for analysis of the interview transcripts to identify patterns or themes within the qualitative data (Maguire & Delahunt, 2017). All transcripts from the interviews were read twice and relevant points were highlighted. Initial coding of the transcript was performed on the extracted interview points based on prior research (Gan & Sun, 2021; Jeong & Hmelo-Silver, 2016; Johnson & Johnson, 1999; Nogales-Delgado, Román Suero, & Martín, 2020; Raypole, 2019). Some new codes also emerged from the results of the present study. A review and reorganization of coding was then conducted for further refinement. Thereafter, the themes were searched, reviewed, and defined (Maguire & Delahunt, 2017). Finally, a thematic map was created to illustrate the connections

between all the themes. Quantitative descriptive analysis (QDA) was also applied on the conditions faced by the students and their emotional responses to the digital disadvantaged situation (Libarkin & Kurdziel, 2002) for better understanding on the themes.

Results

Figure 1 shows the thematic map for this study. The 'digitally disadvantaged students in emergency online learning' shown in the oval box is the focus of this work. Two major themes, as shown in white square box, were identified from the data collected in this study, i.e., learning barriers faced by the digitally disadvantaged students and their perception towards emergency online learning. Two sub-themes were identified under the learning barrier's theme, i.e., the emotional attitudes of the students towards disadvantaged online learning environment and the consequence(s) of being digitally disadvantaged towards the learning process. We are of the opinion that the emotional attitudes of the students could indirectly compound the impact towards consequence(s), hence, the sub-theme box for 'emotional attitudes' is also connected towards the sub-theme box for 'consequences.' Meanwhile, a sub-theme of 'students' needs' was identified under their 'perception towards emergency online learning.' This would allow for better understanding of their needs through their direct expression and opinions.

A third major theme identified in this work is how the 'use of virtual cooperative learning' experienced by the students impacted their learning process. We see this as an intervention towards the situation, hence, the arrow and the box of the theme are marked in red to provide clear differentiation on its impact towards the 'consequences.' The details of the themes and sub-themes are discussed in the following sub-sections.

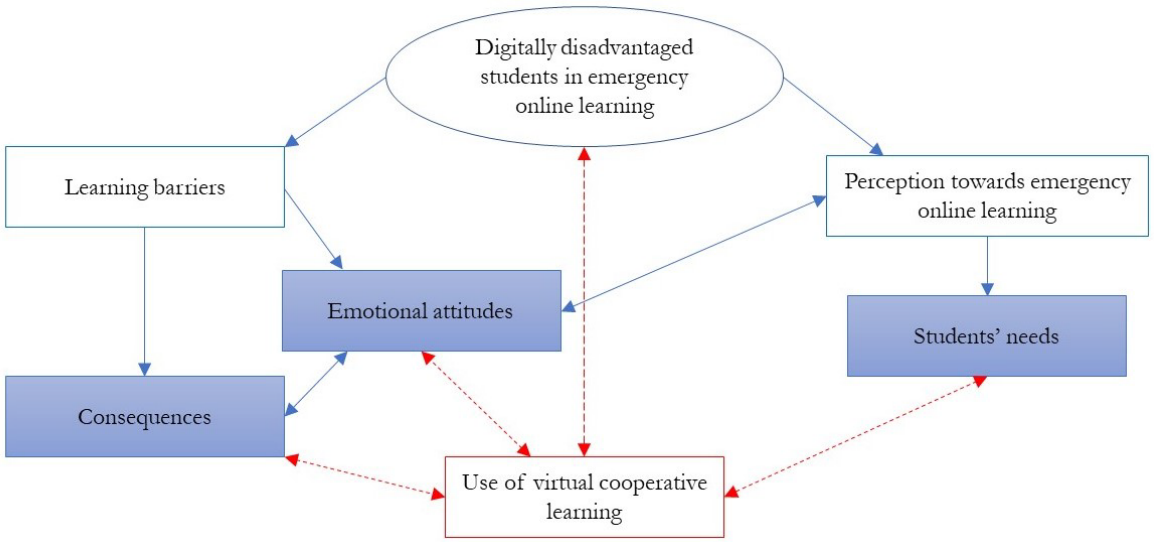

Figure 1. Thematic map for this study

Theme #1: Learning barriers faced by digitally disadvantaged students

Figure 2 shows the distribution of situations faced by the digitally disadvantaged students. Note that there could be multiple situations faced by each participant. Based on data collected from the interview, slow internet was the dominant issue faced by the students under emergency online learning. Some of the examples are:

