

## Research Article

# STEM students' conceptions of online learning during COVID-19 pandemic: A phenomenographic study

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This paper reports on a phenomenographic study investigating former grade 12 STEM students' conceptions of online learning during COVID-19 pandemic. Purposive sampling was employed in selecting participants who were enrolled in a private school in Laguna, Philippines that formally implemented a fully online learning setup for SY 2020-2021. By using semi-structured interviews, results conveyed an outcome space comprised of nine (9) core categories of description: 1) online learning marred with unfavorable sentiments, 2) online learning plagued by technical barriers, 3) online learning accentuated the use of online tools, 4) online learning provided aberrational learning experiences, 5) online learning hampered by the learning environment, 6) online learning adversely affected students' well-being, 7) online learning reaffirmed the importance of social interactions, 8) online learning exhibited unsatisfactory perceptions to teaching, and 9) online learning exhibited dissatisfaction towards institutional support. Within each core category, a variety of subcategories fulfilled the anatomy of experience and describing the complexity of the relation between STEM students and online learning during COVID-19 pandemic. Analysis of all core categories of description revealed a generally unfavorable and unenthusiastic view of online learning during COVID-19 Pandemic, with 'online learning provided aberrational learning experiences' as the most prominent core category of description, emphasizing how the deviation from the normal setup adversely affected their learning experiences. Findings revealed in this study can be beneficial in formulating future policy changes and bases of interventions to improve the conduct of online learning and provide a more effective pandemic response in the educational system.

Keywords: STEM education; COVID-19 pandemic; Philippine education; Phenomenography

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## 1. Introduction

COVID-19 pandemic had severely affected various educational institutions all over the world, especially here in the Philippines (Gonzales, 2020; Mallillin et al., 2020a; Mallillin et al., 2020b; Teräs et al., 2020; Toquero, 2020; Tria, 2020;). UNESCO (2020) reported that at its peak in late April of 2020, disruption in education and school closures had affected more than 1.6 billion students at all levels worldwide, 28 million of which were from the Philippines. This global pandemic

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changed the way we live our lives, mainly the way Filipinos have performed their delivery of learning from a traditional classroom setting to blended-learning modalities, one of which is through online learning.

Philippines E-Learning Market Outlook of 2023 report cited that while the Philippines remains an emerging market, it has steadily posted double-digit growth from 2013 to 2018, led by K-12 schools and higher education institutions that availed Learning Management Systems [LMS] (Ken Research, 2019). Whereas several higher education institutions and private schools had better control of the situation as they were already implementing a blended learning approach even before the pandemic, the same cannot be said for primary and secondary level public institutions. Pre-pandemic, incorporating online learning into educational institutions in the Philippines is of lesser priority, with most adoption focused only on the tertiary level (Javier, 2020; Oluyinka et al., 2019).

Online learning, since the start of the school year 2020-2021, is one of the modes of learning delivery approved both by the Department of Education [DepEd] and the Commission on Higher Education [CHED] (Tria, 2020). Many local researchers (Alea et al., 2020; Alipio, 2020a; Bajaro et al., 2021; Baticulon et al., 2020; De Guzman & Pastor, 2020; Estira, 2020; Fabito et al., 2020; Gonzales, 2020; Hidalgo et al., 2021; Mallillin et al., 2020a; Mallillin et al., 2020b; Pastor, 2020; Toquero, 2020; Tria, 2020) have provided various insights in recognizing the extent of the online learning situation in the country brought by the global pandemic. A study by De Guzman and Pastor (2020) and Pastor (2020) on college students in the same university revealed their lack of readiness to shift to synchronous online learning settings specifically in terms of equipment capabilities or availability (i.e., computer, mobile devices, internet speed) to attend to this kind of classroom setup. A similar study by Alipio (2020a) on students' e-learning readiness reported that the majority of its more than 800 respondents were not fully prepared for a possible shift to completely online delivery of learning, particularly those in the low-income class and rural areas. Despite a positive motivation towards online learning, Estira (2020) reported similar findings and highlighted the role of socioeconomic status in terms of overall readiness. Findings from a national survey study by Baticulon and colleagues (2020) revealed that only 41% of its medical student respondents considered themselves as both physically and mentally capable of online learning. In addition, their study listed five (5) general barriers to online learning: technological, individual, domestic, institutional, and community barriers. Mallillin and colleagues (2020a) added that internet connection issues and weak internet devices (gadgets) hindered students' learning process. Audio or voice destruction during online classes affects the integration of knowledge in an online learning setup. Consequently, household chores clashing with the class schedule had an impact on the learning enhancement of students.

Toquero (2020) provided suggestions on how higher education institutions can adapt to the ongoing pandemic and in the future, specifically through the following: integration of environmental and health courses in the curriculum; strengthening environmental and health practices; incorporating online mental health and medical services; scaling up teacher competences for online learning instructions; and strengthening research efforts and evidence-based practices. She recommended the need for further studies to assess how the ongoing pandemic affected the educational system, of which can the evidence gathered can be beneficial for more effective pandemic responses in the future. In relation to this, Tria (2020) discussed a post-COVID educational plan through the adaptation of current health and safety protocols with educational policies. These include the continued use of facemasks on school grounds and physical distancing, strengthening online learning platforms, strengthening health-related studies, and integrating and creating health courses/programs.

Fabito and his colleagues' (2020) study conducted in March cited that both students and teachers were not fully prepared for a shift into full online learning. He added that on the part of the teachers, there was an observable concern to adapt to the needs of students in an online setting. Additional concerns from teachers were cited by Alea and colleagues (2020) in which there is

acceptance of the possibility of shifting to online learning however, the lack of equipment, facilities, and capacity building were major concerns. Issues in terms of facilities, gadgets, and internet connectivity as limitations to online learning, as cited by Gonzales (2020), were concerns pointed out by both teachers and students. Nevertheless, Mallillin and colleagues (2020b) study amongst private and public-school teachers revealed that they viewed online learning as means to provide new learning opportunities and can empower students in terms of gaining technical skills and access to a variety of learning resources. Availability of technology in terms of virtual platforms, applications, learning modules, and digital devices, as well as access to the internet, are important considerations for online learning pedagogy. Their study recommended that future studies should focus on student motivations towards online learning participation to better assist the students in an online learning environment.

The studies previously mentioned focused primarily on institutional restructuring and general perceptions of students and teachers to a shift in online learning, most of which are on the tertiary level (e.g. Onwuegbuzie & Ojo, 2021; Sari & Keser, 2021). In terms of the studies under the senior high school [SHS] level, a phenomenological study by Obligar and his colleagues (2021) amongst SHS students assessed the significance of internet access as a tool for learning. Their findings revealed that, currently, the internet is an important tool for learning and that students experienced difficulties in terms of internet access, quality of internet connections, and health risks accompanying prolonged use of devices, all of which can affect their quality of learning. While their study is phenomenological, their focus was primarily on students' experiences with their internet use. Likewise, Bajaro and his colleagues (2021) conducted a qualitative study that presented themes about the experiences of, in terms of challenges (no. 1-3) and opportunities (no. 4-6), SHS students in online learning pertaining, namely: 1) intermittent WiFi connection; 2) noisy environment; 3) lack of parental supervision and support; 4) comfortable learning environment; 5) lower total cost; and 6) flexible schedule. Their study focuses on various aspects of students' experience with online learning, yet their methodology of the directed approach of content analysis utilizes relevant research findings to guide their data in the early stages of coding. Another phenomenological study by Hidalgo and colleagues among SHS students highlighted the various challenges, in the form of personal (i.e., academic stress), social (i.e., communication issues), technical (i.e., unstable internet), and workplace aspects (i.e., household responsibilities), that the participants had experienced in their online learning school year. Aside from these challenges, coping mechanism was also emphasized which fell into three categories: social (through constant peer communication), personal (through self-management), and workload (through personal efficiency).

### **1.1. Purpose**

Following the recommendations of Toquero (2020) and Mallillin and colleagues (2020b), the purpose of this study is to gain more insights on the experiences of SHS students during the pandemic SY 2020-2021, primarily their experiences of a fully online learning setup. The use of Phenomenography allowed the researcher to explore each subject's experiences of a phenomenon and how they came to be, giving full attention and emphasis to the data provided by each subject that produced their conceptions of their experiences. Thus, this study aimed to understand SHS students, specifically, former grade 12 Science, Technology, Engineering, and Mathematics (STEM) students' conceptions of online learning during COVID-19 pandemic using Phenomenography.

