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STUDENTS' SENSE OF CONNECTEDNESS AND THEIR ACADEMIC PERFORMANCE IN AN ONLINE MATHEMATICS COURSE

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ABSTRACT

This study sought to investigate how the online sense of connectedness of senior high school students related to their academic performance in Mathematics e-learning course. This research was administered to 261 student-respondents during the first semester of the school year 2020 – 2021 in a private school in Southern Luzon. To collect the data, the researchers administered the Online Student Connectedness Survey (OSCS), formulated by Bolliger & Inan (2012), via Google Form. Moreover, their final 1st-semester mathematics grade records were collected from the respective math teachers. A descriptive-correlational research design was used to analyze the data. Data collected were analyzed and interpreted using frequency, percentage, mean, mode, Pearson Product Moment Correlation and One-sample T-test. Pearson's r revealed a statistically significant positive correlation between the OSCS scores and academic performance in Mathematics. Specifically, the OSCS subscales such as students' online sense of comfort, community, facilitation, and interaction and collaboration have a statistically significant positive correlation to academic performance in Math. Linear regression was generated and showed the OSCS score is a positive predictor of Math grade. While the results of this study suggest that

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online student connectedness can emerge in a senior high school program, further research is recommended across multiple grade levels, populations, and contexts.

Keywords: *comfort, community, collaboration, connectedness, e-learning, facilitation, online sense of connectedness*

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INTRODUCTION

With the unexpected and uncertain COVID19 pandemic, over 28 million Filipino learners, amongst the billion students worldwide, across academic levels have to stay at home and comply with the government's quarantine measures (UNESCO, 2020). As a consequence, Philippines schools had nowhere to go but to transition its traditional face-to-face classes to remote learning.

The pandemic worsened the quality of Philippine education system that was already problematic before the global health crisis set in, according to youth group Samahan ng Progresibong Kabataan. Senator Sherwin T. Gatchalian, who heads the Basic Education Committee also was alarmed that the education sector had been in a "very deep crisis" even before the pandemic. In fact, The Philippines ranked lowest out of 79 countries in the Organization for Economic Co-operation and Development's (OECD) Program for International Student Assessment in 2018. Filipino students posted a mean score of 353 in Mathematics, much lower than the average scores of 489 in Math (OECD.Org, 2018). According to the most recent data by Trends in International Mathematics and Science Study (TIMSS), Filipino students lagged behind other countries in the international assessment for mathematics and science, 4th and 8th grade. In Mathematics 4, only 19% of Filipino students were on the low benchmark, which means that they had "some basic mathematical knowledge," while 81% did not even reach this level (TIMSS, 2019). With the limitation of data and assessment tools to measure students' academic achievement worldwide, organization such as World Economic Forum has re-focused its ranking reports last 2020 to elaborating on the priorities for recovery and revival and considering the building blocks of a transformation towards new economic systems including education amidst pandemic (WEFORUM.org, 2021).

With the new strategies being developed and reintroduced, the direction now seems to point to the possibility of fostering communities of learning and inquiry through distance education (Spencer, 2020), preferably, using social media. It would appear that, in the time of the new

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normal, the shift from a teacher-led education to a student-led and technology-enhanced one has become not only necessary, but more apparent (Casal, 2020). Thus, it would seem that the aims of education have shifted from one that is focused on the students to one that is focused on the family (not just the students) and getting the most out of technology (Baes, et al., 2020).

In the Philippines, while there are laws, like the Open Distance Learning Act (Sixteenth Philippine Congress, 2014), which provide legal bases for funding such platforms, they are not enough as "some national policies will have to be put in place to sustain the growth" of these online platforms (Bandalaria, 2019). Though policies and laws are set even years and decades ago for equitable, quality education, the education-related government agencies rushed only a few months to prepare its resources including manpower for the delayed nationwide opening of the school year 2020-2021 under its new normal – distance education.

Distance education is broadly characterized as any form of learning experience where the learner and the teacher are physically separated from each other (not only by place but also by time). Such dislocation is "the perfect context for free-flowing thought that lets us move beyond the restricted confines of a familiar social order" (Hooks, 2003). Moreover, this type of education is a way of providing learning opportunities to every learner, whatever their circumstances might be. This means that distance education may extend access to education through distribution and economies of scale (Guri-Rosenblit, 2005; Owusu-Agyeman and Amoakohene, 2020).

Based on the data gathered by the Department of Education (DepEd), modular learning is the most popular type of Distance Learning. In the Philippines, this learning modality is currently used by all public schools because according to a survey conducted by the DepEd, learning through printed and digital modules emerged as the most preferred distance learning method for parents with children who are enrolled this academic year. This is also in consideration of the learners in rural areas where the internet is not accessible for online learning. DepEd also has

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organized a team and partnered with local and national radio and television networks to deliver educational shows as support to the learners who are doing modules, but the only access is under these forms.

While most parents and students prefer modular learning, problems arising from this mode also raise concerns. Almost 90% of the participants had a hard time answering their modules. Half of them do not have enough time to accomplish all their modules within a week (Dangle and Sumaoang, 2020). They often receive at least 8 modules in all subjects and each module has 3-5 activities. The subject that they are having the greatest difficulty with are Mathematics, followed by History, Entrepreneurship, and Applied Economics. In Mathematics, some students said that most of the Math problems are difficult to solve and no detailed explanation is provided. Problem Solving does not only include and require computation but there is a need to understand and analyze the problem, students must comprehend the problems (Salma & Rodrigues, 2012).

The proposed solutions of parents to the identified challenges in Modular Distance Learning are reducing/lessen activities in the modules, take out the unnecessary exercises, and Online Learning (a Zoom meeting with the whole class with the teacher going through the modules with the students (Dangle and Sumaoang, 2020).

