Perception of STEM Students in an Online Learning during the COVID-19 Pandemic: Advantages, Academic Challenges, and Solutions

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Abstract—This study examines 101 STEM students' perception of online learning during the COVID-19 pandemic in terms of advantages, academic challenges, and solutions. Using a quantitative research design, the researcher used a survey method in a private school among 101 STEM students in which online learning was implemented. The modified questionnaire underwent reliability testing, and each section (advantages, academic challenges, and solutions) shows excellent internal consistency among the items with Cronbach's alpha scores of 0.914, 0.907, and 0.928, respectively. Results showed that pre-recorded lectures helped them re-watch missed lectures as being perceived by STEM students greatly advantageous. However, during online learning, most of them experienced a lack of concentration. To solve their perceived academic challenges, the survey showed that students should be given reasonable time to manage their assignments. Moreover, the results have also shown no statistically significant difference in sex, age, and year level. The results of this study do not consider online learning that occurs at other schools because it was performed in a single basic education school.

Indexed Terms—Perception, STEM education, Online learning, COVID-19 pandemic, Attitude.

I. INTRODUCTION

People's lifestyles have altered due to COVID-19; people are instructed to keep their distance and travel as little as possible, and these security measures also apply to education. This is done to prevent the spread of COVID-19 [1]. In the Philippines, which has been hit hard by the COVID-19 pandemic and bears the second largest burden of cumulative confirmed COVID-19 cases in the EAP region [2], the government has rolled out various public health measures, including school closures. The Department of Education (DepEd) originally planned to reopen schools via distance learning on August 24, 2020 but moved the reopening to October 5, 2020. Reasons for the postponement included challenges in the distribution of learning materials, questions regarding the modules' quality, and strong reservations from practitioners in the education sector.

Since early October 2020, children have been receiving education via distance learning. The Department of Education created various learning delivery modalities to facilitate remote learning, including the Commons online platform, TV and radio programs, SMS, and paper-based self-learning modules.

The implementation of distance learning is not limited to crises such as the current pandemic. Online learning has been suggested as a substitute for face-to-face learning [3]. Speed, student-teacher ratio, pedagogy, online teacher role, online student role, online communication synchronization, online assessment role, and feedback sources are all critical aspects of effective online learning.

Distance teaching institutions should consider the support that is simple to use, effective, and addresses various aspects of distance learning, such as interactions with students and their parents or guardians, infrastructure requirements, personnel ability to operate distance learning, meeting the need for learning, student difficulties, school personnel,

and outcomes, performance, and feedback from students and staff [4].

Although face-to-face classes have been recognized as a form of learning today, it is necessary to prepare for education using a system due to unexpected changes in the environment that may occur in the future. Face-to-face instructions can be hampered by contagious diseases, war, regional conflicts, and other natural disasters; thus, remote teaching must be done in partnership with other organizations to tackle the problem [5]. Therefore, this study aims to explore the perceived advantages, academic challenges, and solutions of online learning for the Science, Technology, Engineering, and Mathematics (STEM) students which are being implemented as a result of the COVID-19 pandemic.

II. METHOD

In this study using quantitative research design, the researcher used a survey method of STEM students in a private school in which online distance learning was implemented. The questionnaire was modified based on the existing studies [6-8]. The questionnaire contains 41 items scored with a 5-point Likert scale from 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). An online survey invitation was sent to a private school with 65 complete surveys returned. The modified questionnaire has undergone reliability testing, and each section (advantages, academic challenges, and solutions) shows excellent internal consistency among the items, with Cronbach's alpha scores of 0.914, 0.907, and 0.928, respectively. In terms of validity, the modified questionnaire underwent content validation to ensure that the items included were related to the scope of the study. A total of 101 STEM students participated in filling out the modified questionnaire after it was content and face-validated by the experts. The questionnaire contains a demographic profile (gender, age, and year level) and items related to the advantages and challenges STEM students encounter in online learning. The possible solutions were also shown in the questionnaire.

III. RESULTS AND DISCUSSION

Online learning has several advantages over traditional face-to-face learning. It allows many students to receive an education at a fraction of the expense of face-to-face training [9]. Despite technical difficulties and other issues, such as the difficulty many students have obtaining technology tools, online instruction will undoubtedly continue to play an essential role in education at all levels.