As one of the strands under the Academic track that students can enrol once they reach Senior High School, students enrolled under the Science, Technology, Engineering, and Mathematics (STEM) strand are expected to be prepared and well-equipped with skills when they pursue college degrees in various disciplines under the physical or natural sciences, mathematics, information technology, engineering, and medical and allied fields (Rogayan et al., 2021). However, the Commission of Higher Education (2019, as cited in Morales et al., 2020) reported that college completion rate on said fields hover only at 21%, revealing the already challenging state of

STEM education in the Philippines. Having subjects/courses that require laboratory classes, lab or field experiments, and hands-on approach to learning, aside from the traditional classroom learning setup in which STEM students were accustomed to before the pandemic, the abrupt transition to a fully online learning setup was an important concern that should be acknowledged, hence focusing on STEM students' experiences for this study.

## 2. Methodology

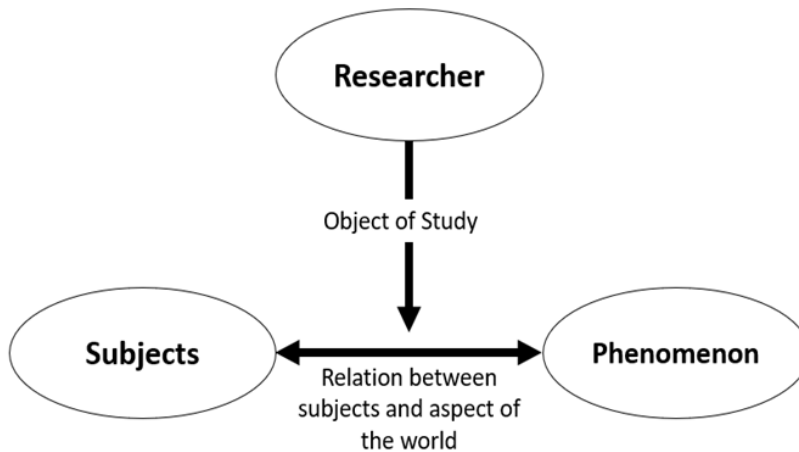
### 2.1. Research Design

Phenomenography is a qualitative approach developed by Ference Marton in the 90s and has since been widely used in educational research (Lam, 2015). According to Marton (1986), phenomenography focuses on "mapping the qualitatively different ways in which people experience, conceptualize, perceive, and understand various aspects of, and phenomena in the world around them (p. 31)." Marton (1986) further explained that "Phenomenography is more interested in the content of thinking ..., thinking that is described in terms of what is perceived and thought about ... never separated from the object of perception or content of thought" (p. 32). Its theoretical underpinnings, according to Yates and colleagues (2012, p. 98), are emphasized by the principle of intentionality through the "non-dualist view of human consciousness" to which knowledge as a product of experiences from the relationship between the individual and the world.

In phenomenography, what is important is how the subjects make sense of the world themselves in a detailed fashion. The general objective of this theory is to find and systematize individual/s' conceptions to interpret significant phenomena or aspects of reality (Marton, 1981). The researcher's primary focus or the 'object of study' is the relation between the subject and phenomenon (see Figure 1). That is, to make sense of this aspect of the world by thoroughly understanding the personal conceptions provided by the subjects who are observing and/or experiencing the phenomenon.

Figure 1

*Focus of Phenomenography by Pramuditya-Wahyudin, Nurlaelah, and Noto (2020)*

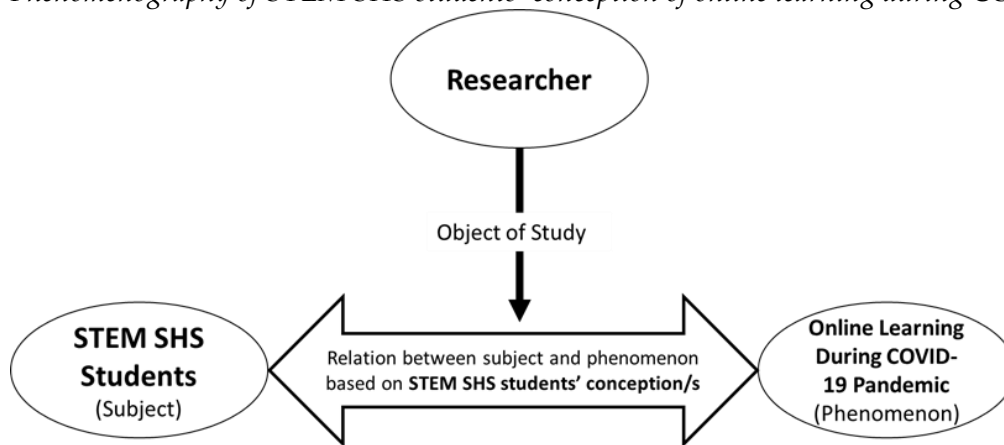


A phenomenographer must follow the second-order perspective. The subject's specific conception of a phenomenon, regardless of its underpinnings, is integral in the thorough analysis of a phenomenon. According to Feldon and Tofel-Grehl (2018, p. 2), examining a subject's conception/s "entails the examination of the phenomena experienced by and the personal meaning-making of individual participants [subject]" to comprehend the dynamic relation existing between the subject and the phenomenon.

Utilizing phenomenography, Figure 2 below illustrates the conceptual framework utilized for this study. Based on the phenomenographic research paradigm shown in Figure 1, the subject, phenomenon, and object of study components were substituted with the appropriate variables of

Figure 2

*Phenomenography of STEM SHS students' conception of online learning during COVID-19 pandemic*



concern. Using phenomenography, the researcher focused on describing the different conceptions of online learning during the COVID-19 pandemic (phenomenon) as held and experienced by STEM students' (subject) for the school year 2020-2021. These conceptions and their bases of explanations, primarily the experiences of subjects of a phenomenon, were analyzed to vividly describe the relationship between the subject and the phenomenon (object of study) by presenting 'categories of descriptions' (collective conceptions) which is consisted of two aspects: referential and structural. Referential aspect emphasizes on what the subjects think about the experience. Conversely, structural aspect focuses on how the subjects carry out and acted towards such experience. Mapping these categories of description to produce the 'outcome space' (conceptual map), as final output, that visualizes the object of study.

## 2.2. Participants

Participants were fifteen (15) former Grade 12 students under the Science, Technology, Engineering, and Mathematics (STEM) strand, who were enrolled in a private school in Laguna that implemented a fully online learning setup for SY 2020-2021. Aside from the previously stated relevance of selecting STEM students, the locale where the participants were formerly enrolled to had approximately 70% of its student population enrolled under STEM strand. Each participant was given a pseudonym for confidentiality purposes. In addition, supplemental information was gathered from the participants to provide their brief description (see Table 1) that includes their

Table 1

*Brief Description of Participants*

<i>Respondent Code</i>	<i>Pseudonym</i>	<i>Gender</i>	<i>Degree to be taken in college</i>
SCOL001	Lizel	Female	Industrial Engineering
SCOL002	Tom	Male	Engineering
SCOL003	John	Male	Multimedia Arts
SCOL004	May	Female	Computer Science
SCOL005	Gia	Female	Applied Physics
SCOL006	Owen	Male	Business
SCOL007	Denver	Male	Civil Engineering
SCOL008	Aiden	Male	Engineering
SCOL009	Peter	Male	Electronics Engineering
SCOL010	Lander	Male	Computer Engineering
SCOL011	Sophia	Female	Mechanical Engineering
SCOL012	Kim	Female	Did not disclosed
SCOL013	Gary	Male	Electrical Engineering
SCOL014	Claire	Female	Psychology
SCOL015	Prescilla	Female	Civil Engineering

respondent code, assigned pseudonym, gender, and their college degree to be taken. It is worth mentioning that despite finishing STEM strand in their senior high school, only eleven (11) of the fourteen (14) participants had pursued college degrees from various Philippine universities that were directly related to their previous education.

### 2.3. Data Collection Tools

In terms of sampling method, according to Alsop and Tompsett (2006, as cited in Mullet et al., 2018), Phenomenography applies purposeful sampling in selecting its interview participants which is aligned with the researcher's main consideration of students' willingness to participate in the study. A semi-structured interview was the primary data gathering procedure (Blummer et al., 2012; Khan et al., 2019), which were conducted via Microsoft Teams.