On the other hand, online learning, similar to the term e-learning (electronic learning) is a term to describe an emerging approach to learn at students' premises through advanced information-communication technologies (such as Blackboard, Moodle, YouTube, Virtual Reality) either asynchronously or synchronously (Yang, 2020, Aoki (2009). Synchronous learning refers to all types of learning in which learner(s) and instructor(s) are in the same place, at the same time, for learning to take place while asynchronous learning occurs in different times and spaces particular to each learner (Finol, 2020).

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Christensen et al. (2011) propose that e-learning will transform the traditional approach in which students learn. This will begin a competition between the student-centered, virtual learning experience and the traditional teacher-centered classroom instructional model. Dillon & Tucker (2011) believed that: Instead of blackboards, schoolhouses, and a six-hour school day, interactive technology will personalize learning to meet each student's needs, ensure all students have access to quality teaching, extend learning opportunities to all hours of the day and all days of the week, and innovate and improve over time. These interactive, virtual learning opportunities are changing the traditional role of the teacher and are putting more emphasis on the student as an active participant in the learning process. Education in isolation versus online collaboration with peers may be the ultimate debate if the virtual classroom can succeed as school districts implement a quality virtual learning experience for students.

Research on students' sense of collaboration and connectedness reveal that these are essential factors in students' achievement in Math, though done in classroom (face-to-face) settings. The learning of Mathematics is often viewed as an isolated, individualistic, or competitive matter – one sits alone and struggles to understand the material or solve the assigned problems. This process can often be lonely and frustrating. Perhaps it is not surprising that many students and adults are afraid of Mathematics and develop "Math avoidance" or "Math anxiety" (Davidson, 2002). On the other hand, People who engage in collaborative learning capitalize on one another's resources and skills, asking one another for information, evaluating one another's work, among other things (Chiu, 2004). More specifically, collaborative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetrical roles (Mitnik, Recabarren, Nussbahum & Soto, 2009; Owoyele & Muraina, 2016). Lawrence (2004) stated that collaborative learning strategy increases students' interest towards Mathematics and invariably enhances achievement. In the same vain,

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Fasli and Kopoules (2005) revealed that collaborative learning strategy provides incentives for students to develop interest and thereby enhance achievement. Ardodo and Gbore (2012).

As students collaborate and share information, they inevitably make social connections. These might be considered high-quality or low-quality connections. Dutton and Heaphy (2016) purported that high-quality connections helped individuals to broaden their thinking and absorb knowledge more quickly. High-quality connections induce feelings of positive regard, mutuality, and vitality while low-quality connections produce feelings of inadequacy, defensiveness, and lack of safety. High-quality connections often elicit positive emotions, but they can also elicit negative emotions such as frustration or anger. More importantly, high-quality connections foster growth and development, are able to withstand setbacks and are a safe place for expressing new and creative ideas (Dutton & Heaphy, 2016).

Freeman (2010) believes that students need to be actively engaged in the educational journey and that teachers are providing them with opportunities to learn practical problem-solving skills. As school districts decide how to incorporate online learning options for K-12 students, budget constraints and technology improvements have helped school districts become more open to the concept of online learning for their K-12 students in recent years. Online learning has not yet taken over the traditional instructional model, but improvements in the process allow students the ability to collaborate with their peers in the online arena (Christensen et al., 2011). These collaborative opportunities are beginning to change the opinion of educators that online equals isolation.

With an increasing number of students who desire online courses, it is essential that educators understand the needs of online students to ensure the quality of their programs and to remain competitive in the online space. Reported attrition rates in online learning varied between 20-80% and were a major challenge for many who taught online (Rostaminezhad,

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Mozayani, Norozi, & Iziy, 2013). Two factors, social interaction (Boston et al., 2009) and student satisfaction of course delivery (Weber & Farmer, 2012) were found to be especially important for retaining students in distance education. Social interaction helps students to build community and offers opportunities for students to support one another.

Harvey et al. (2014) report the lack of social interaction to be an area of concern for students participating as it relates to peer to peer and student to teacher. Additionally, there is a positive relationship in the research with student satisfaction and success with an online course among college students, but currently, there is a gap in the research as it relates to student interaction in online high school courses and the student's overall success in the course. Research of K-12 opportunities exists but Rankin (2013) reports that the literature shows a need for further research into the actual student experiences and how they impact student achievement.

Kim et al. (2012) call for future studies to understand the detailed conditions that lead to student success in the online setting. Though substantial research has been conducted in the areas of online school administration, management, and teacher development, higher education, but very little has been conducted in the student learning experience and what they think about their online interaction and collaboration opportunities. This gap in the literature reveals an area of interest as schools try to understand what students need to be successful in the virtual classroom and how best to engage them in their online experience. By conducting this study, the researchers hope to realize if a student's online sense of connectedness has any relationship to his/her success in the online mathematics course.

MATERIALS AND METHODS

Respondents of the study were selected Senior High School students from a private school in Southern Luzon. The school was chosen because it is one of the few schools in the area to

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have provided a full implementation of e-learning across its high school levels. The school opted to remain anonymous. A random sampling design was then used for this study. Random sampling refers to a variety of selection techniques in which sample members are selected by chance, but with a known probability of selection, and is a critical element to the overall survey research design (Lavrakas, 2008). Slovin's formula was used to determine the number of respondents. There were 261 respondents for the study, and they were randomly selected.

The survey questionnaire utilized in this study was adopted from Bolliger and Inan (2012) with their 'Development and Validation of the Online Student Connectedness Survey (OSCS)'. Students' Online Sense of Connectedness was described into four contexts, namely: Comfort, Community, Facilitation, and Interaction and Collaboration. The academic performance of the students is categorized according to the proficiency level that is based on the K to 12 Curriculum prescribed by the Department of Education: Outstanding (90% - 100%), Very Satisfactory (85% - 89%), Satisfactory (80% - 84%), Fairly Satisfactory (75% - 79%), and Did Not Meet Expectation (74% and below).