> "Every time I typed or wrote something, it was delayed."
> "I could only download learning materials during midnight."

Some students experienced slow internet during bad weather such as raining or windy condition. A student explained:

> "I noticed that whenever the weather was cloudy, windy or raining, I would experience unstable internet connection."

The next major issues reported was technical problem such as computer software, hardware, or network issues during online classes (Muilenburg & Berge, 2005). Students experienced live class glitches and problem with video or audio. Among the remarks made by the students were:

> "During lecture time, the internet would suddenly disconnect for 1 to 2 minutes."
> "Lecturer's voice would sometimes become lost."
> "Auto-disconnection would occur in every class."

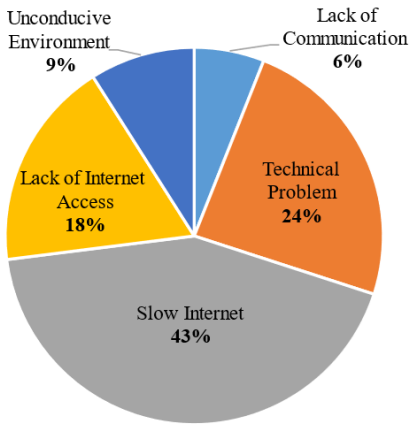

Figure 2. Situations faced by students under emergency online learning

Other learning barrier faced by the students was lack of internet access (Gan & Sun, 2021). Students could only rely on mobile hotspots to proceed with online learning. Their mobile data allocations were limited, and often not sufficient to completely support the monthly data usage required for online learning activities. Worse still, some did not have internet coverage in their respective residences, and they had to go elsewhere to proceed with online learning. Among the examples explained by the students were:

> "I had to use my mobile hotspot for online classes, but the data allocation is not enough for all classes. I had to buy additional mobile data allocation to attend my online classes."
> "Whenever I reached the maximum mobile data allocation for me, the internet speed would be very slow."
> "Once, during analytical chemistry test. I had to walk out from my residence to get the internet connection for submission of my answer script."
> "I have a teammate who needed to go out from her house in the village and went to nearby town in order to receive internet connection for online class."

Not having conducive environments for learning (Gan & Sun, 2021), due to noisy environment, family commitment and sharing of same space with siblings and parents while undergoing online learning, was also deemed by some of the students as barriers towards online learning. The same goes for lack of communication (Nogales-Delgado et al., 2020) with peers due to remote location from each other. Among the remarks recorded on this matter were:

> "The surrounding is very noisy at my hometown, there are lot of heavy machinery passing by since my hometown is near construction site. Dogs are barking everywhere."
> "Since I am at home, I need to help to tidy up the house, cook and take care of my younger siblings."
> "I find it hard to connect with my friends."

Emotional attitudes of students towards disadvantaged online learning environments

Figure 3 shows the emotional responses of students towards their disadvantaged learning environment. Again, note that there could be multiple emotional attitudes experienced by each respondent. Based on the data collected, the most dominant emotional attitude experienced by the students was fear. They expressed emotional attitudes of worry,

anxiety, panic and stress, which were consistent with findings by Raypole (2019). They were afraid of missing out on the lecturer's explanation halfway through the lesson, being called by lecturer when they were disconnected or not being able to submit their answer script during assessment. The following remarks reflect their emotional attitudes:

> "When I couldn't submit, I felt like I wanted to cry."
> "I am afraid I would miss out on lecturer explanation."
> "I would always have to worry that I would have reached the maximum quota limit for my mobile data whenever I connected to it for presentation."
> "I feel very bad. I am not sure how lecturers think of me."