Table 1. Frequency and Percentage Distribution of the Respondents

Variables		Frequency	Percentage
Sex	Male	38	37.6
	Female	63	62.4
Age	16	23	22.8
	17	42	41.6
	18	33	32.7
	19	3	3.0
Year Level	Grade 11	49	48.5
	Grade 12	52	51.5
Total		101	100

Table 1 shows that 37.6% (n=38) males and 62.4% (n=63) females responded in the survey. From the said data, mostly of the respondents were 17 years old (n=42, *41.6%*) followed by 18 years old (n=33, *32.7%*), 16 years old (n=23, *22.8%*), and 19 years old (n=3, *3.0%*). The survey was distributed to the whole senior high school- STEM students, and a number of them responded, of which 48.5% (n=49) were in grade 11, and 51.5% (n=52) were in grade 12.

A. Perceived Advantages

Table 2 below shows the weighted mean of the STEM students' responses in terms of their perceived advantages of using online learning. Eight (8) of the items responded with 'Agree' (i.e., items 12, 7, 5, 9, 10, 8, 6, and 1 with weighted means of 4.38, 4.12, 3.97, 3.92, 3.68, 3.65, 3.59, and 3.51 respectively). The results showed that the STEM students' edge in having online classes were they can have to re-watch the lectures missed, it enhanced their technological skills, and their teachers utilized innovative methods of teaching, especially in E-learning. The results are

also supported by the studies conducted by [10, 11, and 12].

According to the study conducted by [10], pre-recorded lectures (PRL) appear to help students perform higher in memory questions (MQ) than comprehension questions (CQ). This could be because students could review vocabulary or new concepts offered in the lecture videos at their own pace [13] or because they watched the videos right before the exam. Students in live lectures (LL) rely on their ability to take adequate notes. Hence the option to pause and repeat the video may aid in retaining new information.

Table 2. STEM students' perceived advantages

No.	Items	Weighted Mean	SD	Verbal Interpretation	Rank
12	Pre-recorded lectures helped me re-watch the lectures I missed.	4.38	0.75	Agree	1
7	Online learning enhances students' technological skills.	4.12	0.84	Agree	2
5	My teachers use innovative methods of teaching that are reliable with E-learning.	3.97	0.66	Agree	3
9	Online learning is an appropriate strategy to complete the educational process under the COVID-19 pandemic.	3.92	0.83	Agree	4
10	Online learning offers efficient communication tools.	3.68	0.90	Agree	5
8	Online learning increases my self-reliance and urges me to do further research.	3.65	0.99	Agree	6
6	Online learning encourages collaborative activities and group work through social media applications.	3.59	1.00	Agree	7
1	Administering online learning provides me with a worthwhile learning experience.	3.51	0.97	Agree	8
11	Online learning provides a suitable environment between students and instructors.	3.44	0.99	Neutral	9
3	I support online learning as an official method recognized by private and public educational institutions.	3.35	1.14	Neutral	10
2	All the subjects I took could be effectively taught online.	3.27	1.09	Neutral	11
4	Joining online courses increases my confidence.	3.20	1.07	Neutral	12
	Total	3.67	0.94	Agree	

Legend: 4.50 – 5.00 (Strongly agree); 3.50 – 4.49 (Agree); 2.50 – 3.49 (Neutral);
1.50 – 2.49 (Disagree); 1.00 – 1.49 (Strongly Disagree)

Online learners need to understand the dynamics in an online setting, how online learning works, interactions, relations, perceptions, and roles of learners and instructors.Individualization and flexibility should be more accessible in an online learning environment, increasing the demand for self-directed learning. It also requires well-developed lifelong learning skills and strategies, such as goal-setting, action planning, learning-strategy selection and assessment, resource selection and evaluation, reflective learning, and time management.

Providing abundant online resources gives students an avenue to further explore the material. Students prefer to do their research and forward links for articles and additional web-based resources [12]. This further promotes an active collaborative learning process. Creating individual and group assignments can be a successful integration that assists students in learning both independently and collaboratively. The course content orchestrates the type of assignments, with the majority of work in an e-learning course being independent with an infusion of collaboration.

Individual work assignments allow students to learn at their own pace, while group discussions deepen understanding of the content by enabling students to share their perspectives and thoughts.