The researcher collected the data from Online Sense of Connectedness Survey (OSCS) scores via Google Form from the fall 1st semester of SY 2020-2021 and using SPSS software, conducted a bivariate correlational study on the relationship among students' online sense of connectedness and their academic performance in Mathematics. A correlational research design measures a relationship between two variables without the researcher controlling either of them and appropriate to this study, this design aims to find out whether there is either positive, negative, or no relationship between variables (McCombes 2019). Gall et al. (2007) say an advantage of a correlational design is that it allows the researcher to show to what degree a relationship exists or does not exist between more than two variables when several variables exist among a large number of participants. The researcher collected OSCS data after students complete the survey. Responses were reported by individual students, based on the Likert scale

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ranging from 1 (strongly disagree), to 5 (strongly agree). These scores show the students' level of perceived online connectedness with their peers and teacher in their online Math course. Students' 1st-semester grades were also collected and used as data in the bivariate correlational study.

After collecting the numerical data, Statistical Package for Social Sciences (SPSS) was used for statistical computations of the gathered data. A descriptive-correlational research design was used to analyze the data. Descriptive statistics was employed to analyze the data regarding the socio-demographic characteristics of the respondents, online sense of connectedness, and academic performance in Mathematics. This includes frequency, mean, mode, percentages, and standard deviation. The Pearson's Product Moment Correlation (r) was used to determine the relationship between the respondents' online sense of connectedness to their academic performance in mathematics. Gall et al. (2007) report that the "correlational research designs are used for two major purposes: (1) to explore causal relationships between variables and (2) to predict scores on one variable from research participants' scores on other variables" (p. 337). The researchers conducted a Bivariate and computed Pearson's r with SPSS to generate scattergrams to understand the linearity of the collected data and the correlation between both sets of scores.

Additionally, the researchers conducted a one-sample t-test on the Students' Online Sense of to evaluate whether the mean score was significantly different from 3 (hypothesized mean). One-sample t-test is used to compare one group's average value to a single number (a known population mean, for example, the norm), which is performed when the samples typically consist of independent population (Liang, et al., 2019).

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THEORETICAL FRAMEWORK

This study is anchored on Lev Vygotsky's Sociocultural Theory. Neff (2011) stated that it helps an individual to understand how he/she learns in a social context (learn from each other) and informs on how teachers construct active learning communities. However, this learning varies from one culture to the next. It's important to note that Vygotsky's theory emphasizes the dynamic nature of this interaction. Society does not just impact people; people also affect their society (Cherry, 2020). Vygotsky believed the dynamic social surroundings of a child helped to influence the whole child. He examined how the social environments influence the learning process. He suggested that learning takes place through interactions students have with their peers, teachers, and other experts. Moreover, teachers can create a learning environment that maximizes the learners' ability to interact with each other through discussion, collaboration, and feedback (Arcebuche, et al., 2014). In essence, Vygotsky recognizes that learning always occurs and cannot be separated from a social context. Consequently, instructional strategies that promote the distribution of expert knowledge where students collaboratively work together to conduct research, share their results and perform or produce a final project, help to create collaboratively community learners. Knowledge construction occurs within Vygotsky's social context that involves student-student and expert-student collaboration on real-world problems or tasks that build on each person's language, skills, and experiences shaped by each individual's culture.

Based on Vygotsky's (1978) Sociocultural Theory, a student's connectedness with his or her peers and the teacher is instrumental in the learning process. These virtual opportunities are also allowing students access to their teachers at any time, not just during the traditional school day. School systems are currently using online learning opportunities as a new medium in which to learn and prepare students for the 21st-century workplace (Bedard & Knox-Pipes, 2006; Haley, 2013). The online classroom movement is creating a shift from face-to-face opportunities for

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students to more virtual interaction with their peers and instructor. Until recently, the capacity to connect with peers in the online setting was constrained at best (Bolliger, 2016). More quality opportunities are now available for true collaboration and connection between classmates and teachers in the virtual setting as technology advances at its rapid pace. These new online opportunities are allowing students to connect with many more peers than previously possible (Haley, 2013). Vygotsky's (1978) Sociocultural Theory and other similar ones stress the importance of the school experience and interaction with peers as a catalyst for basic human development (Miller, 2011). A student's learning could be greatly affected by this online instructional movement and its ability to connect peers from across the globe (Gredler, 2011).

The ability to meaningfully connect with peers and the instructor must be addressed in the online environment if educators believe in Vygotsky's theory and its potential impact on a student's intellectual growth (Bolliger, 2016). The researchers made use of the above-mentioned theory since social context, both teacher-student and student-student is involved in their study though in an online learning context. By conducting this study, the researchers hope to understand if a student's online sense of connectedness has any relationship to a student's success in the online mathematics course.

To further expound the framework of the study to make it simpler and more understandable, the researchers construct a paradigm to conceptualize the whole content of this research.

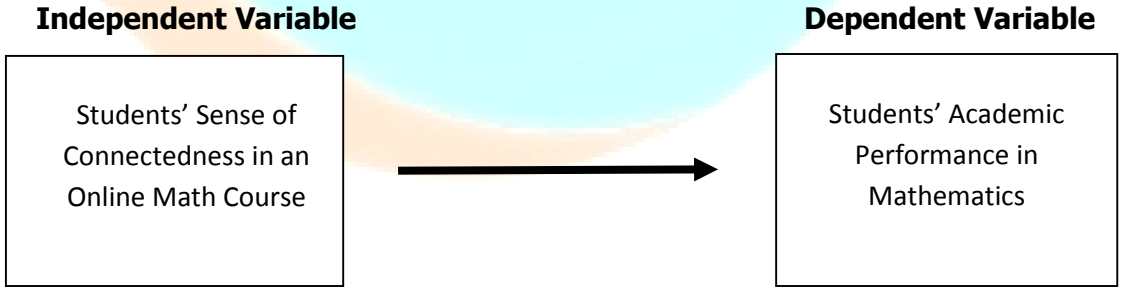

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Figure 1. Research Paradigm

Figure 1 illustrates the paradigm of this study. The student's sense of connectedness in online Math courses was treated as an independent variable. On the other hand, the student's academic performance in Mathematics based on their final grade categorized according to the proficiency level that is based on the K to 12 Curriculum prescribed by the Department of Education, was treated as a dependent variable.

