Teenagers' Utilization of Social Media in Taking Care of their Mental Health During the COVID-19 Pandemic: A Phenomenological Study

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Abstract: With the ongoing pandemic, mental health concerns have been observed to be on the rise. Lockdowns have prompted many, especially the youth, to primarily use social media for communication and for addressing their mental health issues. However, past studies merely investigated the positive and negative effects of social media on mental health in general; there have been scarce resources that detail how these platforms are used for mental health concerns during the pandemic, particularly among teenagers in the Philippine context. Hence, the study aims to examine the experiences of teenagers in using social media platforms in dealing with their mental health issues during the pandemic. Employing phenomenology, ten senior high school teenagers were interviewed through Zoom to determine how and why social media platforms are used in relation to mental health. Thematic analysis was employed to look for emerging themes. The results showed that platforms namely Twitter and Messenger were popularly used by teenagers. Such platforms were found to be used with limitations due to the fear of familial judgment and fear of disingenuous reactions. Also, it was found that the reasons for such social media usage were (a) to seek other modes of communication, (b) to look for a source of entertainment, (c) to express emotions, (d) to spread positivity, and (e) to raise awareness about mental health. With these findings, it can be concluded that social media does have a monumental role in sustaining or improving teenagers' mental health. Thus, recommendations for future studies have been made.

Key Words: social media; mental health; pandemic; effects; platforms

1. INTRODUCTION

The COVID-19 pandemic has forced many countries to implement lockdowns. These lockdowns have led to short or long-term psychological and mental health issues (Evans, 2021), especially among young people (University of Surrey, 2021). Hence, the use of social media and mental health during the pandemic have been found to be correlated (Zhao & Zhou, 2020). Nonetheless, there still has been a huge portion of blame placed towards social media in the context of mental wellness although the findings are still fragmentary.

Numerous studies such as Rasmussen et al. (2020) speculate that there is an indirect relationship between social media use and mental health issues among emerging adults since they encounter difficulties in coping with emotional and perceived stress. There are also significantly higher tendencies for internet addiction among depressive patients (Dieris-Hirche, et al. 2017). Likewise, social media have been found to be negative since cyberbullying is often connected to social media usage (Glazzard & Stones, 2019).

While some prior studies have centered on negative social media effects on mental health, some researchers claim otherwise. Hardy and Castonguay (2018) reported that individuals aged 18-19 felt low levels of anxiety when exposed to social media. Bekalu et al. (2019) also underscored that social media can be a positive tool after linking social media usage and self-rated health.

While there have been varied findings in the literature on the relationship of social media and mental health, studies that attempted to explore how social media is used as a platform by teenagers to address mental health issues are limited. Majority of the previous studies merely focused on the general negative or positive impact of social media on individuals' mental health. In addition, it seems that there have been scant investigations on how social media platforms are used by teenagers in taking care of their mental health during the pandemic,

specifically in the Philippine context. Lastly, the previous investigations primarily utilized quantitative perspectives; and so the need to use a qualitative lens in investigating the phenomenon has become apparent. Addressing these gaps in the literature, we employed a phenomenological research design; and thus answer the following research questions:

1. What social media platforms do senior high school teenagers use in taking care of their mental health during the COVID-19 pandemic?
2. How do these students utilize these platforms in assistance to their mental health?
3. Why are these said platforms used by these students for mental health purposes?

2. METHODOLOGY

2.1 Data Collection, Sampling, and Procedure

Ten participants aged 17-18 years old studying in senior high schools in the Philippines participated in the study. This is the desired number of participants in a phenomenological study to achieve data saturation (Boyd, 2001, as cited in Groenewald, 2004). We purposefully selected the participants by setting the following criteria: a) they have experienced or are experiencing mental health concerns, b) they have used or are using social media platforms for mental health issues during the pandemic, c) they must be in senior high schools in the Philippines. In addition, we followed most of Morrow's (2005) principles of trustworthiness such as the congruence of philosophical assumptions with the research questions, inclusion of intellectual heritage in the research design, describing the rationale for reflexivity, and selecting participants for information richness. An Ethics Clearance Form and Parental Consent Form were also put to use to ensure that the rights and privacy of the respondents were upheld to the fullest.

Semi-structured interviews were utilized and were conducted via Zoom, given the ongoing limitations due to the pandemic. The open-ended questions were checked by experts to have a qualitative face validity.

2.2 Research Design and Data Analysis

We employed phenomenological research design in our study as we sought to determine how and why the participants used social media platforms individually, especially during the time of the pandemic. The primary purposes of phenomenological research are to derive substance from individuals' personal interpretations of experiences and feelings, and to construct in-depth descriptions of the phenomenon (Lester, 1999). Since we would like to investigate the experience of the teenagers in using these platforms for mental health, phenomenology provides a more accurate depiction of how truly these teenagers put them to use for the said purpose.

We analyzed the data gathered in the interviews using a thematic analysis, specifically observing the six steps of thematic analysis that involve data familiarization, generating simple codes, searching for themes, reviewing themes, defining themes, and the write-up (Braun and Clarke 2006, as cited in Howitt, 2016).

Table 1. *Analysis that starts from codes to categories then themes*

CODES	CATEGORIES	THEMES
Alternative communication amidst restrictions	Basic necessity	*3.2.1 To seek other modes of communication*
The need to communicate during times of crises		
Watching videos	Keeping occupied through the pandemic	*3.2.2 To look for a source of entertainment*
Sharing funny memes		
Voicing out problems	Expressing one's mind and thoughts	*3.2.3 To express emotions*
Providing a foundation to be more emotional		
Highly accessible for communicating	Being expressive during the pandemic	
Connecting people with different thoughts		*3.2.4 To spread positivity*
Younger generation being more understanding that older ones	Social media being a channel for relatedness in mental health	*3.2.5 To spread awareness about mental health*
Creating a discussion with others		
Spreading information and content about mental health awareness		
Sustained connection with friends, leading to healthy conversations during the pandemic	Source of positive content	
Hesitating due to possible opinions of older family members	Worriedness due to reception of loved ones	*3.3.1 Fear of familial judgment*
Being aware of unknown individuals	Doubt to the idea of openness	*3.3.2 Fear of disingenuous reactions*
Sudden and harsh judgment from others		

3. RESULTS AND DISCUSSIONS

3.1 Social Media Platforms Used by Teenagers

According to the majority of the respondents, due to these platforms' relevance and popularity in the country, the social media apps Messenger and Twitter were the primary platforms used by senior high school teenagers in maintaining their mental health through various methods, with some being vocal (constantly voicing out their concerns via posts), while more were reserved thus opting for private messaging or posting instead.