### 2.4. Data Analysis

The researcher adopted the five-stage analytical framework formulated by Mullet et al. (2018), based on Ference Marton's general guidelines for conducting Phenomenography, in analyzing gathered data. The framework was composed of 1) immersion in the data, 2) selection of relevant segments from the data, 3) preliminary categorization of meanings, 4) initial refinement of categories, and 5) constant comparative analysis of categories. Minor modifications were made since this study utilized a larger data pool. Similarly, adjustments were made in the data analysis, to accommodate an individual researcher. In terms of reliability, gathered data were recorded using a digital recorder. Transcribed data were re-read multiple times while cross-referencing with detailed field notes to ensure consistency of participants' responses to interview questions. To ensure trustworthiness in the data analysis, the researcher followed guidelines implemented by Mullet and colleagues (2018) in which 1) participants were properly debriefed to verify accuracy of their answers, 2) Phenomenographic bracketing was employed by allowing maximum freedom in sharing experiences, 3) thick description was also employed, linking results to their respective sources, 4) ensuring privacy and rights of participants under the De La Salle University-Dasmariñas Ethics Review, and 5) avoidance of premature closure of data analysis. The last item was specifically implemented by following the fifth step in their five-stage analytical framework

In stage 1, the researcher conducted a series of close readings of each transcript and accompanying interview notes to examine if all questions were vividly answered. Afterwards, all fifteen (15) were read and examined. Initial reflections were noted as part of the preliminary analysis. In stage 2, the researcher re-examined each transcript line by line. From the transcript, relevant segments of generally 2-3 sentences were highlighted and recorded in an excel sheet that served as the data pool. Some segments were at least one to two paragraphs long since they carry one general theme or reflection. Each relevant segment was assigned a line number for easier data acquisition. Initial reflection, which is a phrase summarizing the thought of the segment, was indicated after each segment. By stage 3, individual transcripts were abandoned to focus on obtaining collective meanings from all relevant segments and initial reflections. A total of 48 preliminary categories were obtained of which each relevant segment was assigned accordingly. In stage 4, preliminary categories and their assigned segments were further refined and analyzed. By stage 5, constant comparative analysis of the preliminary categories was employed. Except for 'technical barriers', all other closely related preliminary categories were collapsed, divided, and grouped to produce a set of core categories of description. Data analysis was terminated once core categories, sub-categories of descriptions, and their respective meanings (assigned data segments) had stabilized. After careful analysis, the result of this stage was nine (9) core categories of description (see Figure 3).

## 3. Results

Utilizing phenomenography on gathered empirical data, the researcher conveyed an outcome space comprised of nine (9) core categories of description describing STEM students' conception of online learning during the COVID-19 pandemic. Figure 3 illustrates the outcome space which

provided a visualized, structural understanding of the phenomenon and the diversity of its experiencing. It consists of the main research interest in the middle, eight (8) core categories of description positioned around the main research interest, one (1) core category closely situated above other core categories of description, all of which are reflected as referential aspect. Additionally, a series of subcategories (27 in total) branching out from each core categories of description are also present, reflected as structural aspect. Each core categories and subcategories were presented with its corresponding frequency as it appeared in the data corpus. Succeeding subsections discussed the variations amongst conceptions of online learning by describing each core category and its subcategories in detail.

### **3.1. Category 1: Online learning marred with unfavorable sentiments**

In this core category, the conception of STEM students' online learning during the pandemic primarily revolves around a set of unfavorable sentiments towards their experiences. Appearing 77 times in the data corpus, these are described as unfavorable feelings and recollections towards their overall experience of attending school in an online learning setup during the pandemic which includes negative sentiments, having that 'lacking' feeling, clear preference towards face-to-face classes, completion of tasks and deadlines, and experiencing certain privileges over others. It has also emerged within the description of other core categories' data segments, depicted as means to provide a vivid contextualization of each anatomy of experiences. As such, every other core category of description explained in this section had at least one subcategory within this core category that is embedded in their results.

#### *3.1.1. Negative sentiments including demotivation, disappointment, overwhelmed, and overall difficulty*

Participants' unfavorable sentiments towards online learning were marked primarily by varying negative emotions towards online learning. Amongst these, from the volume of tasks to time management, up to adjustment, and to the whole setup itself, all participants had experienced a feeling of difficulty and hardship throughout their experiences. Some participants promptly described online learning as being difficult. Feeling of demotivation was also expressed towards this setup. One sentiment that stood out was the feeling of disappointment due to the current setup deemed as solely focused on academics, with limited synchronous sessions that scarcely provide classroom-type learning, and degree of unfairness in terms of getting credible grades.

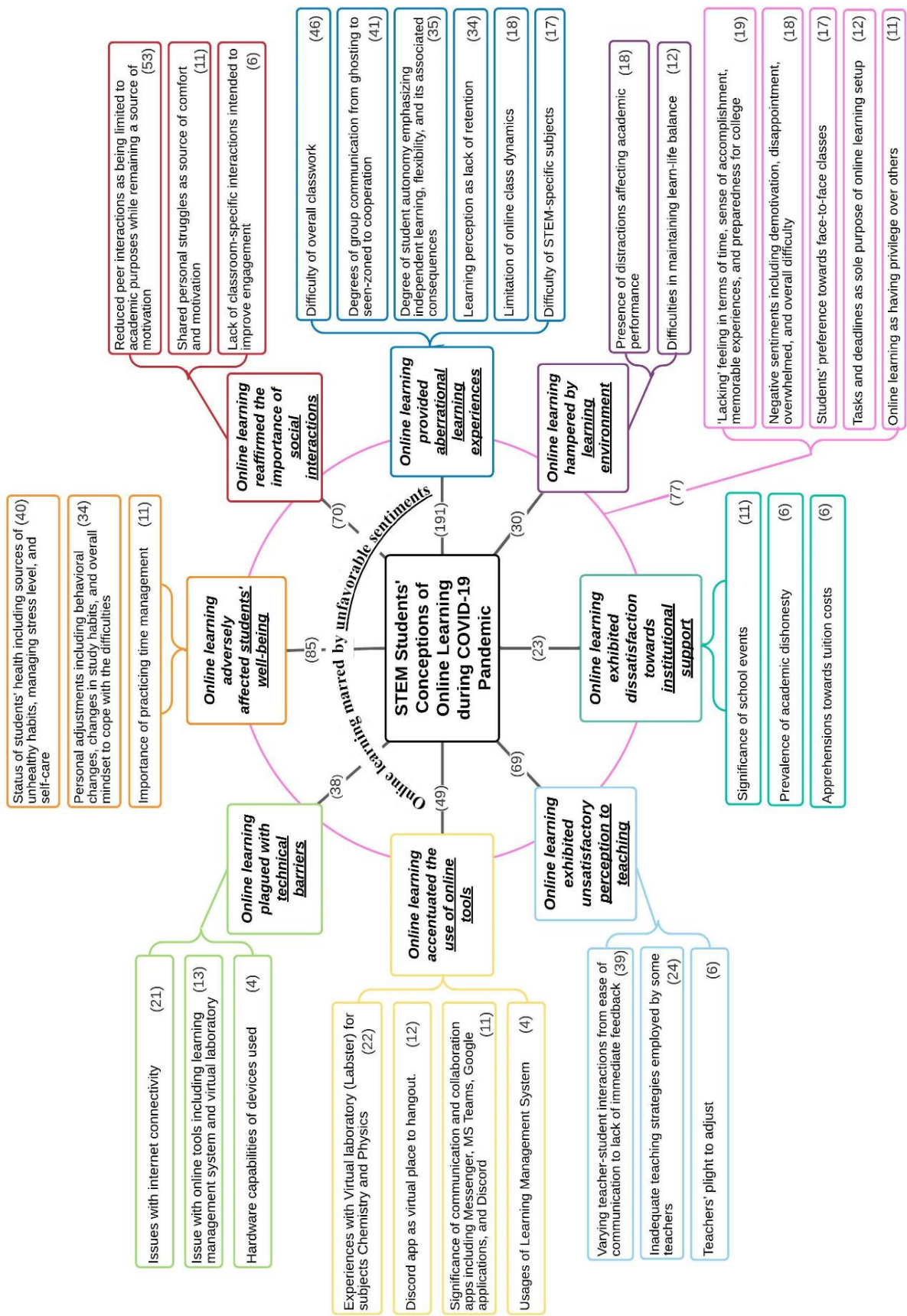
More importantly, participants collectively expressed the overwhelming feeling that online learning brought to them, primarily due to being bombarded with tasks and activities. Several of them felt that they were put in a precarious situation in that SY 2020-2021, provided that their experience of a makeshift online learning setup at the onset of the pandemic (previous school year) was more lenient in schedule and deadlines of tasks.