RESULTS AND DISCUSSION

To address the first objective of the study, the socio-demographic characteristics of the respondents were discussed using mean, mode, percentage, and standard deviation. The following discussions were the findings about the age, sex, educational attainment of the father, educational attainment of the mother, and monthly family income of Senior High School students from a private school in Southern Luzon.

Table 1 presents the socio-demographic characteristics of the respondents which include age, sex, educational attainment of the father, educational attainment of the mother, and monthly family income.

Table 1. Respondents' Socio-Demographic Characteristics

Socio-Demographic Profile	Frequency n=261	Percentage
Age	$\bar{x}$ = **17.33**	**SD = 0.98**
16 years old	47	18.01
17 years old	111	42.53

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18 years old	81	31.03
19 years old	20	7.66
23 years old	2	0.77
Sex		
Female	162	62.07
Male	99	37.93
Father's Highest Educational Attainment		
Elementary Graduate	16	6.13
High School Graduate	120	45.98
College Graduate or Higher	125	47.89
Mother's Highest Educational Attainment		
Elementary Graduate	11	4.21
High School Graduate	151	57.86
College Graduate or Higher	99	37.93
Total Household Monthly Income		
Below P10,000	57	21.84
P10,000 - P19,999	93	35.63
P20,000 - P29,999	54	20.69
P30,000 - P39,999	30	11.49
P40,000 - P49,999	16	6.13
P50,000 and Higher	11	4.22

Age

The mean age of the 261 Senior High School student-respondents who participated in the OSCS was 17.33 years old with a standard deviation of 0.98 as shown in Table 1. Students' ages 17 y/o (42.53%) and 18 y/o (31.03%) comprised the majority of the number of participants. Additionally, students' ages 16 y/o and 19 y/o comprised 18.01% and 7.66% of the respondents.

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There were also 2 participants age 23 y/o who previously were under the 10-year basic education program but transitioned under the new Kto12 program to graduate high school. The data shown in table 1is truthful for ages of students under SHS tracing back that DepEd only allows at least 6-7 y/o Filipino kids to formally qualify for 1st grade.

Sex

The sex of the students as shown in Table 1 displays that 162 (62.07%) of the 261 participants were female and 99 (37.93%) were male. According to the Philippine Statistics Authority March 2021 data projections, there are approximately 5.3 million Filipino males and 5.1 million Filipino females under 15-19 years old. However, the 2020 Global Gender Gap Report of the World Economic Forum (WEF) found that 71.3 percent of women are enrolled in secondary education compared to only 60.2 percent among men which explains the data distribution of this study in terms of the sex of the respondents.

Father's Highest Educational Attainment

The table displays that almost all of the respondents' father was either a college graduate (or higher) (47.89%) or a high school graduate (45.98%) which comprised a total of 93.87 % of the entire sample. The remaining 6.13% of the participants' fathers had elementary or lower education. Education in the Philippines is free and compulsory as mandated by the Philippines Constitution which explains why most of its citizens finish high school. Also, according to the school principal, most of their students have parents who have at least a high school diploma to also sustain their children's fees in the school which already lowers because of the voucher program as support from the government.

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Mother's Highest Educational Attainment

The table presents that almost all of the respondents' mother was either a college graduate (or higher) (37.93%) or high school graduate (57.86%) which comprised a total of 95.79 % of the entire samples. The remaining 4.21% of the participants' mothers had elementary or lower education. Again, the data can be rooted in the free, compulsory education mandated by the Philippine Constitution.

Total Household Monthly Income

The total household monthly income of the respondents as shown in the table is widely distributed with 93 (35.63%) of them had income ranging from P10,000-P19,999. There were 57 (21.84%) respondents who had a below P10,000 total household income followed by 54 (20.69%) students who had between P20,000-P29,999. Thirty (11.49%) of the respondents had a household income ranging from P30,000-P39,999; Sixteen (6.13%) had between P40,000-P49,999; 11 (4.22%) of the respondents had P50,000 and higher total household monthly income.

According to the Department of Labor and Employment (DOLE), the minimum wage earners in private establishments in CALABARZON received a basic minimum wage of P400 in non-agriculture; P372 in the agriculture sector; and P303 in retail/service establishments regularly employing not more than 10 workers. This gives at least 15, 000 for at least 2 people working in a household which explains the distribution of the data in Table 1.

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Students' Online Sense of Connectedness in their Mathematics Online Class

To address the second objective of the study, students' feelings of connectedness to their Math online class were discussed using mode and verbal description of each item. Students' Online Sense of Connectedness was described into four contexts, namely: Comfort, Community, Facilitation, and Interaction and Collaboration.

The survey questionnaire utilized in this study was adopted from Bolliger and Inan (2012) with their 'Development and Validation of the Online Student Connectedness Survey (OSCS)'. The instrument underwent series of revisions and has high reliability and validity.

Some of the results below show a Neutral description, so it is important to know its interpretation. According to Maness et al. (2018), the neutral group of respondents who choose the middle option in a Likert scale fall into two groups: 'opinion neutrality' or those individuals who possess true opinion neutrality on the issue; and 'no opinion' or those individuals having no opinion and without adequate knowledge. Our uninformed group simply looked for a way to indicate an absence of attitude, an evaluative judgment, or opinion by selecting a nonresponse option while the informed or knowledgeable group to a topic choose the neutral response as true neutrality (Lam et al., 2010).