In one of the interviews, Pat (fictive names were used all throughout the discussion) explained her preference for Twitter when voicing out issues pertaining to her mental health:

"Twitter allows me to post what I feel on a certain topic without worrying on who can see it since Twitter has an option wherein you can hide your tweets on only people you follow". (All excerpts here are translated to full English)

Pat's contention may be one of the reasons why Twitter is popular among senior high school students, as it allows its users to have their personal platform in which they can voice out their feelings in a "safer route" of communication. Additionally, the feature that gives the user the option to have a private account allows them to choose who can view their tweets which makes it more appealing. Messenger, on the other hand, provides secure and private long-distance communication between students, which proved to be essential as social distancing is strictly enforced.

Some other platforms used by a minority of respondents are Facebook or Instagram, with Facebook being a choice mainly for leisure and Instagram only being used privately to post "stories" amongst their trusted peers.

3.2 Reasons for Using these Social Media Platforms in Dealing with Their Mental Health

There are four themes that emerged from the data as to why these teenagers used social media platforms in taking care of their mental health. These are (a) to seek other modes of communication, (b) to look for a source of entertainment (c) to express emotions, (d) to spread positivity, and (e) to raise awareness about mental health.

3.2.1 To seek other modes of communication

Respondents elaborated that social media provides a ground for them to find means of efficient communication in a time when lockdowns and isolations are enforced. The necessity of using social media to communicate has also been evident, with mental health playing a role in the situation. RM stated:

"It's more of a need to use social media [now because] it could feel really isolating when

you don't have anyone to talk to [on] a daily basis."

3.2.2 To look for a source of entertainment

Social media usage during the pandemic has spiked among young adolescents (Lurie Children's Hospital of Chicago, 2020). This is so since it seems that teenagers seek for a source of entertainment from these platforms. A respondent named Geralt spoke about using social media for entertainment, saying:

"[Because of the] pandemic, [we have nothing to do] without fun activities. [With me using] Twitter, [that has been my] source of entertainment during the pandemic."

3.2.3 To express emotions

Social media platforms are ideal for expressing one's self as its wide accessibility and ability to connect people has proven to be superior to other platforms. Kathy, speaking on the ability enabled by social media to be more emotional when using such platforms, commented:

"Twitter has allowed me to vent out my thoughts and really feel my emotions, and afterwards, I feel fresh and clear".

3.2.4 To spread positivity

Social media has become a place where some of the participants addressed their mental health needs by spreading positivity since it provides motivation and courage to address their personal issues. For instance, Mae used social media to spread positivity by sharing memes thinking that "everyone is having a bad time."

3.2.5 To spread awareness about mental health

Using social media fosters a healthy discussion among users. Furthermore, most of the interviewees have stated that social media has helped them immensely in nurturing their mental health by keeping them connected with their friends during the pandemic and through sharing information regarding mental health. Hakeem explained that:

"Me speaking on my mental health and spreading awareness about mental health in general is really helpful. My mutuals also give motivational statements that make you want to persevere".

3.3 Ways How Teenagers Use these Social Media Platforms in Dealing with Their Mental Health

There is one overarching theme emerging from the data as to the ways how the teenagers utilized these social media platforms. Teenagers used them with limitations due to one major reason. They tend to have not used the full features of the social media platforms because of "**fear**", which has the following two sub-themes:

3.3.1 Fear of familial judgment

Familial judgment can be rooted out on the families that use social media and are "friends" or connected to each other. This can be one of the main factors why teenagers hesitate to use social media and its full features. For example, Mae did not want to tell them the full story of her struggle because if she told them about it, she "would not know how they will react because what hurts [her] may not hurt others".

3.3.2 Fear of disingenuous reactions

Having millions of users, social media has a diverse group of users, and there is usually little to no way of knowing which users are sincere and which are not. This is primarily why a many of the respondents are often doubtful whenever someone decides to interact with their content. Pat stated:

> "I know people that are being disrespected in social media just because they are expressing what they feel, it's either they are called out for being "fake", or "over exaggerating" which may cause the individual to be more depressed".

Overall, the present study's findings support the previous claims about the positive use of social media in relation to mental health (Bekalu et al., 2019; Hardy & Castonguay, 2018). However, despite all the different positive effects that social media may have, the participants have also acknowledged that without a moderate balance or with constant and borderline addictive usage, social media could have a negative impact mentally, a claim reinforced by the studies done by Pantic (2014) and Rasmussen et al. (2020), in which they suggested that excessive use of social media may cause users difficulties in regulating their emotions.

4. CONCLUSION AND RECOMMENDATIONS

In summary, social media is a useful tool that can be used in various ways depending on an individual. It may be used to address mental health concerns publicly or privately depending on the purpose. Social media like Twitter, Instagram and Messenger were mostly used to address teenagers' concerns, to share information and spread positivity to those who are experiencing mental health issues.

Social media is essential in the pandemic as it became the medium of communication for among teenagers. However, effective as it seems, social media is still a level below face-to-face communication because in social media communication, we may not know the genuine or raw emotions of the person we are talking to. Face to face conversations eliminate this factor as it could cultivate more communicative genuineness.

For future research, we recommend creating a bigger pool of respondents with wider demographics and possibly employ quantitative perspectives to investigate the actual relationship of social media use and mental health.

5. ACKNOWLEDGMENTS

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The Efficacy of BRafeNHS Student Representative Coordinating Council A.Y. 2020-2021

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Abstract: The student council serves as the voice of the student body, enabling them to be engaged in tackling academic matters (Woods, 2002). With the implementation of online distance learning, the duties of the student council should not cease even with the new factors affecting their proceedings. This study aims to find out if the BRafeNHS Student Representative Coordinating Council is still functioning effectively amidst the set-up of online distance learning what is the student body's perception of their performance, and how it differs from the student leaders' perception. Researchers disseminated a survey questionnaire to 75% of the BRafeNHS student body to rate the performance of the Executive, Legislative, and Media Committee. In evaluating the student council performance, four variables were considered in this study (authority, communication with students, implementation of school rules, and project implementation and student involvement). Interviews were also held with selected students from the council and student body to provide a more in-depth inquiry. Results showed that the BRafeNHS-SRCC is still functioning very effectively based on the student body, and they share almost the same perception on the first two variables, although the same cannot be said for the latter two. Still, the research concludes that the BRafeNHS-SRCC is functioning effectively amidst the implementation of online distance learning.

Key Words: student-leaders; leadership skills; online distance learning; student body; perceived performance

1. INTRODUCTION

According to Woods (2002), the student council is an organization serving as the representative, allowing the student body to become more involved with the school's affairs. With it, the students will have a voice. And for the student council to uphold its purpose, it will have different responsibilities and duties to perform. The responsibilities of the student council may vary from school to school, but are summarized as the following:

Planning, Proposing, and Managing Activities. The student council is tasked to plan and manage different events and activities that will happen in and out of the school within the school year. These activities are not limited to projects proposed by the student council itself; but also programs that are done annually and as suggested by the school management. Specifically, they will have to prepare everything needed for the program, execute the plan, and oversee the project or activity until the end, ensuring its success.