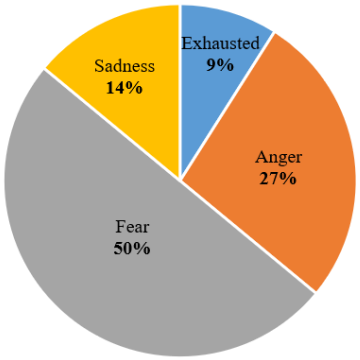

Figure 3. Emotional attitudes when experiencing disadvantaged online learning environment

The next dominant emotional attitude expressed by the students was anger. They felt distressed and frustrated (Raypole, 2019) because they thought that had no control over the situation that they were facing. Some of them remarked:

> "I felt angry and questioned why I couldn't study in the campus."
> "It frustrated me every time this happened."

Some students felt sad when they were lost (Raypole, 2019), while having to bear through such disadvantaged, online learning environments. This emotional attitude was expressed through the following remarks:

> "I felt sad sometimes because it is so difficult for me to obtain the knowledge due to this barrier."
> "I just followed the flow at that time. I didn't know what I could do."

Emotionally exhausted was also expressed by some of the students. It could be due to the overwhelming feeling of having to manage online learning under a disadvantaged learning environment. An example was:

> "I felt tired. Sometimes, I felt like giving up on online learning."

Consequence of being digitally disadvantaged towards the learning process

Being digitally disadvantaged, all the interviewed students unanimously expressed a similar consequence to the learning process, i.e., access-to-knowledge difficulties. They indicated that it was difficult to follow online lessons due to the situations faced. This could be compounded by their negative emotional attitudes experienced when undergoing online learning under disadvantaged learning environment. They could be in the low epistemic motivation condition. This situation could lower the task enjoyment (Lee, 2019). This was reflected in the following remarks:

> "To be honest, I missed a lot of lessons, and I couldn't really follow."
> "It was so hard for me to join the classes. I would only get the knowledge halfway. The lecturer was saying something and then it disconnected."

This shows the criticality of intervention required to bridge the gap of knowledge faced by the students due to their digitally disadvantaged condition.

Theme #2: Perception towards emergency online learning

The perception of the digitally disadvantaged students towards emergency online learning was more inclined towards the negative side. The students deemed online learning as having a greater workload. According to some of them, there were more assignments compared to face-to-face learning. Therefore, it is not surprising that they felt emotionally exhausted. An example of a remark is:

> "Previously during face-to-face learning, I could still have some free time during weekends. But during online learning, I need to complete my assignments during weekends. However, I understand that the assignments are to let us understand the topics better."

Online learning was also perceived as posing a communication barrier. This could be due to difficulty reaching out to others due to being physically remote from each other. This led to them feeling distressed and frustrated, as analyzed in the previous section. Some of them remarked:

> "If during face-to-face learning, I could ask my friends if I had something that I didn't understand. I can ask different friends. But under online mode, I find it quite difficult to find people to ask."
> "Sometimes, I hope that there is no more online learning. During face-to-face class, if I missed some point, it was easy for me to catch up by asking the friend sitting next to me."

Knowledge barrier was also among the perceptions given by the students. Some of them expressed that it was more difficult to understand the subject content when the instructor explained in an online environment. This could also be compounded by the communication barrier which they faced while undergoing online learning. Hence, some of them felt fearful or sad. Example of their remarks are:

> "I felt that it was easier to absorb knowledge through face-to-face class compared to online class because I could directly ask lecturer after class if there was anything that I needed further clarification."
> "It is a bit more difficult to understand when my friends explained through online to me."
> "The feeling of learning by facing the laptop is different from face-to-face."

One of them expressed the thought of online learning as intimidating in the following remark:

> "I thought of unmuting my mic to ask question, but I felt nervous because I felt that everyone would be focusing on me."