#### *3.1.2. 'Lacking' feeling in terms of time, sense of accomplishment, memorable experiences, and preparedness for college*

STEM students also considered how online learning was lacking and even limiting in fully realizing the overall experience of a student. For some, online learning felt fast paced, leading to insufficient time to review lessons, information retention from each lesson, and to an extent, inability to enjoy these lessons being studied. Likewise, Denver shared how his experience of online learning lacked that 'something-to-look-forward-to' feeling, specifically the lack of sense of accomplishment and excitement.

Several participants shared their lack of memorable experiences, describing their online school day-to-day as repetitive and routinary. This may be the reason why it was emphasized that online learning setup was deemed not a substitute to traditional face-to-face setup in reaching their students' full potential. More importantly, some participants have expressed their lacking in confidence once they go to college. In Lizel's word, she felt that their batch as "hilaw pa po kami" (We're still unpolished) due to fewer in-classroom experiences compared to previous graduates. Lastly, both May and Sophia expressed that the skills they had acquired in an online setup may

Figure 3  
STEM Students' Outcome Space with frequency distribution





not suffice for their future college courses, which were computer science and engineering, respectively.

### 3.1.3. Students' preference towards face-to-face classes

Consensus amongst participants was their preference towards face-to-face classes rather than their online learning setup, particularly for STEM-specific subjects. One reason was how physical classroom setup allows for more variety in activities, as opposed to the claim of reaction papers and video submissions in their online setup. Denver reiterated that STEM students who will take engineering degrees in college should have more experience-based learning. Furthermore, some participants cited their inclination towards physical setup was due to their laboratory classes and group activities as more conducive in face-to-face rather than in virtual or online setup.

### 3.1.4. Tasks and deadlines as sole purpose of online learning setup

Participants were in an agreement that online learning only prioritized the completion of tasks and submission within assigned deadlines. Several of them shared similar thoughts on how the current online setup was confined to accomplishing tasks, activities, and interactive videos within set deadlines, leading them into thinking that the priority in an online learning setup was grades alone rather than actual learning.

### 3.1.5. Online learning as having privilege over others

Another sentiment described was having a certain level of privilege over their classmates and other students. The concept of privilege here is operationalized as having an opportunity to be advantageous over other students. A clear example of this privilege was the provision of devices of hardware capable of continuous online learning activities and a stable internet connection to comply with their requirements and activities. While majority of them are privileged enough to adapt to this setup, what bothered Lander was the idea that while his family had the means to provide for devices to use, the same cannot be said for his classmates.

## 3.2. Category 2: Online learning plagued by technical barriers

In this core category, STEM students' conceptions focus on specific technical barriers and issues they have experienced. Appearing 38 times in the data corpus, this conception was significantly impacted by issues related to internet speed and connectivity, online tools used in school, and available devices for online learning.

### 3.2.1. Issues with internet connectivity

There was a consensus on how internet connectivity in the country caused disruption in synchronous classes and in accomplishing online tasks and assessments of STEM students. Several participants spoke about how internet connection issues were both a problem for the students and their teachers. Some of the students experienced episodes of intermittent connections specifically during synchronous sessions. In Prescilla's case, she revealed having difficulties in comprehending lessons in STEM-specific subjects due to cancelled synchronous classes caused by their teacher's weak internet connection. Furthermore, it is important to note how Gia believed that the difficulty her teacher had experienced was due to the quality of internet connection in other areas in the country, which can be related to how her and May's experiences of late feedback to their questions or clarifications from their teachers residing in the other provinces.

### 3.2.2. Issue with online tools including learning management system and virtual laboratory

In some way, each participant had experienced a problem with their online tools, specifically their learning management system (LMS) and virtual laboratory. With the LMS, the consensus was how the website can be laggy during synchronous session and submissions despite stable internet connection, and its mobile application being buggy in terms of task notifications. For Claire, there were instances that due date was different on different devices, in her case, her laptop, personal

computer, and mobile phone displayed different due dates for a specific task. May added that the mobile app being buggy resulted to late notifications of important announcements and deadlines, that in some way triggered unnecessary anxiety. With the virtual laboratory, one specific case wherein Claire, despite having quality devices and a stable internet connectivity, was unable to use the online tool at all, leading to her asking their teacher for alternative means to comply with the laboratory requirements.

### 3.2.3. *Hardware capabilities of devices being used*

While this specific subcategory was not prevalent amongst every participant, it is important to illustrate that the condition of the devices that some STEM students used in their online learning were also met with inconveniences. Such issues were due to camera issues, laptop malfunction caused by prolonged usage, and laptop specifications incapable of handling graphics-intensive tasks such as video editing. These issues prompted some of them to express how having quality devices or any types of devices for online learning is a privilege.

## 3.3. **Category 3: Online learning accentuated the use of Online Tools**

In this core category, STEM students' conception emphasizes the use of various online tools in conducting their online learning. Appearing 49 times in the data corpus, their conception was influenced by their use of various online learning tools that includes uses of communications and collaboration apps, significance of Discord app, a virtual laboratory, and their learning management system (LMS).

### 3.3.1. *Experiences with Virtual laboratory for Chemistry and Physics subjects*

Of all the online tools utilized by STEM students, a virtual laboratory tool was the newest and unfamiliar amongst participants. According to them, Labster, the name of their virtual laboratory, was introduced as alternative to physical laboratory for their Chemistry and Physics subjects. It was described as an interactive game-like laboratory setup that provided step-by-step guides in simulating laboratory procedures and the learning accompanying it. For most participants, Labster was deemed helpful in gaining knowledge for STEM-related topics and by some means, simulating the laboratory experience in a virtual environment.

Nevertheless, there remained reservations about the use of virtual laboratories among them. Primarily, they have expressed how it has its limitations when applying their learnings in a real laboratory setting. It being a point-based system was likened to a quiz rather than laboratory activity and how it was only a laboratory by name, not an actual application of the lessons rather just another material to study. Such notions reinforced the idea of self-studying as it was particularly done during personal time rather than during class and assisted by a teacher.

### 3.3.2. *Discord app as virtual place to hangout*

Discord was one of their primary communication and collaboration applications. It was a place where they meet during and after synchronous classes since through Discord servers and channels, students can communicate more freely and hear each other's voices to share insights about their lessons and other forms of chatter. Peter shared that for groupworks, Discord was more preferred if grouped with friends because they can create a server for themselves. Discord was viewed as comfort zone for such interactions.

More importantly, participants saw Discord as more than another tool for academic-related communication rather, as an application for interactions or 'online tambayan' (hangout place). Their activities there include playing online games while streaming themselves in and organizing movie nights, further cementing the application's significance as a place for leisure amongst STEM students.

### 3.3.3. Significance of communication and collaboration apps including Messenger, MS Teams, Google applications, and Discord

Messenger, Microsoft (MS) Teams, Google applications, and Discord were the prominent applications that were used by the participants for communication and collaboration-related conduct. Several of them shared that Messenger was primarily utilized to communicate with a classmate or create group chats (GCs) for their respective groupings to facilitate communication and collaboration, specifically for group projects or performance tasks. Additionally, each participant was a member of their section's group chat (GC) in Messenger that was often managed by their respective class representatives. These GCs were utilized, specifically this past school year, as summarized in Table 1.

Table 1

#### *Academic-related Functions of Group Chats*

<i>By class/section</i>	<i>By small group</i>
Posting announcements or task updates from their LMS or directly from their teachers	Communicating and collaborating with groupmates.
Compiling lecture materials esp. for classmates who were unable to attend synchronous class or check their LMS promptly	Updating members on overall status and progress of project/activity.
Updating classmates on upcoming deadlines for online tasks and performance tasks	Submission of accomplished delegated task within agreed upon deadline
Communicating with other classmates with regards to creating groupings for class activities or projects	Communicating with members on the status of delegated task.

### 3.3.4. Usages of learning management system

Claire had shared that even before the pandemic, their school had been using an LMS as part of their learning. Pre-pandemic, their LMS was utilized primarily lecture material repository, answering online quizzes, submission of written assessments, and communication via its messaging function. While few have mentioned their difficulties in adjusting to a fully online setup despite their familiarity with the tool, Owen expressed how important having an LMS for online classes was since it has the necessary features to accommodate online classes.