Involvement of Students in the Activities of the Council. The student council has the job of ensuring the participation of the student body in its activities. Such events will serve as the best way to involve the school administration and the students, therefore regularly holding it is the essential job of the council. The student council will not be able to carry out the purpose of the activity or event if neither the students nor the school management will be involved.

Communication with the Student Body. The student council must establish the best way to communicate with the students from different grade levels and sections. To ensure that the student council will stay connected and updated with the student body, batch representatives are usually appointed to know the concern that has to be addressed.

Working in Partnership with the School Administration. Although they serve as the representative of the student body, the student council will also be working together with the administration, teachers, Association of Parents in facilitating matters that concerns the student body.

Financial Management. The student council projects and activities will be all covered by the budget provided by the school, which should be maximized for reasonable and worth causes. . The student council will also host different fundraising programs to gain extra money that can be either added to the council's budget or used for charitable purposes to beneficiaries.

Out of all responsibilities stated, establishing regular and effective communication with the

students is the way to a successful student council. And without effective communication between the two parties, they would not be able to perform their purpose. In the case of the BRafeNHS community, the school is under the online distance learning (ODL) for the academic year 2020-2021 due to the COVID-19 pandemic. With massive limitations in communication during ODL, the performance of the BRafeNHS Student Representative Coordinating Council (BRafeNHS-SRCC) would be determined by their way of implementing projects and the involvement of the student body with it, the enforcement of school rules, and their established authority.

This research will not criticize the student council as the researchers only aimed to see the performance of the BRafeNHS-SRCC during ODL based on the set variables.

2. STATEMENT OF THE PROBLEM

Generally, this study aims to find out if the performance of the BRafeNHS-SRCC was not affected by the implementation of ODL. Specifically, it will answer the following questions:
1. What is the student body's perceived performance of the BRafeNHS-SRCC during ODL in terms of:
    1. authority;
    2. communication with the student body;
    3. implementation of school rules and regulations; and
    4. implementation of projects and student involvement?
2. How is the perception of the student-leaders on their performance during ODL different from the perception of the student body?
3. Does the BRafeNHS-SRCC continue to function effectively with the implementation of ODL for A.Y 2020-2021?

3. HYPOTHESIS

The following are the null and alternative hypotheses of this research.

3.1 Null Hypothesis

The BRafeNHS-SRCC is functioning effectively amidst the implementation of ODL for A.Y. 2020-2021, based on the perception of the student body.

3.2 Alternative Hypothesis

The BRafeNHS-SRCC is not functioning effectively amidst the implementation of ODL for A.Y. 2020-2021, based on the perception of the student body.

4. Methodology

The researchers administered a survey questionnaire to the 75% of the total population of BRafeNHS students with a 5% margin of error to know the perspective of the student body about the performance of the BRafeNHS-SRCC during ODL. Some of the respondents, selected through a direct selection method, were interviewed by the researchers for an in-depth analysis of their perspective.

The BRafeNHS-SRCC committees for this study were the Executive, Legislative, and Media. The following committees were assessed for the study due to their functions: the Executive Committee presides over the entire student council; the Legislative Committee involves the level representative who handles the concern of a batch they hold and supervise the class officers; and the Media Committee is responsible for the social media accounts and online programs of the council. The researchers believed that these leaders are in the frontlines of council activities even in ODL.

The mentioned student-leaders also answered the survey questionnaire on how they perceived their performance during online distance learning and were also interviewed by the researchers. It allowed the researchers to compare and contrast the data coming from the different groups of participants and formulate more concrete and comprehensive conclusions about the effectiveness of the student-leaders during ODL.

In analyzing the collected quantitative data, the researchers used Descriptive Statistical Analysis. The measure of central tendency (mean) constitutes a prerequisite for the t-test. The two-tail independent sample T-test showed how significant the differences between the perspective of student-leaders and student body were.

5. RESULTS AND DISCUSSION

TABLE 1: PERFORMANCE OF THE STUDENT-LEADERS AS PERCEIVED BY THEMSELVES

| STUDENT-LEADER | MEAN SCORES OF PERCEIVED PERFORMANCE | | | |
	Authority	Communication with the Student Body	Implementation of School Rules and Regulations	Implementation of Projects and Student Involvement
A	3.60	3.50	2.80	4.00
B	3.60	3.67	4.00	4.00
C	3.80	3.83	4.00	4.00
D	3.40	3.83	3.60	3.75
E	3.20	3.00	2.60	2.75
F	3.80	3.83	3.00	3.00
G	3.60	3.00	2.40	4.00
H	3.00	3.33	3.60	3.00
I	2.40	3.17	1.80	4.00
J	4.00	4.00	4.00	4.00
K	4.00	3.83	4.00	4.00
L	3.80	3.67	4.00	3.75
M	4.00	3.83	3.80	4.00
N	3.60	3.67	3.60	3.75
O	2.80	2.67	3.00	2.75
P	4.00	4.00	4.00	4.00
Q	4.00	3.83	4.00	4.00
R	4.00	4.00	4.00	4.00
S	2.80	2.83	2.20	3.25
T	3.00	3.50	3.20	3.00
U	2.00	2.00	2.40	2.00

One of the objectives of this research was to determine the perception of the student-leaders on their performance during ODL. This study considered four variables as a means to rate the student council.

The first variable, an established authority, 17 out of 21 student-leaders scored 3.00 or higher in their mean scores. Student-Leader U had the lowest mean score of 2.00, followed Student-Leader I with 2.40. Two student-leaders had a mean score of 2.80 and another of 3.00. Student-Leader D and E with a mean score of 3.20 and 3.40 respectively; four student-leaders had 3.60; three more with 3.80; and six student-leaders scored perfect 4.00. Based on this, most of the BRafeNHS-SRCC had confidence in their authority, with the latter still improving.

In the second variable, communication with the student body, 18 student-leaders scored 3.00 or higher mean score: Student-Leader U with the lowest with 2.00; followed by Student-Leader O with 2.67; then Student-Leader S with 2.83. Two student-leaders scored 3.00, Student-Leader I and H with 3.17 and 3.33 respectively, another two with 3.50 and three more with 3.67. There are six student-leaders with a score of 3.83 and three with a perfect score of 4.00. The results were very similar to the first variable, which means that the BRafeNHS-SRCC was sure that they did not neglect the student body's needs.

For the third variable, implementation of school rules, 15 student-leaders scored 3.00 or higher, with Student-Leader I having 1.80, the lowest mean score. It was followed by Student-Leader S with 2.20, next is Student-Leader G and U having 2.40, then by Student-Leader E with 2.60. Student-Leader F and O acquired 3.00, Student-Leader M attained 3.80, and eight student-leaders have 4.00. It entails that the BRafeNHS-SRCC was quite unsure if they enforced school rules enough, affected by both the new set-up and delegation of tasks.