They acknowledged that in general, students required strong self-discipline to go through online learning. The physical presence of the instructor was deemed to make a difference to them. Among the remarks on this perception are:

> "I am having trouble to focus during online learning because no one is monitoring me."
> "I guess people with stable internet connection will be more focused, although they can also be distracted by their phone and other stuff."
> "If lecturers kept lecturing during live class, we would feel tired and sleepy."

Nevertheless, some students commended the positive side of online learning where they could rewatch recorded lecture for revision. Recorded lectures were rarely provided by their instructors during the previous face-to-face learning method.

Digitally disadvantaged students' needs

Most of the students expressed that they needed flexible learning time, especially to attend online lessons. The need for recorded lectures was evident from the responses provided by majority of the students. This was because students could choose to engage in learning activities during off-peak internet usage time when their internet connections were more stable. Some of the remarks are:

> "For people with unstable internet connection, if there is no recorded lecture, they have to learn by themselves."
> "I think recorded lecture, Quizziz and Kahoot were helpful. We can complete all those at our own pace when our internet connection was okay."

On top of that, some expressed their hope for empathy from instructors. Structured learning activities such as assigning homework related to the class content would be helpful for them to persevere through emergency online learning. Assigning homework related to class content could indirectly compel the students to be more focused towards the subject content. However, it should be done cautiously as not to overburden the students.

Theme #3: Use of virtual cooperative learning approach

In this study, the seven affordances of computer-supported collaborative learning (Jeong & Hmelo-Silver, 2016) emerged in the students' learning experiences with the incorporation of cooperative learning in one of the subjects taken by the students. So did the academic assistance from the instructor (Johnson & Johnson, 1999) which was outlined as one of the important elements in cooperative learning approach. Table 1 presents the code and interview extracts of the students on how virtual cooperative learning facilitated their learning process.

Based on the traits of the improved learning process experienced by the digitally disadvantaged students, through incorporation of virtual cooperative learning in their lesson activities, such intervention was found to be effective to reduce their access-to-knowledge difficulties. Their learning experience was improved when they had a sense belonging and accountability towards the learning community developed from the process. This could motivate them to persevere even under disadvantaged learning environments. The significance of virtual cooperative learning, which was implemented in this study by adopting the CSCL framework (listed codes in Table 1), revealed positive outcomes related to the two major themes identified (Figure 1), i.e., learning barriers faced by digitally disadvantaged students and their perception of emergency online learning. Remarks by the students indicated that they had a more positive learning experience with the incorporation of virtual cooperative learning.

As explained in the Research Design and Methods Section, the approach applied in this work required students to watch pre-recorded lecture videos before their live classes. This allowed the digitally disadvantaged students to go through the learning contents when their internet condition was more stable, or when their surrounding environment was more conducive to be more focused. During the live class session, the interaction with their peers to work towards a shared goal of solving the given question reduced their fear. Knowing that they were not alone, students realized that their groupmates would help and support them if they faced issues staying connected to the live session. They could also rely on their groupmates to clarify the information explained by the instructor if such situation occurred, hence, indirectly reducing their frustrations. For the instructor, monitoring the progress of students during live class and providing feedback to the students, could affirm or correct students' understanding, as well as alleviating their feeling of being lost. All these traits are reflected by a more positive emotional attitudes expressed by the students in Table 1.

Discussion

This study discovered that students who were digitally disadvantaged had negative emotional attitudes and perceptions of online learning. Their emotional attitudes and perceptions of their learning experiences improved when the situation incorporated virtual cooperative learning.

In the Results Section, the digitally disadvantaged students expressed their need for recorded lecture. While recorded lecture could be provided as part of the learning materials, a more interactive learning experience, such as cooperative learning, should be designed for meaningful and effective learning which can motivate students to participate online. This is because the learner's online participation is the driving factor towards online learning. Online lecture or recorded lecture lacks a key characteristic of online learner participation, i.e., a complex process of taking part and maintaining relations with others (Hrastinski, 2009).