However, despite such functionality, Peter was eager to share how some of his classmates were unenthusiastic in using LMS for collaboration or group-related communications due to some unpleasant experiences. These included LMS concerns and how students see it as tantamount with formality and academic stress they have experienced even in their previous year. Hence, the preference for other communication and collaboration tools, specifically Discord.

## 3.4. Category 4: Online learning provided aberrational learning experiences

In this core category, STEM students' conception was clustered around the entirety of their collective learning experiences. Appearing 192 times, represented as the most frequent category within the outcome space, this conception was described as involving overall coursework, group communication, the degree of student autonomy, learning perception, class dynamics, and difficulty of STEM-specific subjects.

### 3.4.1. Difficulty of overall coursework.

In terms of the volume of tasks, all participants indicated that there was a high volume of tasks and assessments to accomplish on a weekly basis. John explained that since they have eleven (11) subjects per semester, every subject has at least one task/assessment per week. The amount of workload to accomplish was viewed as time-consuming which affected his time to review and comprehend each lesson, particularly for minor subjects. For Gia, she expressed that when tasks were piling up, so was her stress level, and felt as if the tasks were not dwindling, "...no matter

what you do, it never ends.”

Some had mentioned of instances were projects required specific skills, i.e., photo and video editing, that students need to acquire personally to create quality outputs and receive better scores. This was on top of their impression that their teacher demanded high standards, akin to normal setup, on the part of the students who were still adjusting to this setup during their first semester. Correspondingly, Kim and Sophia shared that while teachers were considerate; most of their deadlines fell on the same date which led to periods of exhaustion. Nevertheless, for some participants, the sheer number of tasks and assessments that they had accomplished, once completed, led to a sense of accomplishment and satisfaction.

#### 3.4.2. Degrees of group communication from ghosting to being ‘seen’-ed to familiarity

One prominent description amongst participants was the difficulty and frustration they had experienced when doing groupworks, specifically the extent of communication with their respective groups throughout the school year. Tom emphasized that a stable internet connection was an important resource for group communication. Although internet connectivity was the common culprit, there were instances that some or atleast one group member does not communicate with their group. In May’s case, the term she used was ‘ghosted’, described as “[y]ung parang literally *di na po talaga magpaparamdam* (It’s as if they just completely cut off our communication).” Claire had a similar experience in which she aptly labelled it as being ‘seen’ in group chats that led to their groupwork changing into individualized task. She described this being ‘seen’-ed as groupmates merely checking messages posted in their GC but with no responses at all. Such actions were believed to be caused by different privileges that each student possess to accommodate online learning, personal problems they were experiencing, or just them being intentionally negligent.

Due to difficulties that may arise from teacher-assigned groupings, several participants preferred the ‘choose-your-own’ groupmates method so that they can select their friends to ensure proper communication and awareness of their work ethic. Gia had mentioned that knowing their classmates pre-pandemic was deemed as essential for effective communication instead of “walk[ing] on eggshells” just to understand how another classmate collaborates in group. Still, scheduling of meetings remained a concern since not everyone was available on a specific time and date due to personal reasons or conflict with other scheduled group meetings on other subjects.

#### 3.4.3. Degree of student autonomy emphasizing independent learning, flexibility, and its associated consequences

An important aspect of the online learning setup was the flexibility it offered to students. Several participants viewed this setup as means to discreetly encourage self-studying amongst students. For Owen, he viewed his experience as leaning towards independent learning, through pre-recorded lectures and recorded synchronous sessions, rather than seeking teacher’s assistance. Some of them mentioned how Google searches and YouTube tutorial videos were the preferred methods to fully comprehend lessons, particularly on STEM-specific subjects.

Various participants were optimistic about such an indirectly encouraging situation as it allowed them to be more independent and recognize their strengths and personal interests in life. Several participants also felt less pressured as the school year progressed. They shared that the degree of student autonomy provided them more freedom in their daily routine as there was no need to go to school, being allowed to consume meals anytime, capacity to prioritize tasks, and engage in multi-tasking while attending synch sessions.

Nevertheless, there were concerns over their independent learning i.e., virtual laboratory lacking teacher assistance and animosity towards “*mag-research kami ng amin* (to research on our own)” narrative when seeking teacher clarifications on aspects of their lessons. Some participants expressed that with the freedom and control afforded to them, apart from the minimum guidelines set by the teacher, students were the ones regulating themselves. This led to their observations in which some of their classmates show lack of discipline through misconducts such as skipping of

classes or playing games while in class, and how these acts had no repercussions. This is aligned with Peter's notion in which having said flexibility led to increased personal responsibilities because "*wala nang school na magse-set ng time, na mamimilit sa'yo* (there's no school to regulate your behavior)". To a certain extent, several participants willingly shared that this situation also presented opportunities to cheat in their academics.

#### 3.4.4. Learning perception as lack of retention

Most participants shared similar perception towards the extent of their learnings throughout the pandemic – the lack of learning retention. Such perception was mentioned as subject-dependent, primarily for Physics and Chemistry. Both of which were described as packed with information and unsuitable to a fast-paced structure. Lizel further described their setup for these subjects as attempting to adhere to standards of face-to-face classes despite being time-bounded and reduced to sheer completion and submission of tasks. The fast-paced nature of the online setup, for them, affected their ability to retain knowledge from their lessons.

Conversely, several of them expressed that while they knew they have learned something, they were doubtful enough to express it or even assert to be college ready. Consequently, Gary was disappointed in himself for excessively relying on others and searching the internet since he felt that as a student, he needed to acquire that knowledge on his own. He added that while getting passing grades was suitable in the short run, the consequences of eluding in-depth learning later on will be more problematic.

#### 3.4.5. Limitations of online class dynamics

Generally, participants described their online learning setup as composed of weekly synchronous classes and asynchronous sessions, pre-recorded lectures, online quizzes/tests, online activities, and projects. Several participants expressed that synchronous class were limited in terms of frequency and allotted time for discussions. Owen mentioned that lesson-related questions were usually asked at the end of each discussion to maximize time. Their experience was also described as merely watching and listening in front of a screen while sitting for much of the day.

Their STEM-specific subjects also utilized interactive Q&A videos and pre-recorded lectures as part of the teaching strategies, in which pre-recorded lectures were intended to be reviewed before the actual synch class. Despite these, Kim shared that there were occurrences of lacking in-depth explanations for these lessons. Moreover, several participants mentioned the limited engagement and participation of the students during synchronous classes. If there were participations, recitation was usually done via the chat function. Several of them also commented that opening their cameras was voluntary and, in most cases, students do not open their cameras thus, the teacher may not be aware of what the student was doing during an online class. On such incidents, Lander expressed his disappointment in the lack of strict monitoring to his classmates.

#### 3.4.6. Difficulty of STEM-specific subjects

Several participants previously expressed that there were subjects specific to the STEM strand that were unsuitable to online learning, leading to diminished interest of learning. These subjects, according to several participants, were Mathematics, Chemistry, Physics, and Disaster Readiness and Risk Reduction (DRRR). Although, some of them clarified that it was by no means the teacher's fault, rather the shortcomings of the setup. As conveyed by Lizel, these subjects would have been more enjoyable in a face-to-face setting. Additionally, some participants expressed their struggles with STEM-specific subjects which led to one of them to seek tutorial services, while others sought the help of tutorial videos from YouTube channels (i.e., Organic Chemistry Tutor, Khan Academy) in comprehending their lessons.

### 3.5. Category 5: Online learning hampered by learning environment

In this core category, STEM students' conception was affected by their current learning environment. Appearing 30 times in the data corpus, it was described as dealing with the presence of distractions while at home, and simultaneously, maintaining learn-life balance.

#### 3.5.1. Presence of distractions affecting academic performance

Amongst several participants interviewed, dealing with various distractions inside their house and their surroundings while attending classes or doing online tasks was normal. May explained that while inside a classroom, she had full attention to her classes. Inside her bedroom was a different scenario because all forms of comfort are accessible to her i.e., smartphone and bed. However, she also emphasized that her smartphone was a distraction, to the point that she resorted to downloading a time management app to keep her attention.