Lastly, in project implementation and student involvement, 18 student-leaders scored 3.00 or higher: Student-Leader U scored the lowest with 2.00 while Student-Leader E and O scored 2.75. Three student-leaders scored 3.00, Student-Leader S with 3.25, another three with 3.75, and the remaining eleven officers obtained 4.00. These data confirmed that the BRafeNHS-SRCC believed they did more than enough in launching and promoting their projects.

Moreover, during the interview with the student-leaders; The Executive Committee mentioned that communication inside the council is one of their problems. They also scored the lowest on the variable of Authority and/or Implementation of Rules as they believe it was not within the scope of their responsibilities. The Legislative committee said that communicating with the student body had been a challenge as not everyone has an internet connection.

They also never exercised their authority to give violation reports during ODL. The Media Committee was overwhelmed with the number of responsibilities they have during ODL and believes that they were only efficient in implementing projects.

TABLE 2: PERFORMANCE OF THE STUDENT-LEADERS AS PERCEIVED BY THE STUDENT BODY

STUDENT-LEADER	MEAN SCORES OF PERCEIVED PERFORMANCE			
	Authority	Communication with the Student Body	Implementation of School Rules and Regulations	Implementation of Projects and Student Involvement
A	3.55	3.54	3.55	3.59
B	3.45	3.45	3.49	3.53
C	3.42	3.41	3.43	3.50
D	3.48	3.50	3.48	3.53
E	3.43	3.42	3.45	3.48
F	3.52	3.48	3.48	3.52
G	3.47	3.45	3.47	3.50
H	3.38	3.52	3.48	3.56
I	3.45	3.59	3.38	3.56
J	3.39	3.40	3.32	3.37
K	3.58	3.58	3.58	3.70
L	3.34	3.35	3.34	3.30
M	3.63	3.66	3.65	3.80
N	3.44	3.45	3.50	3.57
O	3.41	3.38	3.36	3.36
P	3.42	3.41	3.47	3.46
Q	3.68	3.65	3.68	3.66
R	3.79	3.76	3.76	3.81
S,T,U	3.46	3.45	3.44	3.51

The main objective of this research was to determine the perceived performance of the student-leaders in terms of authority, communication with the student body, implementation of school rules, and project implementation and student involvement. Student-Leader S, T, and U scored as one given that their work was not individually divided. Hence it was not rated per officer.

In the variable perceived authority, all student-leaders scored a mean score higher than 3.30, three of which scored in the range of 3.30-3.39. Ten student-leaders have scores falling between 3.40-3.49, and another three collected scores between 3.50-3.59. Student-Leader M scored 3.63, Student-Leader Q had 3.68 as the mean score, and Student-Leader R scored the highest with 3.79.

As for the variable communication with the students, all student-leaders scored higher than 3.30. Student-Leader L scored the lowest mean with 3.35, followed by Student-Leader O with 3.38. Nine student-leaders attained scores in the range of 3.40-3.49 and five student-leaders between 3.50-3.59. Student-Leader Q and M scored 3.65 and 3.66, respectively, and Student-Leader R scored 3.76, the highest among the scores.

With the variable implementation of school rules, four student-leaders scored between 3.30-3.39, nine had scores within the range of 3.40-3.49, and three student-leaders obtained scores between 3.50-3.59, two had scored between 3.60-3.69, and Student-Leader R scored the highest, with a mean score of 3.76.

In the last variable, project implementation and student involvement, three student-leaders scored within the range of 3.30-3.39, another two between 3.40-3.49, and ten student-leaders between 3.50-3.59. Student-Leader Q had a mean score of 3.66; Student-Leader K has 3.70, Student-Leader M with 3.80; and Student-Leader R scored the highest (3.81).

Moreover, during the interview, the students recognized how the BRafeNHS-SRCC implemented more projects during ODL than on face-to-face; and how the legislative committee addresses their concerns. However, they did not think that the BRafeNHS-SRCC was efficient in implementing rules and establishing authority. They also did not know who the other members of the student council are, other than the president, and their respective level representative.

The majority of the student-leaders acquired 3.40-3.49 mean scores in each variable, except on the variable of project implementation and student involvement which placed the most scores in the range of 3.50-3.59. Therefore, the researchers conclude that the BRafeNHS-SRCC is doing great in their performance during the ODL.

TABLE 3: EVIDENCE OF RELATIONSHIP BETWEEN THE PERCEPTIONS OF THE STUDENT LEADERS AND STUDENT BODY

STUDENT-LEADER		P VALUE		INTERPRETATION
A	I.	0.863	I.	No Evidence
	II.	0.877	II.	No Evidence
	III.	0.198	III.	No Evidence
	IV.	0.000004	IV.	Very Strong Evidence
B	I.	0.569	I.	No Evidence
	II.	0.360	II.	No Evidence
	III.	0.0000001	III.	Very Strong Evidence
	IV.	0.000004	IV.	Very Strong Evidence
C	I.	0.131	I.	No Evidence
	II.	0.054	II.	Weak Evidence
	III.	0.000002	III.	Very Strong Evidence
	IV.	0.00001	IV.	Very Strong Evidence
D	I.	0.755	I.	No Evidence
	II.	0.100	II.	Weak Evidence
	III.	0.652	III.	No Evidence
	IV.	0.440	IV.	No Evidence
E	I.	0.566	I.	No Evidence
	II.	0.303	II.	No Evidence
	III.	0.026	III.	Moderate Evidence
	IV.	0.226	IV.	No Evidence
F	I.	0.230	I.	No Evidence
	II.	0.089	II.	Weak Evidence
	III.	0.00000009	III.	Very Strong Evidence
	IV.	0.000003	IV.	Very Strong Evidence
G	I.	0.633	I.	No Evidence
	II.	0.0000006	II.	Very Strong Evidence
	III.	0.012	III.	Moderate Evidence
	IV.	0.000004	IV.	Very Strong Evidence
H	I.	0.0003	I.	Very Strong Evidence
	II.	0.421	II.	No Evidence
	III.	0.664	III.	No Evidence
	IV.	0.00001	IV.	Very Strong Evidence
I	I.	0.013	I.	Moderate Evidence
	II.	0.231	II.	No Evidence
	III.	0.001	III.	Strong Evidence
	IV.	0.00002	IV.	Very Strong Evidence
J	I.	0.000002	I.	Very Strong Evidence
	II.	0.0000002	II.	Very Strong Evidence
	III.	0.000002	III.	Very Strong Evidence
	IV.	0.0000002	IV.	Very Strong Evidence
K	I.	0.00001	I.	Very Strong Evidence
	II.	0.190	II.	No Evidence
	III.	0.000007	III.	Very Strong Evidence
	IV.	0.0001	IV.	Very Strong Evidence
L	I.	0.083	I.	Weak Evidence
	II.	0.196	II.	No Evidence
	III.	0.000004	III.	Very Strong Evidence
	IV.	0.171	IV.	No Evidence
M	I.	0.0006	I.	Very Strong Evidence
	II.	0.335	II.	No Evidence
	III.	0.0002	III.	Very Strong Evidence
	IV.	0.003	IV.	Strong Evidence
N	I.	0.558	I.	No Evidence
	II.	0.344	II.	No Evidence
	III.	0.709	III.	No Evidence
	IV.	0.516	IV.	No Evidence
O	I.	0.180	I.	No Evidence
	II.	0.086	II.	Weak Evidence
	III.	0.463	III.	No Evidence
	IV.	0.093	IV.	Weak Evidence
P	I.	0.000002	I.	Very Strong Evidence
	II.	0.000001	II.	Very Strong Evidence
	III.	0.00002	III.	Very Strong Evidence
	IV.	0.00003	IV.	Very Strong Evidence
Q	I.	0.00005	I.	Very Strong Evidence
	II.	0.323	II.	No Evidence
	III.	0.00002	III.	Very Strong Evidence
	IV.	0.003	IV.	Strong Evidence
R	I.	0.0002	I.	Very Strong Evidence
	II.	0.000002	II.	Very Strong Evidence
	III.	0.0004	III.	Very Strong Evidence
	IV.	0.003	IV.	Strong Evidence
S,T,U	I.	0.0003	I.	Very Strong Evidence
	II.	0.015	II.	Moderate Evidence
	III.	0.013	III.	Moderate Evidence
	IV.	0.003	IV.	Strong Evidence