The approach, adopted in this study whereby the instructor assigned collaborative activities that required students to complete tasks through communication, sharing of resources and co-construction of solutions, indirectly regulated the learning process in a cohesive group. To maximize the impact of cooperative learning, the instructor should provide the necessary scaffolding to support students in achieving the goal assigned to them. An improved learning experience could lead to a more positive emotional attitude. Subsequently, this could result in higher epistemic motivation.

Table 1. Impact of virtual cooperative learning towards disadvantaged students' learning experiences

Code	Remarks by students
Establishing a joint task (Jeong & Hmelo-Silver, 2016)	"In fact, I felt relaxed because we could discuss with groupmates. So, we didn't have to worry that we wouldn't be able to solve it." "Usually, we worked on it together. If there was anything missing, we helped to add on."
Communication (Jeong & Hmelo-Silver, 2016)	"My groupmates were very helpful. We would use WhatsApp text or video call to explain to each other what the lecturer explained in the live class, if we missed any of the points due to bad internet connection." "My groupmates were very supportive. Sometimes, if I missed out something, they would inform me if they thought it was something important that I needed to know. So, I could still follow the lesson."
Sharing resources (Jeong & Hmelo-Silver, 2016)	"Usually after the lecturer posted the question for us to solve, whoever was the fastest would snap a photo of it and post in our team's WhatsApp group to share with all. That way, it would be easy for us to refer to." "I can see how other people solved the question, and I can learn from them."
Engaging in productive processes (Jeong & Hmelo-Silver, 2016)	"If one of us wrote solution steps that are different from the others, we would notice it and start to discuss until we reached a consensus on which solution could be the correct one." "If any of us were not sure whether the solution steps were correct or not, we would also seek for clarification from our groupmates in our WhatsApp group."
Engaging in co-construction (Jeong & Hmelo-Silver, 2016)	"We would be dividing the solution into parts and fill in our answers in Jamboard together. Sometimes, if some steps were not so complete, others would help to add in the details." "I wrote on a piece of paper, sent my answer to my groupmates and they would help me to write answer for my part."
Monitoring and regulation of learning (Jeong & Hmelo-Silver, 2016)	"We would make sure everyone was clear and could remember what they need to explain." "Each of us would usually individually solve by writing on a paper first. Then, we would compare our solutions and we could see whether our solutions were the same or different."
Finding and building groups and communities (Jeong & Hmelo-Silver, 2016)	"My groupmates were very supportive." "In a group, I feel more motivated to study."
Academic assistance from lecturer (Johnson & Johnson, 1999)	"Lecturer's comment was very helpful to correct our understanding." "Lecturer's comment was helpful because I would know what I need to do correction on"

Hrastinski (2009) advocated that we need to enhance online learner participation to encourage online learning. Digitally disadvantaged students could be apprehensive of online participation, with slow internet and the technical issues that they encounter. This apprehension was reflected through the negative emotional attitude of the students when experiencing disadvantaged online learning environments. Designing an online classroom where students can depend on peers and support each other as a community is crucial to encouraging participation from all students. The instructor must understand that students will not succeed simply because they work together in a group. Designing a productive and meaningful task, leading to retention of knowledge in subject content, where students could have positive interdependence with each other, while individual accountability exists (Johnson & Johnson, 1999), are crucial

elements that should not be overlooked.

From this study, the most dominant emotional attitudes expressed by the digitally disadvantaged students was fear. When students have better clarity on expectations with details of the planned activities, and have high epistemic motivation level, they could make the necessary efforts to participate as required (Lee, 2019). Hence, the details of planned learning activities should be provided and explained to student at the beginning of the semester. This would enable the students to have better clarity of the structure and flow of the teaching and learning activities. The necessary mental and digital preparation for the activities could be established in advance, and the students would not be unprepared by unexpected requirements of learning activities.