Table 2. Students' Online Sense of Connectedness Mode Rating and Verbal Description

PARAMETERS	Mode	DESCRIPTION
COMFORT	**4**	**Agree**
I feel comfortable in the online learning environment provided by my school.	4	Agree
I feel that my Math teacher has created a safe online environment in which I can freely express myself.	4	Agree
I feel comfortable asking other students in my online Math class for help.	4	Agree

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I feel comfortable expressing my opinions and feelings in my online Math class.	3	Neutral
I feel comfortable introducing myself in my online Math class.	4	Agree
If I need to, I will ask for help from my classmates.	4	Agree
I have no difficulties with expressing my thoughts in my online Math class.	4	Agree
I can effectively communicate in my online Math class.	4	Agree
COMMUNITY	**3**	**Neutral**
I have gotten to know some of the other teachers and classmates well.	4	Agree
I feel emotionally attached to other students in my online Math class.	3	Neutral
I can easily make acquaintances in my online Math class.	3	Neutral
I spend a lot of time online with my online class peers.	3	Neutral
My peers have gotten to know me quite well in my online Math class.	3	Neutral
I feel that students in my online Math class depend on me.	3	Neutral
FACILITATION	**4**	**Agree**
My Math teacher promotes collaboration between students in my online class.	4	Agree
My Math teacher integrates collaboration tools (e.g., chat rooms, wikis, etc.) into online activities.	4	Agree
My online Math teacher is responsive to my questions.	5	Strongly Agree
I receive frequent feedback from my online Math teacher.	4	Agree
My online Math teacher participates in online discussions.	5	Strongly Agree
In my online class, my Math teacher promotes interaction between learners.	4	Agree
INTERACTION AND COLLABORATION	**3**	**Neutral**
I work with others in my online Math class.	3	Neutral
I relate my work to others' work in my online Math class.	3	Neutral
I share information with other students in my online Math class.	4	Agree

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I discuss my ideas with other students in my online Math class.	3	Neutral
I collaborate with other students in my online Math class.	4	Agree
Overall Mode:	**4**	**Agree**

The Online Student Connectedness Survey (OSCS) scores were analyzed to determine the overall mode. As shown in Table 2, the overall mode for all OSCS was Mo=4 which can be interpreted that respondents did agree that they had a feeling of connection in their online Math class despite the fact that this is the 1st year of the school has implemented its distance education. It is imperative that educators understand the impact less face-to-face instruction may have on a student's academic success (Borup, Graham, & Davies, 2012; Luehr, 2011; Rankin, 2013).

Comfort is defined as experiencing contentment and security, and comfort with either integrated technologies or the learning environment as mentioned by researchers as an important aspect for distance students (Aragon, 2003; Haythornwaite et al., 2000; Kanuka & Jugdev, 2006; Shin, 2003). As shown in the table, students agreed (mode = 4) that they had a feeling of comfort in their online Math class. Specifically, the respondents had an agreeable feeling of comfort (1) in the online learning environment set up by the school; (2) that their Math teacher created a safe online learning environment where they could express themselves; (3) asking their classmates for help; (4) introducing themselves in their online Math class; (5) expressing their thoughts; and (6) effectively communicating in their Math class. However, the respondents were neutral on their feeling of comfort in expressing their feelings and opinions in their online Math class. Online teachers shall strive to create a safe online learning environment where students felt comfortable and free to express themselves. In addition to various group work assignments, students shall be engaged in learning activities such as asynchronous discussion boards and synchronous online case discussions (Conner, 2019).

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A learning community is defined as "groups of people engaged in intellectual interaction for learning" (Cross, 1998, p.4). As shown in the table, the students were neutral as to their sense of community in their online Math course. The result is supported by Rovai which claimed that the physical separation of online learners can reduce the students' sense of community (Rovai, 2002). Specifically, with the context of their online Math class, the respondents were neutral in their feelings of: (1) emotional attachment to their classmates; (2) ease in finding acquaintances; (3) spending time online with classmates; (4) getting to be known quite well by classmates; (5) dependence and trustworthiness as perceived by their classmates. On the other hand, students agreed that they have gotten to know their teachers and some classmates in their online course. Distance students may have fewer opportunities to form close working relationships with program faculty, advisers, or peers. Establishing educational relationships with learners "is more difficult when using computer-mediated conferencing" (Wikeley & Muschamp, 2004).

Respondents overall agreed in terms of their overall sense of facilitation in their online Math class. Precisely, the students agreed that their Math teacher (1) promoted a sense of collaboration between students; (2) integrated collaboration tools such as wiki, math rooms, etc; (3) gave frequent feedback; and (4) promoted interaction between students. They strongly agreed that their Math teachers were responsive to their questions and did participate in their online discussions. Indeed, teachers are central in creating communities and establishing teaching presence (Rouke et al., 1999). Young (2006) measured effective online teaching and found that one important element of good online teaching is the effective facilitation of a course.

Interaction is a two-way communication process that involves two or more individuals (Berge, 2002). Projects that require students to work together collaboratively can reduce levels of student isolation (Wikeley & Muschamp, 2004). With respect to the students' sense of collaboration and interaction in their online Math course, they responded neutrally. Specifically, they responded neutrally that they (1) worked with others in their online Math class; (2) related

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and compared their work to others; and (3) discussed ideas with classmates. On the other hand, they agreed that they share information and collaborate with other students. One important factor in student satisfaction and learning in the online environment is interaction (Bolliger & Martindale, 2004). Social interaction is an essential component of learning in the online environment (Garrison, 2000; Rovai, 2002).

Students' Academic Performance in Mathematics

To address the third objective of the study, the student's academic performance in Mathematics was discussed using verbal description, frequency, percentage, and descriptive statistics such as mean and standard deviation. Table 3 presents the Academic Performance of the student-respondents categorized according to Department of Education Order no. 8 s. 2015 grading policy guidelines. The data shown in the table were the average grades of the participants in their Math class during the 1st semester, SY 2020-2021.