To answer the second research question, the third table shows the evidence of the relationship between the perceptions of the student body and student-leaders.

> **I. Authority**
> Very strong evidence: 8 student-leaders
> Moderate evidence: 1 student-leader
> Weak evidence 1 student leader
> No evidence: 9 student-leaders

In the variable authority, nine student-leaders had no evidence that the student-leaders perceived their performance as the same as the student body. Eight student-leaders had very strong evidence; one acquired moderate evidence, and another one had weak evidence.

> **II. Communication with the Student Body**
> Very strong evidence: 4 student-leaders
> Moderate evidence: 1 student-leader
> Weak evidence 4 student leaders
> No evidence: 10 student-leaders

For this variable, ten student-leaders had no evidence; four student-leaders got very strong evidence; one student-leader for moderate evidence; and four with weak evidence. The majority of BRafeNHS-SRCC had a similar perception of their performance with those of the student body.

> **III. Implementation of Rules and Regulations**
> Very strong evidence: 10 student-leaders
> Strong evidence: 1 student-leader
> Moderate evidence: 3 student-leaders
> No evidence: 5 student-leaders

As for the third variable, ten student-leaders had very strong evidence; one got strong evidence; three with moderate evidence; and five for no evidence. The data showed that for this variable, the BRafeNHS-SRCC and student body had different perceptions.

> **IV. Implementation of Projects and Student Involvement**
> Very strong evidence: 10 student-leaders
> Strong evidence: 4 student-leaders
> Weak evidence: 1 student-leader
> No evidence: 4 student-leaders

For the last variable, ten student-leaders obtained very strong evidence. Four student-leaders acquired strong evidence; 1 student-leader with weak evidence; and another four student-leaders got no evidence. Again, for this variable, the BRafeNHS-SRCC and student body had different perceptions.

6. CONCLUSIONS

Although some of the student-leaders doubted their performance due to inconsistent activeness in the student council, internet connection problems, being new to ODL, and performance criticisms. The study showed that the BRafeNHS-SRCC did a great job during ODL. While working as a council, each member had their specific task assigned

to them that could affect or limit what they could do about their performance. Nonetheless, the researchers can conclude that the student body perceived the student-leaders of BRafeNHS-SRCC to be effective with their assigned tasks. Therefore, the researchers accepted the null hypothesis and rejected the alternative hypothesis.

The researchers were also able to identify, through the interpretation of the P-value, that there is no difference between the perceptions of the student-leaders and student body on the variables authority and communication with the student body. For the rules and regulations implementation and Implementation of projects and student involvement, the data entailed that the student-leaders and the student body perceived the former's performance differently.

7. RECOMMENDATIONS

The study showed that BRafeNHS-SRCC continued to perform effectively despite the implementation of ODL. However, the researchers still hope for improvements for the future academic years in ODL. Implementing projects that promote inclusivity and a system wherein the student council and student body can communicate despite having low or no internet connection, and projects that help the students academically and mentally. Most of the interviewees from the student body and student-leaders identified internet connection and mental health as their main challenges during ODL. Hence, communication within the student council and between the student-leaders and student body should be strengthened during ODL as it would help for the betterment of everyone and the service and leadership of the student council.

For future researchers, the researchers recommend finding a way to distribute the survey questionnaire in each section/batch equally, for more comprehensive and accurate data. It is also better to check first the delegated task of each student-leader to sense the scope and limitations of the study.

8. ACKNOWLEDGMENTS

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Two Roads that (should) Converge:
Perceived Effectiveness of Synchronous and Asynchronous Learning by Senior High School Students at José Rizal University

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Abstract: With the outbreak of the COVID-19 pandemic, online learning has become the students' only hope to continue their learning process in a safe and secure manner. This study aimed to examine the perceived effectiveness of synchronous and asynchronous learning and evaluate the factors which may affect students' experience in such a highly emergent learning context. To this end, descriptive quantitative research involving 100 conveniently selected senior high school students enrolled in online classes at a private university was conducted. A researcher-developed, expert-validated four-point rating scale consisting of four parts was administered to the respondents online via SurveyHero. The responses were analyzed using descriptive statistics, mean and standard deviation. The results indicated that, while students perceived synchronous learning as effective and in-par with face-to-face classes, they reported a negative evaluation of the efficacy of asynchronous learning. The study further revealed that factors such as gadgets and a peaceful home environment were essential for successful online learning. It was then concluded that synchronous learning is more effective than asynchronous, and the quality of learning materials provided to the students impact their views on these learning set-ups. The study draws several pedagogical implications useful for both students and teachers in online learning environments. Recommendations for future research are also discussed in this paper.

Key Words: online learning environment, asynchronous learning, synchronous learning

1. INTRODUCTION

Online learning has become a central issue that has arisen in today's educational landscape. With the outbreak of the COVID-19, all aspects of the country suffered heavily, including education which affected nearly 1.6 billion learners globally (United Nations, 2020). Consequently, the adoption of online learning has been spurred to prevent the spread of the virus (Dennon, 2021).