Other responses were also made in this section. Four (4) items were responded with 'Neutral' (i.e., items 11, 3, 2, and 4 with weighted means of 0.99, 1.14, 1.09, and 1.07. The results showed that the STEM students have neutral feedback on whether online learning provides a suitable environment between them and their teachers, online learning as an official method, all subjects they took online were effective, and confidence levels remain even joining online classes.

The results show that students have neutral agreement whether they prefer online learning. Several factors can be considered, such as speed, student-teacher ratio, pedagogy, online teacher role, online student role, online communication synchronization, online assessment role, and feedback sources [3]. This implies that students may encounter less online availability when entering synchronous sessions. Instead of joining the lesson asynchronously, the remaining students may decide to forego the materials posted online.

B. Perceived Academic Challenges

Table 3 shows the weighted mean of the STEM students' responses in terms of their perceived academic challenges using online learning. Twelve (12) of the items were responded with 'Agree' (i.e., items 22, 16, 21, 23, 13, 17, 26, 20, 18, 14, 24, and 25 with weighted means of 4.21, 4.07, 4.06, 4.05, 3.91, 3.77, 3.76, 3.72, 3.68, 3.66, 3.60, and 3.54. The results show the students' difficulties faced in online learning where they can be easily distracted by social media, have other responsibilities aside from being a student, and have a slow or intermittent connection.

Table 3.STEM Students' Perceived Academic Challenges

No.	Items	Weighted Mean	SD	Verbal Interpretation	Rank
22	Lack of concentration and some students are distracted using other social media.	4.21	0.86	Agree	1
16	Other responsibilities (e.g., work, part-time student, parent, etc.) besides being a student negatively affected online learning.	4.07	0.83	Agree	2
21	Intermittent or slow internet connection.	4.06	0.86	Agree	3
23	Online learning increased the load of assignments and studying hours.	4.05	0.91	Agree	4
13	Absence of real interaction.	3.91	0.86	Agree	5
17	Inadequacy of reliable technical support for students.	3.77	0.87	Agree	6
26	Some students do not acquire the necessary technological skills to enroll in online classes.	3.76	0.93	Agree	7
20	Insufficient time for students with special needs to accomplish the assignment and exams.	3.72	0.96	Agree	8
18	Inadequate timely feedback for students' assignments.	3.68	0.82	Agree	9
14	Evaluation methods (e.g., exams, quizzes, etc.) were inaccurate due to accessible means of cheating.	3.66	0.90	Agree	10
24	Recorded lectures encouraged some students not to show up in their respective classes.	3.60	1.09	Agree	11
25	Some instructors do not have the necessary skills to deal with online learning.	3.54	1.08	Agree	12
19	Inadequate virtual library and resources that meet students'	3.49	0.93	Neutral	13

	academic needs.				
15	Evaluation was unfair and subjective manner.	3.27	0.88	Neutral	14
	Total	3.67	0.94	Agree	

Legend: 4.50 – 5.00 (Strongly agree); 3.50 – 4.49 (Agree); 2.50 – 3.49 (Neutral);
1.50 – 2.49 (Disagree); 1.00 – 1.49 (Strongly Disagree)

The negative consequences of social media outnumber the favorable ones [14]. Because students spend more time on social media for reasons other than education, they become distracted from their studies, compromising their academic development. Furthermore, spending too much time on social networking sites can lead to a sedentary lifestyle and a reduction in regular physical activity, making individuals more susceptible to non-communicable diseases, including obesity, diabetes, and hypertension [15-17]. This implies that social media use adversely affects mental health and can lead to depression and anxiety. As teachers and parents, we must ask our learners whether such technologies are being used to gain knowledge.

According to [18], the excitement of having an online class doesn't stay long after four weeks thinking they can juggle home and work responsibilities. They find their selves missing the human element. This implies that students may have less (working students) or more free (full-time students) time, feel less productive, and take more time to complete each assignment. Possibly, students are bored with reading the learning materials and applying them to their assignments.

Moreover, two (2) items responded 'Neutral' (i.e., items 19 and 15 with weighted means of 3.49 and 3.27). The results show that students were in the middle of whether the virtual library and resources meet their academic needs and if they were evaluated objectively.