Table 3. Students' Academic Performance in Mathematics

GRADES	FREQUENCY n=261	PERCENTAGE	DESCRIPTION
90-100	206	78.83	*Outstanding*
85-89	39	14.94	*Very Satisfactory*
80-84	11	4.21	*Satisfactory*
75-59	5	1.92	*Fairly Satisfactory*
74 and Below	0	0	*Did Not Meet Expectations*
$\bar{x}$ = 91.98		SD = 4.07	

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Table 3 illustrates that the majority of the students attained a 90-100 grade which is interpreted as an Outstanding Academic Performance in Mathematics, comprising 78.83% (206) of the total samples. 39 (14.94%) of the respondents got Very Satisfactory performance which means their grades range from 80 to 84. Additionally, 11 (4.21%) and 5 students (1.92%) received Satisfactory (80-84) and Fairly Satisfactory (75-79) performances, respectively in their Math Online class. None of the respondents Did Not Meet Expectations or Failed which is a grade of 74 and below.

The students' grades were also analyzed to determine the overall mean and distribution of scores. As shown in Table 3, the standard deviation was 4.07 and the mean was $\bar{x}$ =91.98 which was under Outstanding Academic Performance.

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Relationship between the Students' Sense of Connectedness in an Online Math Course and Their Academic Performance

To address the fourth objective of the study, a Pearson Correlation between students' sense of connectedness and their academic performance in math online course is generated. The results of multiple Pearson Correlations are presented in Table 4.

Table 4. OSCS and Academic Performance in Mathematics Correlation Results

Online Sense of Connectedness	Academic Performance r	Interpretation	p-value
Comfort	0.2851	Weak Positively Correlated	< .00001**
Community	0.1315	Very Weak Positively Correlated	.033714*
Facilitation	0.2633	Weak Positively Correlated	.000016**
Interaction and Collaboration	0.2728	Weak Positively Correlated	< .00001**
Overall OSC	0.2394	Weak Positively Correlated	.000094**

*Legend: * significant at p < .05*
***highly significant at p < .01*

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Table 4 shows that there is a positive correlation (r = 0.2394) between the students' online sense of connectedness and their academic performance in an online Math course. The result is statistically highly significant with p=.000094 which is less than .01. This means that the students with a higher sense of connectedness tend to gain higher academic performance. Consequently, students with a lower sense of connectedness in an online Math course seem to have lower academic performance in the said subject.

Specifically, all its subscales established a positive correlation. Pearson's r correlation generated an r of .2851 between the students' online sense of comfort and their academic performance in mathematics and is highly significant with a p less than .00001. This means that the increase in the students' sense of comfort relates to an increase as well in their math grades. If students are comfortable and feel safe in the learning environment, they are more likely to interact with instructors and peers and less likely to miss learning opportunities (Shin, 2003). Dutton and Heaphy (2016) purported that high-quality connections at work helped individuals to broaden their thinking and absorb knowledge more quickly. High-quality connections induce feelings of positive regard, mutuality, and vitality while low-quality connections produce feelings of inadequacy, defensiveness, and lack of safety. High-quality connections often elicit positive emotions, but they can also elicit negative emotions such as frustration or anger. More importantly, high-quality connections foster growth and development, are able to withstand setbacks and are a safe place for expressing new and creative ideas (Dutton & Heaphy, 2016).

Students' online sense of community is also positively correlated to their academic performance in Math as demonstrated by its generated r value which .1315 and is a statistically significant p-value of .33714. This means that there is enough evidence that students with a greater sense of community seem likely to have higher math grades. Research suggested a positive correlation between a sense of community or student connectedness and perceived learning engagement and course satisfaction. Responsiveness helped to build social presence and

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was critical in building an online community (Palloff & Pratt, 2007). One of the greatest contributors to building community in the program was the timely responsiveness of both students and faculty. Gallien and Oomen-Early (2008) suggested that students performed better academically and were better satisfied when they received personalized feedback from the instructor rather than collective feedback.

The students' sense of facilitation also positively correlates with their math grade, with a generated r-value of .2633, and highly significant at a p-value of .000016. This means that the increase in students' sense of facilitation is likely an increase as well in their math grades and vice versa. Young (2006) measured effective online teaching and found that one important element of good online teaching is the effective facilitation of a course. Therefore, instructors need to ensure that students have the opportunity to communicate, interact, and collaborate with course participants. "Online communication between distance students is purported by some authors as lessening student's feelings of isolation" (Motteram & Forrester, 2005).

The table also reveals a positive correlation of r value .2394 between students' sense of interaction and collaboration and their academic performance in math. The p-value which is <.00001 means that there is highly significant evidence that students who have a higher sense of interaction and collaboration seem to have higher academic performance in Math. Arbaugh (2010) suggested that collaborative learning in online courses had a positive impact on learning outcomes while another study showed a positive relationship between a sense of community and perceived learning engagement, learning outcomes, and course satisfaction (Liu et al., 2007).

The four subscales of the OSCS (Bolliger & Inan, 2012): (a) comfort, (b) community, (c) facilitation, and (d) interaction and collaboration contributed to the weaving of a tapestry of components that when used collectively, positively influenced online students' connectedness and helped build community (Conner, 2019).

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Students' Online Sense of Connectedness Mean Difference

The researcher conducted a one-sample t-test on the Students' Online Sense of Connectedness results as shown in Table 5, to evaluate whether the mean score was significantly different from 3. The number 3 was chosen because a value less than 3 on this survey instrument indicates a negative response to the survey questions in each category on the OSCS Likert scale.