Online learning provides opportunities for students to continue their learning process in a safe and secure manner despite the pandemic (Khalil et al., 2020). Online learning can be synchronous or asynchronous. Synchronous learning refers to the type of class sessions that takes place in real-time, while asynchronous learning is where the students are self-paced and learn without the supervision of their instructors (Scheider, 2021).

Several past works on the effectiveness of synchronous and asynchronous learning have been conducted. Hrastinki's study (2008) found that synchronous learning is deemed more beneficial by students because the learners thought of synchronous communication as "more like talking." Meanwhile,

Kenworthy and McNamara (2012) affirmed that synchronous engagement with the courses or modules caused the students' final examination grades and course grades to rise. On the other hand, asynchronous sessions have been proven effective in promoting creativity in project-based prompts (Beck & Corfman, 2019). Similarly, Hrastinski (2008) proved that, in asynchronous discussions, students can articulate their thoughts better because they can find more facts and read other source materials to grasp the lesson better. Moreover, in asynchronous communication set-ups, the person's capability to understand the information at hand improves (Dennis & Robert, 2005), suggesting that students may be able to process the lessons they have more thoroughly when learning asynchronously.

Despite the prevalence of previous research conducted on online learning, some questions, however, remain unresolved. This is because students now do not get the chance to choose online learning voluntarily since, because of the pandemic, online classes are being imposed upon them. For example, in the Philippines, the Department of Education adopted distance learning methods, which include online learning to facilitate the students' education (Llego,

2020). This then creates a gap if one wants to assess the effectiveness of online learning in such a highly emergent context. In addition, the issue of internet connectivity and digital readiness (Kritz, 2020) is not present in other research, while it may be a big problem in the Philippine setting.

Hence, this study was conducted to determine the perceived effectiveness of online learning. Specifically, this study was designed to answer the following research questions:

1. How effective is synchronous learning as perceived by the students?
2. How effective is asynchronous learning as perceived by the students?
3. What factors in synchronous and asynchronous learning environments do students have to cope with?
4. What strategies do the students utilize to cope with the synchronous and asynchronous learning demands?

2. METHODOLOGY

A quantitative approach, specifically descriptive research design, was applied in this study. The study respondents were 100 Senior High School (SHS) students who were enrolled in online classes at Jose Rizal University (JRU); they were selected through convenience sampling. This sampling technique allowed the researchers to choose those who were more readily accessible given the context of online data collection (Etikan et al., 2016). This means that during the initial data collection, more than 100 students were recruited to participate. However, only 100 students willingly responded to the questionnaire within the timeframe set for the data collection. A four-point Likert scale was developed by the researchers after a careful literature review on online learning—the questionnaire comprised four parts, with each part addressing each research question posed in this study. The original version of the questionnaire only had three parts, totaling 20 items. After an expert validation, an additional part (Part 4) was added to the questionnaire, and an additional statement was added to Part 1 and Part 2, making a total of 26 items. Several statements were also revised to improve their clarity.

Data collection was undertaken through an online survey via SurveyHero. Before the respondents participated, their consent and assent to partake in the research were acquired. The entire data collection lasted for a week due to the number of responses needed.

Descriptive statistics, mean and standard deviation (SD) were used in the data analysis. The responses were first collated in Microsoft Excel. The mean and SD of each item were then calculated. After calculations were done, the data were tabulated, and each item was interpreted using the range of mean scores, whereas 3.26-4.00 equated to strongly agree; 2.51-3.25 to somewhat agree; 1.76-2.50 to somewhat disagree; and 1.00-1.75 to strongly disagree.

3. RESULTS AND DISCUSSION

3.1 How effective is synchronous learning as perceived by the students?

Table 1 shows a grand mean of 2.97, indicating that the students somewhat agree that synchronous class effectively accommodates their academic needs. Moreover, the results indicate that students strongly agree that the instructional materials utilized during synchronous sessions are relevant to their needs. Similar outcomes can be learned from past works. For example, the study of Francescucci and Rohani (2018) reported that synchronous courses have the same level of student performance outcomes as with face-to-face learning because of effective instructional materials. In the current study, teachers may have utilized various teaching materials which get positive engagement from the students, as explained by the highest mean in item 1. Moreover, learners value spontaneous feedback and meaningful interactions, which are present during synchronous sessions (Bonk & Park, 2007), and could be the significant reasons why the students generally show a positive attitude towards the aforementioned learning set-up.

Table 1 *Effectiveness of Synchronous Learning as Perceived by the Students*

Items	Mean	SD	Verbal interpretation
1. The instructional materials used during synchronous classes are appropriate and suited for my academic needs.	3.36	0.61	Strongly agree
2. Subject teachers utilize various strategies to encourage active learning among students, which enables me to learn more effectively.	3.21	0.66	Somewhat agree
3. My internet connectivity is good and conducive for learning, so I am able to keep up with the discussions.	2.65	0.88	Somewhat agree
4. I can easily interact with my teachers, so the questions I have in mind are clarified immediately and clearly.	2.91	0.88	Somewhat agree
5. I can easily interact with my classmates, and we are able to discuss the content of a topic, which enables me to take the level of depth into a topic	3.03	0.90	Somewhat agree

	Mean	SD	
further than the instructor's presentation alone would.			
6. I get higher grades on my assessments when the topic is taught in synchronous sessions than when I do under the synchronous classes.	3.03	0.81	Somewhat agree
7. I can say that synchronous learning is in-par with face-to-face classes when it comes to the quality of learning that I get from it.	2.62	0.98	Somewhat agree
Grand mean	2.97	0.82	Somewhat agree

3.2 How effective is asynchronous learning as perceived by the students?

In Table 2, it is revealed that students somewhat disagree that asynchronous classes are effective, as indicated by the grand mean of 2.48. The result also shows that the students do not perceive asynchronous learning as on par with traditional classes, as shown by the 2.13 mean for item 7. The students' negative outlook towards asynchronous classes may be caused by their lack of experience with the mentioned learning set-up. Several studies prove that, by practice, asynchronous learning does not work as designed due to students' lack of perceptions of interdependence (Peterson et. al, 2018). Since the students are new to the asynchronous modality, it may be harder to adjust to the schedule flexibility and interdependence given to them. Moreover, students tend to have a greater interest in synchronous activities as those are more interactive and reinforce knowledge retention better than asynchronous tasks (Malik et al., 2017). This finding also offers a probable explanation as to why the students' perception regarding the effectiveness of asynchronous classes is substandard.