Gia shared a valuable sentiment, shedding light on the importance of owning a separate study area from one's bedroom to offer distinction between schooling and rest. While she deemed such as essential to this setup, she clarified that not everyone has an option for such privilege. Some of the participants also shared firsthand experience on how schooling at home was unideal, especially with household chores looming at the corner and visitors exhibiting unnecessary distractions during study time. Furthermore, for some, being at home means additional problems brought by other factors i.e., family problems, mental and emotional struggles, appended responsibilities of being the eldest, and even uncontrollable noises from nearby construction projects.

#### 3.5.2. Difficulties in maintaining a learn-life balance

The term 'learn-life balance' was adapted from Maqableh and Mohammad (2021) which is similar to home-school balance, however, the emphasis lies on balancing the aspects of being a student with that of their personal life and interests while confined in their homes during the pandemic. Several participants stated having difficulties maintaining learn-life balance. John shared that as graduating students, majority of their waking time was consumed by tasks and deadlines, notably by the end of each semester. He recounted that experience as being burnt-out, constantly pulling all-nighters, and losing personal boundaries between their personal time and school time.

In Sophia's case, she shared that inside her room, no one bothers her but as soon as she steps outside her room, her responsibilities and errands in their house rained down on her. She added that in school, her only responsibility was to be a diligent student, but at home, she had to be both a diligent student and a responsible daughter. Others also shared that they barely had time to socialize with family members or even afford time for personal leisure as academic demands and uncooperative groupmates burdened their semesters.

### 3.6. Category 6: Online learning adversely affected students' well-being

In this core category, STEM students' conception focused on the well-being of students while attending their online school year during the pandemic. Appearing 85 times in the data corpus, it is described as well-being in terms of personal adjustments made, status of their health, and their practice of time management.

#### 3.6.1. Personal adjustments including behavioral changes, changes in study habits, and overall mindset to cope up with the difficulties

"It was difficult to adjust in an online learning setup", this statement was the unanimous sentiment amongst participants, even their classmates, as they were introduced to a formalized online learning school year. Emotional frailty, unstable internet connectivity, a drastic change to their learning environment, and varying teaching styles in an online setup hampered the participants abilities to properly adjust at the onset of the 2020-2021 school year.

Prescilla asserted that this setup demanded constant adjustment, particularly in her first

semester. Their difficulties to adjust led to feelings of stress, wavering mindset to learn, and episodes of laziness leading to academic cramming. Consequently, most participants gradually adjusted, 2-3 months into the first semester, and were in a better position by the second semester. To which a few had mentioned how their first semester was a learning curve to get well-adjusted.

When it comes to actual adjustments, every participant had their way of getting through that whole new experience. Some shared that it was about accepting the reality of the situation while for Peter, his coping mechanism was to construct a mental image of the school in his mind, to lessen his stress. Since John realized how lax his attitude was before, he made drastic changes in his study habits by second semester, primarily submitting tasks as soon as possible.

Getting low grades in their first semester also served as a reason for pushing themselves to do better by getting used to this setup. For Gia, she shared that most of her classmates tend to work on their tasks at night as it was easier to focus and concentrate since their environment was quiet and undisturbed. She also reassured that, once fully adjusted to this setup, things will get better for any student.

### *3.6.2. Status of students' health including sources of unhealthy habits, managing stress level, and self-care*

On health-related concerns, every participant mentioned experiencing a certain degree of stress throughout the school year. For most of them, stress was due to academic-related triggers, specifically the pressure to keep up and graduate on time. Gia shared that during their hectic schedules, instead of remembering the lessons, what retained in her mind was the stress brought by incoming deadlines. Additionally, stress was also brought by the ongoing pandemic and the abrupt changes and transitions that resulted from it, specifically when school-related activities started occurring within their homes instead of school.

Some participants also shared how stress led to having acne, large eye bags, mood swings, and in some cases, triggering skin allergies. Others had experienced other health-related concerns i.e., tiredness, feeling burned-out, lack of time for self-care, and episodes of mental breakdown. For Lizel and John, being burnout was due to a lack of proper sleep brought by heavy workload in their first semester. Others shared of instances in which they have felt guilty when resting or doing their hobbies. More importantly, few of them expressed concerns about prolonged exposure to device screens due to its harmful effects on their eyes.

For most of the participants, second semester was better in terms of their overall health, primarily because they have learned what adjustments to be made after their first semester. Still, several participants shared that playing online games was their go-to stress reliever throughout the school year. As concisely expressed by Kim, online games offered a venue to forget their academic-related stress while enjoying the company of their friends.

Few participants also saw this setup as an opportunity to explore new interests. Likewise, Gia revealed that despite being a diligent student throughout her student life, the stress brought by this setup instigated moments of procrastination, postponing accomplishing tasks and focusing on her hobbies. She aptly labelled this stress-relieving behavior and mindset as "rebellious towards workloads."

### *3.6.3. Importance of practicing time management*

One of the most observable ways that the participants were able to adjust and cope with their online learning experience was through the practice of time management. Learning to manage one's time was important so that, as shared by Priscilla, academics will not control her daily life. One method was by dutifully adhering to their to-do list. May also utilized a productivity application called Focus to manage her time. Such app was said to block other unnecessary apps that will cause distractions when studying. She even likened the app's warning/notifications to the idea of being reprimanded by a teacher when using one's phone in class, a way to get herself back on track.

### 3.7. Category 7: Online learning reaffirmed the importance of social interactions

In this core category, the conception of STEM students during the pandemic emphasizes the role of social support gained from peers (classmates and/or schoolmates) in the conduct of their online learning experience. Appearing 70 times in the data corpus, their conception was emphasized by social interactions with friends and/classmates, classroom-specific interactions, and shared personal struggles.

#### 3.7.1. *Reduced peer interactions as being limited to academic purposes while remaining a source of motivation*

While each participant had various experiences on how they interact and reasons for interaction, each of them shared that their interactions with friends, classmates, and teachers were limited to online means such as Messenger and Discord. Most of them expressed how their interactions, even with friends, somehow lessened. Sophia admitted that she finds it easier to talk in person rather than through messaging her classmate/s. Similarly, both Denver and Peter shared how they were gradually distancing themselves from their classmates and friends that year as they had only known them in the previous year. Several of them also mentioned that their interactions were limited to academic-related concerns and how the posts in their class GC were either inquiry about upcoming deadline/s or clarification about a particular task.

Whereas Claire believed that the pandemic negatively affected her social skills, she was clear in expressing the importance of social interactions, specifically with friends as means to cope with this setup and motivated her to graduate from SHS. In Gary's case, he shared that since he had few people to talk within their house, as they were minding their own businesses, he felt totally engaged whenever they had groupworks and had someone to talk to. Furthermore, John was grateful that he personally knew his classmates and their personalities pre-pandemic, allowing him to effectively communicate with them. Some participants also shared how playing online games became a frequent means of communication and how engaging in this activity replicated fun and memorable interactions with their peers.

As for their teachers, majority of them stated that teachers were easy to contact or communicate with. Though, a few had shared how little their student-teacher interactions during or after classes, mostly due to the students themselves. As such, several participants stated that for the most part, they seek help from their classmates when they have clarifications about their lessons since, in Sophia's case, due to reluctance to directly consult with teachers.

#### 3.7.2. *Lack of classroom-specific interactions intended to improve engagement*

For this subcategory, peer interactions focused primarily on interactions that transpired inside the classroom. Highlighting the importance of classroom interactions, Lizel shared that she misses her conversations with a seatmate while in the middle of the lecture. Comparing this setup with the traditional one, the subtle glances and random conversations between seatmates within lectures were non-existent. For Gia, recitation was a motivating factor for her to study for their lesson as she feels obligated to study hard whenever a classmate was able to confidently recite in class, which was missing in their synchronous classes.

Furthermore, while recalling his experiences, Gary felt gloomy thinking back on how their online class interactions transpired for the rest of their school year. He expressed how there were no more interactions or loitering after a class had ended, both with classmates or teachers, and that every time he leaves a Teams meeting (synchronous class), it left an empty feeling.

#### 3.7.3. *Shared personal struggles as source of reassurance and motivation*

Several participants emphasized how sharing similar experiences of their struggles was a significant factor in surviving and pushing through this online school year. Several of them expressed how such struggles were important in establishing better communication and cooperation amongst their respective classes, especially in their second semester. As they were all



struggling in this setup, it was mentioned that there was no competition, rather seeking each other's assistance to deal with their academic woes. In Gia's case after getting a low score in an exam despite diligently reviewing the lectures, talking to classmates and realizing their similar circumstances, it had comforted her for not being alone in said predicament.