Table 5.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
OSCS	261	3.34	0.96	0.0594

One-Sample Test

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
OSCS	5.79239	260	< .00001	0.3441	0.2271	0.4610

The average Online Sense of Connectedness of the 261 students is 3.34 and the standard deviation is 0.96. Compared to 3 (neutral), the mean difference is .34. The computed t-statistics t=5.792 and the p-value is <.00001 which reveals that the result is significantly different to 3 (neutral). The positive t-value reveals that the mean of the respondents' Online Sense of Connectedness Scores is significantly higher than 3 (neutral).

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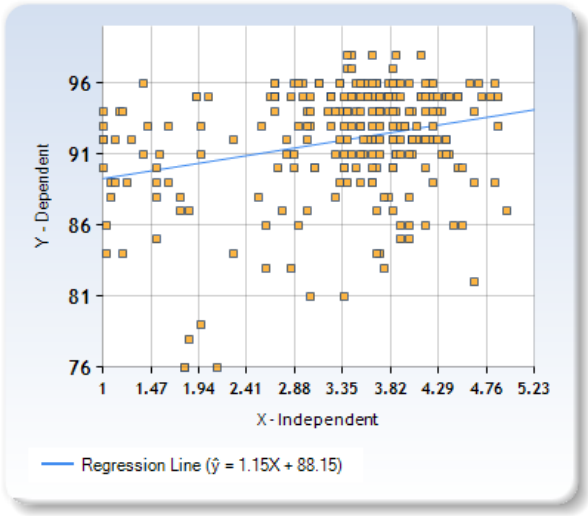
Students' Online Sense of Connectedness Linear Regression

The researcher also conducted a linear regression analysis to visually display the data and show the predictive value of the academic performance in an online Math course score and their Online Connectedness Survey score. Green and Salkind (2012) report that a Bivariate Linear Regression should be used to evaluate the independent (x) variable and its relationship to the dependent (y) variable to display the relationship between two variables. In this study, the Online Student Connectedness Survey score was the independent (x) variable, and the online student's Math grade was the dependent (y) variable.

Figure 1. Linear Regression between Students' OSCS and Academic Performance in Math



The scatterplot, as seen in Figure 6 does indicate the two variables have a positive linear relationship. The analysis of survey results reveals that a student's academic performance in Mathematics (dependent variable) does have a positive directional correlation with the student's OSCS (independent variable). The linear regression equation y=1.15x + 88.15 means that for every unit (1) increase in OSCS scores, it corresponds to a 1.15 increase in Math grades.

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To specifically see the impact of each subscale on the academic performance in Mathematics, separate linear scatter plots were formulated and shown in the figures below.

Figure 2. Students' Sense of Comfort

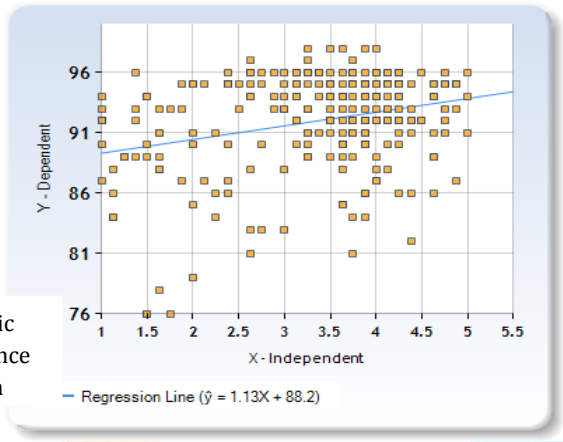


Figure 3. Students' Sense of Community

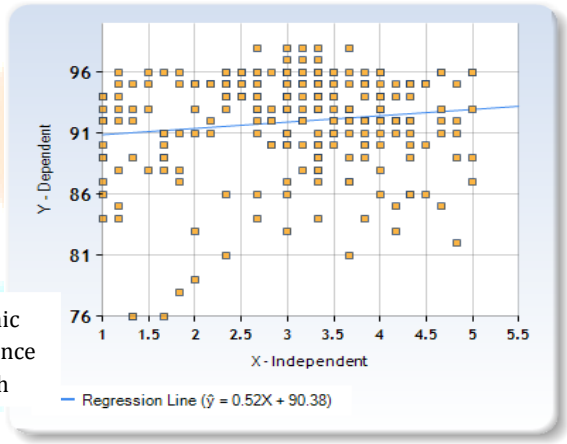


Figure 4. Students' Sense of Facilitation

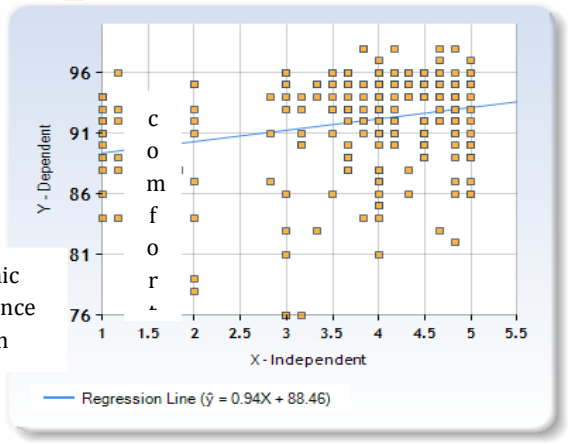
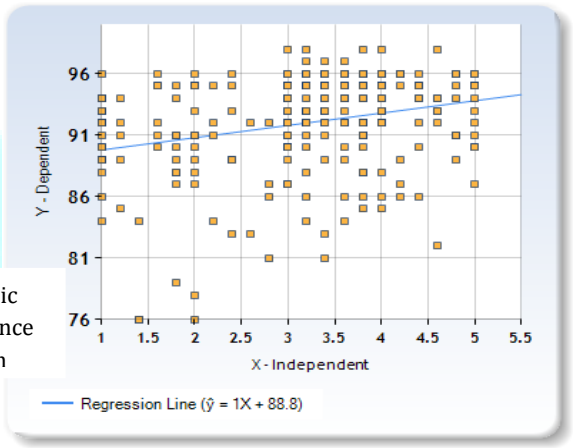