Table 2 *Effectiveness of Asynchronous Learning as Perceived by the Students*

Items	Mean	SD	Verbal Interpretation
1. The instructional materials uploaded in Canvas are clear and easy to understand, and the modules are arranged properly; thus, I am able to learn effectively even without the supervision of a teacher.	2.46	0.91	Somewhat disagree
2. There are different types of instructional and supplementary materials provided by the teachers (e.g., video presentations, recording of the discussions, etc.) that help me understand the lessons better.	2.49	0.89	Somewhat disagree
3. The subject teachers use different strategies such as evaluation tests and lesson sharing to assess what I learned about the topic.	2.72	0.93	Somewhat agree
4. I can easily reach my subject teachers through email or using Canvas inbox whenever I have questions regarding the modules or lessons.	2.05	0.93	Somewhat disagree
5. The time I allot for different topics/subjects allows me to focus well, thus helping me learn at my own pace.	2.74	0.92	Somewhat agree
6. I get higher grades on my assessments when I study under an asynchronous set-up than when I do under synchronous classes.	2.77	0.95	Somewhat agree
7. I can say that asynchronous learning is in-par with face-to-face classes when it comes to the quality of learning that I get from it.	2.13	0.97	Somewhat disagree
Grand mean	2.48	0.93	Somewhat disagree

3.3 What factors in synchronous and asynchronous learning environments do students have to cope with?

As shown in Table 3, the grand mean of 2.49 indicates that the students somewhat disagree that their study environment is conducive to learning. The results generally show that the students' home environment is not that beneficial in helping them learn better, implying that students may be having a more challenging time learning at home than in a classroom. Students taking the course in a traditional classroom setting outperformed their peers who study at home because of the presence of various distractions (Brooks, 2011). Also, Perks (2014) stated that, given the profound influence of the physical environment on their learning competency, the slightest distractions around the students' workspace could significantly impact their learning behavior. In the present study, distractions such as household chores and the presence of gadgets and other factors such as a peaceful home environment may have contributed significantly to how students perceive the conduciveness of their home as their learning environment.

Table 3 *Factors in Synchronous and Asynchronous Learning that Students have to Cope with*

Items	Mean	SD	Verbal interpretation
1. The submission deadlines of my assignments give me ample time to focus on and fulfill each task satisfactorily.	2.75	0.86	Somewhat agree
2. The number of tasks assigned to me on different	2.6	0.85	Somewhat agree

	2.88	0.81	
subjects is manageable; thus, I am able to finish them on time.			
3. I can open the instructional materials in Canvas across different devices, thus enabling ease of access.	2.88	0.81	Somewhat agree
4. The different features in Canvas, such as Inbox and Chat, allows me to interact with my teachers and classmates whenever needed.	2.86	0.85	Somewhat agree
5. I am able to manage my time well for household chores and academic responsibilities.	2.25	0.85	Somewhat disagree
6. Doing household chores does not distract me or affect my performance towards academic responsibilities.	2.28	0.95	Somewhat disagree
7. My home environment is peaceful and conducive for learning, thus allowing me to study effectively.	2.18	0.82	Somewhat disagree
8. I am not distracted by the gadgets and available at home (such as television, gaming consoles, etc.), and I can focus well on my synchronous and asynchronous classes.	2.13	0.88	Somewhat disagree
Grand mean	2.49	0.86	Somewhat disagree

3.4 What strategies do the students utilize to cope with the synchronous and asynchronous learning demands?

Table 4 reveals that the students generally employ different learning strategies to make their academic lives easier, as shown by the grand mean of 2.85. The results also show that the students list academic tasks but do not join group or class review sessions. Students' preference for tracking their tasks through lists may be explained by the sense of added efficiency it causes. Most learners agree that task tracking dramatically impacts the success of their online learning experience because it helps organize responsibilities (Song et al., 2013). On the other hand, the students' lack of interest in group reviews may be caused by the perceived disadvantages from the aforementioned review style. Since the students are undergoing online classes, they might not be comfortable or feel productive when they review with others. Self-studying is more efficient than group review sessions since it offers fewer distractions and allows for the customization of learning techniques that an individual can use (Weinberger, 2020).

Table 4 *Students' Strategies to Cope with Synchronous and Asynchronous Class Set-ups*

Items	Mean	SD	Verbal interpretation
1. I am able to manage my time by using different techniques (e.g., Pomodoro method, 2-minute approach, etc.) to avoid procrastination.	2.77	0.87	Somewhat agree
2. I list all the tasks that need to be accomplished so that I'll have a smooth workflow.	3.34	0.84	Strongly agree
3. I participate in group review sessions with my classmates to reinforce my understanding of the lessons.	2.44	0.97	Somewhat disagree
4. I set aside a particular time or day dedicated to reviewing the modules and lessons for the week.	2.83	0.92	Somewhat agree
Grand mean	2.85	0.90	Somewhat agree

4. CONCLUSION

This study has attempted to examine the effectiveness of synchronous and asynchronous learning from the perceptions of students. Based on the findings of the study, it can be concluded that synchronous learning is more effective than asynchronous learning. The main factors that influence students' perceptions are the relevance of the instructional materials used and the variation in the real-time interaction during the mentioned learning set-ups. In addition, several environmental factors, including the lack of a peaceful home environment and the presence of distractions in gadgets, affect the students' online learning experience. Lastly, while the students prefer listing their tasks to have a smooth workflow, they rarely participate in group review sessions to reinforce their understanding of the lessons.

Based on these conclusions, several implications to teaching and learning in online learning environments could be drawn. First, the instructors must provide a variety of supplementary materials for the students to work with, and these materials should be understandable even without teacher supervision for synchronous and asynchronous learning to converge successfully. Second, the instructors and learners should interact more frequently during asynchronous classes to ensure knowledge retention among the latter. Third, the students must learn to adjust to the online learning environments, which they can do by finding a quieter spot in the house to be able to focus well. Fourth, they must take action to prevent gadget addiction from distracting them from studying. Fifth, different study techniques which will help the students manage their time and reinforce their learnings better should be employed.

The present study has its limitations. Future research may explore more factors affecting students' learning experience in online learning environments through a qualitative inquiry. Furthermore, research on synchronous and asynchronous learning involving teachers may provide a more comprehensive result.

5. ACKNOWLEDGMENT

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Students' Preferences on the Kinds of Online Learning Resources

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Abstract: During this time of a pandemic, the traditional learning shifted to an online learning mode. This demands adjustments to both the teacher and the learner along with the learning resources they will utilize. The learner should be immersed in a personalized learning environment that suits the learner's personal learning needs. Knowing these learning needs will enable both the learners and the teachers to create an inclusive learning environment. One of the learning needs is the students' preferred online learning resources (OLR). There are four kinds of OLRs: texts, sounds, images/videos, and artefacts. The study aims to identify the preferences of the students on the kinds of online learning resources. Descriptive quantitative research design is the nature of this study which utilized online questionnaires to gather the data needed from the grade twelve students of LORMA Colleges Senior High School. The results show that artefacts are the most preferred OLR, followed by images/videos, texts, then sounds. Given these, the researchers created a LORMA E-Library prototype to establish a corpus of learning resources. The LORMA E-Library will enable students to have convenient and reliable access to various kinds of OLRs. The features of this LORMA E-Library are based upon the innovative environment for OLRs, which are availability, accessibility, and convenience.