Last but not the least, instructors are recommended to maintain two-way communications with the students. Providing online avenues for students to provide feedback from time to time would enable better understanding of their learning situation. If necessary, adjustment can be done to the online instruction for a more inclusive online learning environment for the disadvantaged students.

Conclusion

This study found digitally disadvantaged students faced not only digital access hurdles while undergoing emergency online learning, but also non-digital access related challenges. The disadvantaged situation affected them negatively, in terms of emotions and access-to-knowledge. The digitally disadvantaged students generally had negative perception towards emergency online learning, although some could see the silver lining in it. Intervention in such situations, such as the incorporation of cooperative learning could help to alleviate the negative impacts experienced by the disadvantaged students. With the uncertain timeline for transition back to the face-to-face learning method, students hoped for flexibility of lesson time through recorded lecture, empathy from instructors and structured learning activities. We hope that this study will compel instructors or education practitioners to rethink and redesign the online teaching and learning activities to enable a more inclusive emergency online learning environment for digitally disadvantaged students.

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References

Adhikari, J., Mathrani, A., & Scogings, C. (2016). Bring your own devices classroom: Exploring the issue of digital divide in the teaching and learning contexts. *Interactive Technology and Smart Education, 13*(4), 323-343. doi:10.1108/ITSE-04-2016-0007

Chatterjee, R., & Correia, A.-P. (2020). Online students' attitudes toward collaborative learning and sense of community. *American Journal of Distance Education, 34*(1), 53-68. doi:10.1080/08923647.2020.1703479

Chipeva, P., Cruz-Jesus, F., Oliveira, T., & Irani, Z. (2018). Digital divide at individual level: Evidence for Eastern and Western European countries. *Government Information Quarterly, 35*(3), 460-479. doi: 10.1016/j.giq.2018.06.003

Cicuto, C. A. T., & Torres, B. B. (2016). Implementing an active learning environment to influence students' motivation in biochemistry. *Journal of Chemical Education, 93*(6), 1020-1026. doi:10.1021/acs.jchemed.5b00965

Davidson, N., & Major, C. H. (2014). Boundary crossings: Cooperative learning, collaborative learning, and problem-based learning. *Journal on Excellence in College Teaching, 25*(3&4), 7-55.

de Back, T. T., Tinga, A. M., Nguyen, P., & Louwerse, M. M. (2020). Benefits of immersive collaborative learning in CAVE-based virtual reality. *International Journal of Educational Technology in Higher Education, 17*(1), 51. doi:10.1186/s41239-020-00228-9

El-Bawab, T. S. (2020). Toward access equality: Bridging the digital divide. *IEEE Communications Magazine, 58*(12), 6-7. doi:10.1109/MCOM.2020.9311933

Felder, R. M., & Brent, R. (2007). Cooperative learning. Active learning: Models from the analytical sciences, 970, 34-53.

Gan, I., & Sun, R. (2021). *Digital divide and digital barriers in distance education during COVID-19*. Paper presented at the Proceedings of the 54th Hawaii International Conference on System Sciences.

Gares, S. L., Kariuki, J. K., & Rempel, B. P. (2020). Community matters: Student–instructor relationships foster student

motivation and engagement in an emergency remote teaching environment. *Journal of Chemical Education, 97*(9), 3332-3335. doi:10.1021/acs.jchemed.0c00635

Gould, K. S., Gilbert, A., Pike, A. J., & Menzies, I. J. (2019). Interactive touch-screen monitors facilitate collaborative learning of microscopy skills in an introductory-level plant biology lab. *Journal of Biological Education, 53*(1), 47-53. doi:10.1080/00219266.2017.1420680

Hrastinski, S. (2009). A theory of online learning as online participation. *Computers & Education, 52*(1), 78-82. doi:10.1016/j.compedu.2008.06.009

Jeong, H., & Hmelo-Silver, C. E. (2016). Seven affordances of computer-supported collaborative learning: how to support collaborative learning? How can technologies help? *Educational Psychologist, 51*(2), 247-265. doi:10.1080/00461520.2016.1158654

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory Into Practice 38*(2), 67-73.