During the first day of classes in October 2020, some teachers and students encountered Internet connection problems for their online classes – one of the alternative learning modalities under distance learning [2]. This implies that it may contribute to students falling behind academically. Educational setbacks can significantly impact academic issues, college admissions, and career opportunities.

Many schools and school libraries were closed due to the COVID-19 outbreak, resulting in a transition to online or hybrid instruction and limited access to school libraries. From the study conducted by [19], face-to-face students showed less disruption in their access than online and hybrid students. It could imply that the pandemic has brought to light the need to educate for home access to school library materials, pushing outward on the four walls of the traditional library and extending the common view of the school community by school librarians.

Assessments have been employed in school since the beginning, and pupils have always complained that the evaluation was 'unfair.' What distinguishes a 'fair' or 'unfair' assessment? As instructors, we must consider this question and ensure that we follow some basic principles to ensure that any assessments we give to students are fair and equitable. An assessment checklist [20] was provided to consider when developing and administering your assessments (i.e., improves learning, has validity and reliability, matches the learning outcomes and contents of the course, endeavors to be free from bias, and has transparency.

C.Perceived Solutions

Table 4 below shows the weighted mean of the STEM students' responses regarding their perceived solutions for solving the challenges of using online learning. All of the items were responded with 'Agree.' The results showed that all of the items mentioned above would greatly help them solve the challenges STEM students encounter in online learning.

Assessment is a necessary part of the teaching and learning process, helping us measure whether our students have learned what we want them to know [21]. Based on the aim of the lesson, teachers should determine suitable time frames for homework assignments. Some tasks may take more than one day to complete. If this is the case, provide detailed

instructions. Also, remember that other teachers may assign homework with the same deadlines.

With the growth of technology, traditional education techniques are fast altering worldwide. Technology has become more prominent in traditional classrooms, altering how lessons are presented and absorbed. While there are many other teaching methods, most of the standard approaches that are utilized in class may also be employed online. However, your teaching approach will change depending on your teaching philosophy, objectives, subject area, and classroom demographics. According to [22], these are effective online teaching methods that'll help simplify the delivery of your virtual lessons: Presentations (Google slides, Microsoft PowerPoint, Prezi, & SlideShare), Online Whiteboards, Live Online Classes, Pre-Recorded Video Lectures, Flipped Classroom, Game-Based Teaching, Class Blog, Live Chatting, Discussion Boards, and Forums.

Due to the effect of the current pandemic that the world is experiencing, the educational system swiftly remedied the problem of student learning. The study conducted by [23] assessed the students' internet connection capability and the availability of learning devices in their homes. It showed that majority of students have smartphones. This possesses an opportunity for students to learn on an online basis. Mobile devices such as smartphones are a great help because of their multiple functions, especially in learning nowadays. Moreover, gadgets play an essential role for students. These gadgets are necessary to improve their learning skills and enhance their knowledge.

Table 4.STEM Students' Perceived Solutions

No.	Items	Weighted Mean	SD	Verbal Interpretation	Rank
37	Provide students with reasonable time to manage their assignments.	4.29	0.86	Agree	1
41	Training teachers on the various teaching methods and online delivery.	4.19	0.83	Agree	2
38	Providing underprivileged students with reliable gadgets for online learning.	4.18	0.86	Agree	3
39	Strengthening the internet speed to keep up with my online classes/activities.	4.17	0.91	Agree	4
33	Establishment of a technical support unit in the school to help students to overcome technical difficulties.	4.15	0.86	Agree	5
34	Granting students valid contact details (mobile number, emails) of technicians who offer continuous technical support.	4.14	0.87	Agree	6
40	Training students to be fully equipped with technological skills necessary for their online application.	4.10	0.93	Agree	7
36	Offering teachers the necessary technical support that they need while teaching online.	4.08	0.96	Agree	8
31	Development of an attendance system for students and sending them a notification if they were absent.	4.07	0.82	Agree	9
27	Accommodating students' timely and accurate feedback to create an honest and trusting relationship with their teachers.	4.05	0.90	Agree	10
29	Applying varied teaching methods that encourage meaningful interaction in the online learning environment.	3.98	1.09	Agree	11