Moreover, Aiden and Kim explained that doing groupworks with your friends was more motivating in accomplishing tasks. Consequently, through Discord video calls with friends, Aiden expressed how knowing and seeing that he was not alone in their struggles, especially during hell week, was reassuring and a motivating factor to accomplish their assigned tasks.

### **3.8. Category 8: Online learning exhibited unsatisfactory perception to teaching**

In this core category, the conception of STEM students' online learning during the pandemic focuses on the perception of their teacher's teaching strategies and interactions. Appearing 69 times in the data corpus, their conception was significantly impacted by concerns regarding teacher-student interactions, teaching strategies employed, and teachers' adjustment to online learning.

#### *3.8.1. Varying teacher-student interactions from ease of communication to lack of immediate feedback*

As previously stated, majority of the participants agreed that most of their teachers were easy to communicate with. One of the reasons that helped establish effective communication between student and teachers was personally knowing said teachers in their previous year. While there were teachers who were eager to assist students or provide feedback past their consultation hours or even working hours, there were still who had provided late responses or no feedback at all despite urgent inquiries. Likewise, few had expressed that while some teachers were late to address their concerns, such will not be the case if they were in face-to-face setup.

More importantly, Peter treated feedbacks or commendations from teachers, however minimal they were, as a form of motivation, not only for him but also for his classmates, specifically to those who were underachieving in this setup. Still, several of them emphasized that students themselves created the barrier to communication with teachers, regardless if such was due to one's timid or nonchalant attitude.

#### *3.8.2. Inadequate teaching strategies employed by some teachers*

In terms of teachers' adjustment to online learning setup, several participants had concerns with their teacher's teaching strategies throughout the school year. Tom and Aiden expressed how they once had a teacher who only provided PowerPoint slides or .pdf files that contains the necessary information for their subjects. While reading slides and documents may be acceptable for others, such was not the case for students with trouble comprehending these lessons, especially the visual learners. Tom added that since it was a STEM-specific subject, the lack of in-depth explanation made the subject more difficult. Similarly, Lander shared that since they were only provided with a written guide for their virtual laboratory activity, he and his classmates had difficulty understanding their lab activities.

Likewise, May expressed her frustrations with the ineffective teaching style in one of her Math subjects, in which an interactive video was provided but teacher was said to be reading the contents of the PPT slides rather than explaining it. There was also a case in which a teacher who rarely conducted synchronous classes but required numerous tasks to accomplish. Moreover, several participants had experiences of teachers referring them to YouTube links made by foreign content creators as means to deepen their lesson understanding. Such led to them perplexingly expressed their dissatisfaction with such actions, as their families were paying high tuition fee to ensure quality education. Nonetheless, several participants emphasized that their teachers were responsive to concerns and were considerate with deadlines as the school year progressed.

#### *3.8.3. Teachers' plight to adjust*

Several participants have noticed that some of their teachers were unable to fully adjusted to a

fully online learning setup. Lizel observed the effort to teach effectively but there's only so much that one can do with video calls and posting pre-recorded lectures. However, Claire mentioned having a teacher who refused to give his/her full attention to students' learning, but just dismissed it as her teacher, like everyone, was unprepared for this setup. Lastly, it was also shared that they had teachers who were not tech-savvy, specifically in operating their LMS.

### **3.9. Category 9: Online learning exhibited dissatisfaction towards institutional support**

In this core category, STEM students' conception was accentuated by their perceived inadequacy of institutional support. Appearing 23 times, their conception was described in terms of school events, prevalence of academic dishonesty, and apprehensions toward tuition costs.

#### *3.9.1. Significance of school events*

Several participants observed very few school events this past school year. Claire said that the current setup deprived them of chances to experience school events that promotes bonding amongst classmates. For Sophia, she shared that there were no academic-related events similar to previous school year which served as avenues for them to improve as STEM students. Even so, there were events for students that, as shared by Aiden, were broadcasted through Facebook but reiterated his preference face-to-face events or concerts that he and his friends will enjoy all together. However, some of the expressed their displeasure to how bland their graduation was. It was described as like any normal day and with no classmates to celebrate with, it didn't feel like an actual day of celebration, as it was online. Lander expressed how unmemorable that event was, knowing that graduating from SHS was an achievement, even stating that it was uneventful as compared to other online graduation.

#### *3.9.2. Prevalence of academic dishonesty*

Several participants willingly shared one of their key observations and/or experience in this online school year, the prevalence of academic dishonesty amongst students. One of them believed that various ways to conduct academic dishonesty were more frequent in this setup. While the effort of her classmates was there, there remained the question in terms of authenticity of their grades this past school year. When asked about how she felt about academic dishonesty in her class, she thought it was unfair and felt disgusted simultaneously. She added that she suspected it got worse in grade 12 as they learned more methods to perform it.

Owen mentioned that the freedom and flexibility that the online setup permitted to students became a factor to perform academic dishonesty. Being at home and with no teacher to supervise them when taking quizzes, he said that students had the means to search for answers online, open their notes, or even ask classmates while in the middle of it. However, he admitted not being proud of it but not remotely embarrassed to admit that he did it. He added that his lack of interest in studying in this setup and giving more time to his newfound interest played a crucial role in why he resorted to such behavior. Relative to this, Peter shared that one can find tips and tricks on YouTube to accomplish their virtual lab activities. Lastly, Gary shared that for some students, this setup worked well for them, but even he admitted resorting to such methods because of the difficulty of their subjects and their overall setup.

#### *3.9.3. Apprehensions towards tuition costs*

Few participants voiced their apprehensions about the cost of their tuition fees despite the school year being conducted online. Lander shared that he and his classmate taking a gap year because they felt that what they paid did not commensurate with their learning experience. There were also concerns with miscellaneous fees when compared to what students had utilized and how little the tuition fee discount was. In Claire's case, she felt that her tuition was wasted due to a disinterested teacher who told them to conduct a Google search or YouTube "because everything's in there". Consequently, one of expressed his regrets with the amount of tuition paid, but just accepted it as is since this setup was the best option to continue schooling.

#### 4. Discussion

The primary assumption of phenomenography is the existence of finite number of conceptions within a phenomenon being investigated. Analysis of the findings gathered through semi-structured interviews revealed that nine (9) conceptions of online learning during COVID-19 pandemic held by STEM students that was experienced and conceptualized. Specifically, these nine (9) conceptions or core categories of description uncovered, as seen in the outcome space above, are as follows: online learning marred with unfavorable sentiments, online learning plagued by technical barriers, online learning accentuated the use of online tools, online learning provided aberrational learning experiences, online learning hampered by the learning environment, online learning adversely affected students' well-being, online learning reaffirmed the importance of social interactions, online learning exhibited unsatisfactory perceptions to teaching, and online learning exhibited dissatisfaction towards institutional support. Within each core category, there were a variety of subcategories, twenty-seven (27) in total that explains how STEM students had carried out/go about/acted towards their experience or phenomenon and critically distinguished the distinctiveness of each core categories of description.

Analysis of core categories of description revealed a generally unfavorable and unenthusiastic view of online learning during COVID-19 Pandemic, aligned with previous research related to transitioning to online learning during said situation (Baticulon et al., 2020; Chiu et al., 2021; Huda & Imro'ah, 2021; Lemay et al., 2021; Warfvinge et al., 2022). For this discussion, the three core categories with highest frequencies were highlighted, nevertheless, all core categories are of equal importance in displaying variations and describing the investigated phenomenon, as illustrated in the outcome space.

Among these, online learning provided aberrational learning experiences was presented as the most prominent conception. Findings implied how online learning was viewed as a deviation from the normal and in turn, participants illustrated a generally unenthusiastic view of their learning experiences during the pandemic school year 2020-2021. Being accustomed to face-to-face setup, watching in front of a monitor or device screen throughout their school hours was unsatisfactory. The limited synchronous class session was viewed as a concern, which according to Trang and colleagues (2021) was the most preferred mode of students as it promotes engagement, motivation, and mitigates feelings of isolation during the pandemic. Additionally, the high volume of workload needed to be accomplished within a given period, that had increased compared to their previous setup, was aligned with the results of Maqableh and Mohammad's (2021) study.