Lee, H. (2019). Teachers' negative emotional feedback can facilitate students' learning: the role of epistemic motivation in undertaking divergent- and convergent-thinking tasks. *An International Journal of Experimental Educational Psychology* 39(7), 900-922.

Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The same course, different access: the digital divide between urban and rural distance education students in South Africa. *Journal of Geography in Higher Education, 44*(1), 70-84. doi:10.1080/03098265.2019.1694876

Libarkin, J. C., & Kurdziel, J. P. (2002). Research methodologies in science education: Qualitative data. *Journal of Geoscience Education, 50*(2), 195-200. doi:10.1080/10899995.2002.12028052

Loh, R. C.-Y., & Ang, C.-S. (2020). Unravelling cooperative learning in higher education: A review of research. *Research in Social Sciences and Technology, 5*(2), 22-39.

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Teaching and Learning in Higher Education, 9*(3), 3351-33514.

Mathrani, A., Sarvesh, T., & Umer, R. (2021). Digital divide framework: online learning in developing countries during the COVID-19 lockdown. Globalisation, Societies and Education, 1-16.

Moore, B., Boardman, A. G., Smith, C., & Ferrell, A. (2019). Enhancing collaborative group processes to promote academic literacy and content learning for diverse learners through video reflection. *SAGE Open, July-September 2019*, 1-15.

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

Murtiningsih, R. R. S., Hastanti Widy, N., & Ahmad, S. (2020, 2020/11/12). *Considering the effective online learning design: distance learning and digital divide in the pandemic era.* Paper presented at the 2nd Early Childhood and Primary Childhood Education (ECPE 2020).

Muruli, & Kumar, S. B. (2012). *Dimensions of digital divide and digital opportunities: An Indian scenario.*

Mwendia, S. N., Wagacha, P. W., & Oboko, R. (2016). Ambient learning conceptual framework for bridging digital divide in higher education. In International Business: Concepts, Methodologies, Tools, and Applications (pp. 179-208). IGI Global.

Nogales-Delgado, S., Román Suero, S., & Martín, J. M. E. (2020). COVID-19 Outbreak: Insights about teaching tasks in a chemical engineering laboratory. *Education Sciences, 10*(9), 226. Retrieved from https://www.mdpi.com/2227-7102/10/9/226

Raypole, C. (2019). Big feels and how to talk about them. Retrieved from https://www.healthline.com/health/list-of-emotions

Unger, S., & Meiran, W. R. (2020). Student attitudes towards online education during the COVID-19 viral outbreak of 2020: Distance learning in a time of social distance. *International Journal of Technology in Education and Science (IJTES), 4*(4), 256-266.

van Deursen, A. J. A. M., van Dijk, J. A. G. M., & ten Klooster, P. M. (2015). Increasing inequalities in what we do online: A longitudinal cross sectional analysis of Internet activities among the Dutch population (2010 to 2013) over gender, age, education, and income. *Telematics and Informatics, 32*(2), 259-272. doi:https://doi.org/10.1016/j.tele.2014.09.003

van Dijk, J. A. G. M. (2006). Digital divide research, achievements and shortcomings. *Poetics, 34*(4), 221-235. doi:https://doi.org/10.1016/j.poetic.2006.05.004

Vassilakopoulou, P., & Hustad, E. (2021). Bridging digital divides: A literature review and research agenda for information systems research. *Information Systems Frontiers*. doi:10.1007/s10796-020-10096-3

Yap, J. S., & Tan, J. (2022). Lifelong learning competencies among chemical engineering students at Monash University Malaysia during the COVID-19 pandemic. Education for Chemical Engineers, 38, 60-69.

Zhonggen, Y. (2018). Third-level digital divide in English teaching and learning. *International Journal of Information and Communication Technology Education (IJICTE), 14*(3), 68-80. doi:10.4018/IJICTE.2018070106