35	Implementing a virtual laboratory with helpful learning resources.	3.95	1.08	Agree	12
32	Diagnosing the technical situation of students-electronic devices/network speed.	3.94	0.93	Agree	13
30	Developing online educational applications against cheating.	3.85	0.88	Agree	14
28	Adopting oral and analytical exams to make the assessment further reliable.	3.70		Agree	15
	Total	4.06	0.79	Agree	

Legend: 4.50 – 5.00 (Strongly agree); 3.50 – 4.49 (Agree); 2.50 – 3.49 (Neutral); 1.50 – 2.49 (Disagree); 1.00 – 1.49 (Strongly Disagree)

D.Significant Differences based on Sex, Gender, and Year Level

Table 5 shows the significant difference between sex and perception of STEM students using the One-way ANOVA. By level of significance and by the rule of rejection, 'Sex' significantly differs from 'Academic Challenges.' This means that 'sex' affects the 14 items under academic challenges. On the other hand, sex does not affect STEM students' perceived advantages and solutions.

Table 5. Significant difference in one way ANOVA based on sex

Perception of STEM students	p-value	Verbal Interpretation
Advantages	.351	Not significant
Academic Challenges	.024	Significant
Solutions	.054	Not significant

Level of significance, $p \leq 0.05$

Statistically, this study shows that females significantly encountered academic challenges compared to males. The following studies conducted may suggest the researcher's claim. An example is that female students have many roles, such as parents, spouses, and employees, compared to male students, who experience more pressure of financial, school responsibilities, and child care [24]. Adult students have responsibilities such as employment, family, and other obligations of adult life [25]. However, both sexes have difficulties juggling the role of student, worker, and family member [26]. Therefore, the possible solutions provided, as shown in table 4, should be implemented to address the problem encountered by STEM students.

Table 6. Significant difference in one way ANOVA based on age

Perception of STEM students	p-value	Verbal Interpretation
Advantages	.890	Not significant
Academic Challenges	.689	Not significant
Solutions	.867	Not significant

Level of significance, $p \leq 0.05$

Table 6 above shows the significant difference between age and perception of STEM students using the One-way ANOVA. By level of significance and by the rule of rejection, 'Age' has no effect on the perception of STEM students regarding advantages, academic challenges, and solutions.

Table 7. Significant difference in one way ANOVA based on year level

Perception of STEM students	p-value	Verbal Interpretation
Advantages	.614	Not significant
Academic Challenges	.893	Not significant
Solutions	.917	Not significant

Level of significance, $p \leq 0.05$

Table 7 shows the significant difference between year level and perception of STEM students using the One-way ANOVA. By level of significance and by the rule of rejection, 'Year Level' has no effect on STEM students' perception regarding advantages, academic challenges, and solutions.

CONCLUSION

The perceived advantages that the STEM students feel through online learning are that pre-recorded

lectures (PRL) help them re-watch the lectures they've missed, it enhances students' technological skills, and teachers use innovative methods of teaching. This implies that PRL appears to help students perform higher in memory questions than comprehension questions. This could be due to the ability to revisit terminology or new concepts presented in the lecture videos at their own pace. STEM students have also understood the dynamics in an online setting and are given an avenue to further explore the lesson by providing abundant online resources. Additionally, the perceived academic challenges are lack of concentration, and some students are distracted using social media, having other responsibilities besides being a student, and intermittent or slow internet connection. This implies that students tend to spend more time on social media other than on educational purposes, also, having more responsibilities may have less time, feel less productive, and take more time to complete each task in school and having intermittent or slow internet connection can contribute to students falling behind academically.

Moreover, the perceived solutions were to provide STEM students with reasonable time to manage their assignments, train teachers on the various teaching methods and online delivery, and provide underprivileged students with reliable gadgets for online learning. This implies that as teachers, we should consider reasonable time frames for homework assignments, we should adapt to necessary changes, especially in the advancement of technology, thinking that it will be efficiently delivered online, and students should have access to gadgets for them to improve their learning skills and enhance their knowledge in an online learning modality. Examining the significance of the demographic profile and the perceptions (advantages, academic challenges, and solutions) of the STEM students shows that sex and perceived academic challenges have a significant difference.

Furthermore, students' perspectives over several periods of time during online learning should be examined. However, because this study only included a small number of students, it does not represent all students' experiences. The results of this study do not consider online learning that occurs at other schools because it was performed in a single basic education school.

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