Figure 5. Students' Sense of Interaction and



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The figures above show that students' sense of comfort, community, facilitation, and interaction, and collaboration are all positive predictors of their academic performance in Math. The linear regression equation y=1.13x + 88.2 in Figure 2 means that for every unit (1) increase in students' sense of comfort, it corresponds to a 1.15 increase in Math grades. Figure 2 displays a linear regression equation of y=0.52x+90.38 which means that there is an increase of 0.52 in the students' academic performance for every 1 unit of increase in their sense of community. Figure 3 reveals that the scatterplot generated a linear regression equation of y=0.94x+88.46 which means that every unit (1) increase in students' sense of facilitation corresponds to a 0.94 increase in Math grades. Finally, the last subscales predict the students' academic performance by an increase of 1 for each 1 unit of increase as well on the students' sense of interaction and collaboration, as demonstrated by the generated linear regression equation y=1x+88.8.

Borup et al. (2012) believe that as online options become more available to K-12 students, it is imperative to increase the effort by educators to improve the outcomes of students taking those courses. Levykh (2008) believes that Lev Vygotsky's Sociocultural Theory may have a positive influence on students when receiving computer-based instruction. Zunker (2008) believes the computer can act as the "more knowledgeable peer". The computer-based instruction can provide the needed support to a student who may not be getting enough support in the traditional setting. The role of the teacher or facilitator in guiding the online student through the process is found to be critical by Ng and Nicholas (2010). They think the role of the teacher in the online experience is to provide a presence, maintain continuity and guidance, be a motivator, and mentor students as they learn how to understand and apply the information in the course (Ng & Nicholas, 2010).

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CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, the following conclusions were drawn.

1. In this study, Fewer than half of the 261 respondents were mostly 17 years old (42.53%). The majority of the respondents were female (62.07%). Their fathers were college graduates (47.89%) and their mothers were high school graduates (57.86%). Additionally, 35.63% of the respondents belonged to a family whose monthly household income range from Php 10,000 to Php 19,999.
2. The respondents agreed they had a sense of connectedness in their online Math class which specifically comprised of its subscales such as students' sense of comfort (agree), community (neutral), facilitation (agree), and collaboration and interaction (agree).
3. The majority of the 261 respondents (78.83%) had an outstanding academic performance in their online Math class, with grades from 90 to 100.
4. Students' Online Sense of Connectedness is significantly and positively correlated with their academic performance in Mathematics which means that the higher the sense of connectedness, the higher is the students' academic performance in Mathematics. All its subscales: student's sense of comfort, community, facilitation, and collaboration and interaction also positively correlated with the student's academic performance.
5. The mean score of the respondents' Online Sense of Connectedness Scores is significantly higher than 3 (neutral). The linear regression equation $y=1.15x + 88.15$ was generated which means that for every unit (1) increase in OSCS scores, it corresponds to a 1.15 increase in Math grades.

From the findings and conclusions, the following recommendations are offered.

1. If feasible, the same research shall be conducted but with a controlled number of respondents in each category of sex, parents' highest educational attainment, and age.

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2. Students should identify their online sense of connectedness in mathematics class. With this, they can understand that connectedness plays a big role in their academic performance in mathematics. If they become aware of how connectedness impacts them, they may develop a culture with high regard for students' comfort, community, facilitation, interaction, and collaboration. As a result, they will contribute and have a sense of solidarity and accountability in building a class with a safe online learning environment where students: (a) comfortably share their thoughts, feelings, and themselves; (b) get to know their academic community very well with trust, dependability and emotional attachment; (c) dominate class participation and encourages teacher's facilitation rather than the main source of knowledge; (d) collaborate with their peers and teacher and eagerly solicits for a responsive and feedback-driven interaction;
3. The online sense of connectedness and the academic performance in mathematics of the respondents were significantly related to each other, so to improve the students' performance in math, mathematics teachers should consider that students' performance in mathematics is affected by their online sense of connectedness. Thus, teachers should think of creative ways to incorporate positive emotions and connections in their lesson planning. More importantly, teachers should also develop first an online learning environment with a culture of connectedness such as high regard in comfort, community, facilitation, and interaction and collaboration both students-students and teacher-students. They should leverage their position to foster student connectedness by (a) developing teacher presence and setting a positive tone for the Math online class, (b) having a plan to guide students through potential challenges of group work, and (c) showing their enthusiasm for and connection to the students, teachers and whole school or institution.
4. Philippines has just begun implementing K-12 online learning starting this school year 2020-2021, so very little research is available in secondary education, even in tertiary education. There is available research that was concluded overseas, but the researcher is strongly recommending conducting related research in the context of Philippine education and Filipino students. Borup et

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al. (2013) feel that as online options become increasingly more available for K-12 students, it is imperative to understand what today's student needs to be successful in the online classroom setting.

5. One limitation of this study is the difference in teaching methods and styles of facilitators in online courses. It is suspected that the level of interaction between the facilitator and students might vary greatly depending on one's teaching style and experience with teaching in a virtual environment. These differences could have influenced participant responses to the questions, specifically those that were focused on facilitation and learning. A recommendation for future research is to determine if teaching style has an impact on the results of the data.
6. While the results of this study suggest that online student connectedness can emerge in a senior high school program, further research is recommended across multiple grade levels, populations, and contexts, recommend future research in online student connectedness with the following:, (a) an expanded study which includes multiple schools and/or grade levels, (b) a study which considers the influence of the student's personality type (Myers, 1993) on the perception of connectedness, (c) a study which explores student choice when offered opportunities for optional collaborative work, and (d) a mixed-methods study with an emphasis on the qualitative data.

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