For group communication, this study highlighted the importance of cooperation, personally knowing classmates, and choosing preferred groupmates to reduce possible complications that may arise in doing group activities. However, there remains the issue of stable internet connectivity that hinders effective communication for groupworks, attending synchronous classes, and timely submission of tasks that affected students similar to other local findings (Baticulon et al., 2020; Fabito et al., 2020; Obligar et al., 2021). It persists to be an issue and remains a prevalent setback even with other developing countries (Maphosa, 2021; Maqableh & Mohammad, 2021; Wijayanengtiyas & Claretta, 2020).

The difficulty of STEM-specific subjects can be deemed exacerbated by the fact that some students are unreceptive to modules or watching recorded lectures, an aspect of online learning that future local research must focus on. Participants preferred interactive, feedback-oriented explanations, an option that was limited and is considered a top predictor of the effective adoption of online learning amongst students (Maphosa, 2021). It was also observed that the use of academic tutorial videos, i.e., YouTube, was prevalent to gain a clearer lesson understanding. Such method was aligned with the degree of student autonomy that the online learning setup had afforded them, the flexibility to find means to maximize their time and reduce their workload (Laksana, 2020; Maphosa, 2021; Trang et al., 2021). However, this also allowed students to behave undesirably and perform academic dishonesty, an important concern during the pandemic (Herdian et al., 2021; Wahyuni et al., 2021). The lack of stricter monitoring guidelines, based on the

findings, had adverse effects on the students, not only in terms of academic dishonesty but in terms of overall discipline as a person that is inculcated by a school environment.

Another prominent core category of description centered on how online learning adversely affected students' well-being. Findings revealed that stress can also be reflected in two types: academic-induced stress due to workload and inability to adjust; and health-related stress due to personal health problems and the ongoing pandemic. Both of which affected disposition towards online learning and motivation to learn. Additionally, adjusting to an online setup was perceived as a difficult endeavour, with the first semester as their learning curve to realize the adjustments they needed to make. Similarly, practicing time management was an important behavioral practice to properly adjust in the setup. It is noteworthy that aside from the conventional use of to-do lists and other self-managing techniques, the use of productivity apps was also mentioned which supports recent findings on the utilization of selected productive apps to prevent excessive smartphone, social media use, and distraction it causes to students' productivity (Throuvala et al., 2020).

Such steps were made to minimize the stress and other negative impacts on their overall well-being that were considered significant because stress and psychological distress were primary concerns of students in an online environment (Baticulon et al., 2020; Li et al., 2021; Maqableh & Mohammad, 2021; Rotas & Cahapay, 2020; Rotas & Cahapay, 2021). Additionally, playing online games was another factor to alleviate stress levels amongst students, which corresponds to the previous findings on how online games was a form of stress relief during the pandemic despite its reported negative effects on students (Mohd Yunus et al., 2021; Teng et al., 2021).

Another unfavorable sentiment of emphasis was the negative sentiments attributed to the setup. These negative emotions that the students had experienced were aligned with Maqableh and Mohammad's (2021) findings which described various difficulties that students were facing, which included the psychological, managing time, and learn-life balance. In terms of 'lacking' feeling, previous research (see Picton et al., 2018; Schnitzler et al., 2021) indicated a significant relationship between positive academic emotions and student engagement, which the students had trouble displaying based on their analyzed data. In terms of college preparedness, participants shared their doubts on their capabilities. Since most STEM-specific subjects required laboratory classes and hands-on activities or experiments, the limitations of a fully online learning setup were the reasons behind their doubts. While graduates of the STEM strand were viewed as more college-ready compared to other strands (Alipio, 2020b; Tahil, 2021), previous results on STEM graduates' preparedness for STEM-related college degrees were met with moderate success (Fernando et al., 2019). If current STEM senior high school students were having doubts on their capabilities to perform in the collegiate level, then future studies may likely reveal the possible negative correlation between the online learning setup and college-preparedness of STEM strand graduates. More importantly, results also showed how the students undoubtedly preferred face-to-face setup as learning should be done in a school and supervised and assisted by teachers.

Another core category of description to highlight was how online learning reaffirmed the importance of social interactions. The significance of peer interaction, despite being limited to online means, as the primary source of motivation is consistent with previous findings (see Baber, 2020; Bernasco et al., 2021; Li et al., 2021; Rotas & Cahapay, 2021; Trang et al., 2021) that emphasized the positive effects of social interaction, specifically with friends, for better mental health condition and learning motivation. Classroom-specific interactions were also presented, an aspect of the school environment that the students longed for. More importantly, awareness that each student, classmate, or friend was experiencing similar struggles or shared personal struggles became a positive source of relief and motivation.

Based on the results, playing online games was one of the primary methods for having friendly interactions, followed by using the Discord app. Aside from its academic purposes for the students that were well-documented by other researchers (see Ardiyansah et al., 2021; Fonseca-Cacho, 2020; Ramadhan & Albaekani, 2021), Discord application was utilized by students as a place of hangout,

an 'online tambayan', as a venue to emulate physical interactions with friends, where they can use video or voice call to freely communicate and interact with their friends, host movie nights, or livestream their online games.

Additional findings were how students also saw teachers with difficulties fully adjusting to the setup at the start of the school year, further supporting similar research (Alea et al., 2020; Dulay & Manuel, 2021; Maqableh & Mohammad, 2021; Robosa et al., 2021;). Employing communication and collaboration apps is consistent with the research of Opataye and Ejike (2021), while using Labster for virtual simulations and laboratory activities further support the application's significance in improving the experiential learning of Science subjects (Alvarez, 2021).

For LMS concerns, other related studies (see Alturise, 2020; Turnbull et al., 2021) presented how there remains areas for improvement in the adoption and implementation of LMS in educational systems, primarily if the goal of an institution is to fully integrate it into their learning methods. Lastly, the presence of distractions inside the students' houses such as smartphone use, household chores, and uncontrollable noises within and outside their study areas, was also present in previous research (see Bajaro, et al., 2021; Baticulon, et al., 2020; Mallillin, et al., 2020), concerns that students had faced throughout the online school year.

## 5. Conclusion and Recommendations

This study aimed to understand grade 12 STEM students' conceptions of online learning during the COVID-19 pandemic by utilizing Phenomenography. One of the advantages of using this approach was how it provides a spectrum, an outcome space, that illustrates a wide range of conceptions about the phenomenon. Based on the gathered data from the experiences of STEM students, the results conveyed an outcome space that is comprised of nine (9) core categories of description and twenty-seven (27) subcategories across the outcome space. Each core category of description and its subcategories provided a vivid, collective explanations and insights into the experiences of STEM students with online learning during an ongoing pandemic.

By exploring the logical relationships between each subcategory up to the core categories of description, this study demonstrated how diverse the STEM students' experiencing of the phenomenon being investigated was and how they have displayed a generally unfavorable and unenthusiastic view of online learning setup during a pandemic. While phenomenography was utilized here for analysis of the phenomenon, the results are still aligned with similar studies amongst experiences of students in online learning setup during the pandemic. These findings are considered essential in fully understanding the extent of their experiences and furthering the research on student experiences at the height of the pandemic, which if employed appropriately, its implications can be beneficial for the parents, teachers, school administrators, and even government education agencies to understand students' experiences and crafting institutional guidelines and policies that address the concerns and practices of students.

Findings of this study clearly specified the extent of the experiences that the students had undergone in the online learning setup during the pandemic, particularly the difficulties that they had experienced throughout the school year. Thus, it is important that the contents of the outcome space are significantly considered by teachers, school administrators, government education agencies, as well as the parents, when crafting policies and guidelines in the event of similar circumstances. Moreover, several other implications can be further drawn from this study, the first of which is to provide informative data to the growing literature of education research during the pandemic, both in the Philippine context and internationally.

Second, since this is a qualitative approach, a purely quantitative research design can be employed to further validate the findings of this research. Third, future studies can focus on similar approach but different SHS strands to compare the extent of similarities and differences of their experiencing of online learning. Fourth, given that online learning provided aberrational learning experiences was the most prominent conception, future research should focus on its overall content or specific results (i.e., degree of student autonomy, difficulty of STEM-specific

subjects) as research topics. Fifth, researchers can also work on mapping the extent of prevalence of various forms or techniques of academic dishonesty that transpired during pandemic school year. Lastly, provided that the participants were already in their first year of college by the time this study was published, future research should consider assessing the college preparedness of STEM graduates of SY 2020-2021, by examining their first-year college academic performance, to further assess the overall implications of online learning during a pandemic school year.

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