Key Words: online learning; online learning resources; students' preferences

1. INTRODUCTION

1.1. Background of the Study

The COVID-19 pandemic caused a disruption in the educational sector by forcing much of the educational institutions to transition to the online learning mode of delivery to continue the educational process of the learners (Crawford et al., 2020, as cited in Tria, 2020). This is what is being considered today as the new normal mode of education and being in the online mode of delivery demands adjustments to both the teacher and the learner along with the learning resources they will utilize.

The very nature of online learning presents the need of compensation for the lack of physicality of the course materials (Amiet et al., 2017). Such needs are attained by being able to have a video conferencing between students and teachers, student to student discussions, good internet connections, lectures accessible through different digital devices, the possibility of rewatching or replaying recorded lectures, and receiving of assignments and quick feedback from teachers (Dhawan, 2020). The part where the lectures should be accessible in any gadget at any time indicates that having online learning resources (OLRs) are necessary and complementary for online learning.

Various factors act as barriers in the engagement of students in an online learning environment (Amiet et al., 2017). Two of the factors that were enumerated are poor academic performance and lack of motivation. With the given factors, it is necessary for educational institutions to help their students prepare for online learning. One of the elements comprising the readiness for online learning is the individual differences of students (Vonderwell, 2004; Watkins et al., 2004; Pillay et al., 2007; Mercado, 2008; Dray et al., 2011; Farid, 2014; Wladis et al., 2016, as cited in Amiet et al., 2017).

Students who are engaging in an online learning mode of education often encounter lesser access with the support services the institution could offer as compared to those who are having the traditional learning (Lee, 2010, as cited in Amiet et al., 2017). The first and most important among the "four pillars" to supporting student success is all about providing students with online-friendly academic resources and student-instructor interactions (Cannady, 2015 as cited in Amiet et al., 2017).

In order to achieve this, a strong collaboration between the faculty of the institution and the institution's librarians is needed when delivering the students' OLRs (Arnold et al., 2002; Kumar & Heathcock, 2014, as cited in Amiet et al., 2017). If the educational instructors are not aware of the individual differences of its students, then the OLRs may not be

utilized to its full potential. Relying solely on the general resources present in the Learning Management System being utilized by the institution, especially with a lack of proper instruction, might be insufficient to fulfill the needs of the students (Kumar & Heathcock, 2014, as cited in Amiet et al., 2017).

In an international context, particularly in the United States, Bacher-Hicks et al. (2021) stated that the search intensity for learning resources received a spike after the pandemic struck. Bacher-Hicks et al. (2021) identified the top 10 most searched learning resources in the search engine Google. The following results are as follows (arranged by greatest search intensity to least): Google Classroom, Khan Academy, Kahoot, Seesaw, Schoology, ClassDojo, Flipgrid, D2L, Nearpod, and Edmodo.

In the Philippine context, the "big four" universities coped up by implementing their own Learning Management Systems to provide their students with the necessary OLRs. The "big four" universities are De La Salle University (DLSU), Ateneo de Manila University (ADMU), University of Santo Tomas (UST), and University of the Philippines (UP). For DLSU, the institution is utilizing *AnimoSpace*. For ADMU, the institution is utilizing *AteneoBlueCloud*. For UST, the institution is utilizing *UST Cloud Campus*. And UP is utilizing University Virtual Learning Environment (UVLE) and UP Open University (UPOU). Each of these institutions is implementing fully online classes, blended learning, or scheduled face-to-face classes depending on the implemented protocols of the government (Biana et al., 2020). Since these institutions are implementing various modes of learning delivery, all kinds of OLRs are being utilized.

Now that the importance of online learning resources has been settled, there are insights innovating the environment for the online learning resources. The environment for online learning resources should be capable of being shared through social networks, the environment should also be capable of housing a huge number of resources or data (in this case the online learning resources) and is compatible with a wide range of technologies. This innovative environment allows availability, accessibility, and convenience for the users in need of the online learning resources (Ahmad et al., 2018).

The research study now aims to specifically answer the question, "*What are the preferred kinds of online learning resources of the grade 12 students of LORMA?"*. Knowing their preferences will be beneficial in satisfying their individual needs in learning as the researchers will be able to create a solution on how to enable students with convenient and reliable access to OLRs.

1.2. Conceptual Framework

1.2.1. Online Learning Resources

Online learning resources are online learning contents and online learning tools obtainable in an online learning environment through the internet. The learning contents can be in the format of audio, video, or HTML documents of lectures, course objectives, tutorials, e-books, etc. As for the online learning tools, these are mind-mappings, interactive quizzes, exams, etc. (Cooper, 2009 & Lebeničnik et al., 2015). Online learning resources are important to students venturing the online mode of learning since online learning makes the learning process more student-centered and flexible resulting in a more customized learning experience (Dhawan, 2020 and Josep, 2020).

1.2.2. Kinds of Online Learning Resources

There are different kinds of OLRs which an individual can access. These are Text, Images, Sounds, Artefacts, (Moore & Kearsley, 2012 as cited by Lebeničnik et al., 2015) and Videos (Lebeničnik et al., 2015).

a.) Text

Text in the online educational domain takes the form of 'e-text' which is basically a collection of text-based resources for online readings which can be utilized in complement or in replacement of traditional print-based media. E-texts are continuously being incorporated with innovative functions such as outlining tools, quizzes, speech, video libraries, and the ability to share the e-text via various social media platforms (Chase, 2017).

b.) Images

Images could be still or moving (video) which is capable of implying the same meaning of several texts in a concise manner. It invokes subjective interpretation and is not bound to any language (Burns, 2020).

c.) Sounds

Sounds carry out a straightforward and associative meaning capable of evoking images and ideas that are closely related to what is being taught resulting in an efficient way of transmitting a message (Bates, 2015).

d.) Artefacts

Artefacts are the end products of teachers or students. It includes samples of students' works, photographs, film or audio recordings of classes, documents or records which have an impact on the performances (Cope & Kalantzis, 2015).

1.3. Theoretical Framework

1.3.1. Connectivism Learning Theory

The Connectivism Learning Theory expresses that an individual learns when connections are being formed. It is not necessarily grounded on the connection between an individual to a fellow individual as it can also be found in non-human appliances. The fourth principle of the theory also emphasizes importance on the capability of acquiring further knowledge than focusing on what an individual already knows (Siemens, 2005). Therefore, in relation to the study, a student will be able to learn more when a connection is made. This further supports the importance of knowing the students' preference on the kind of online learning resources.

1.3.2. Intrinsic Motivation Theory

The Intrinsic Motivation Theory talks about the motivation of an individual to do a certain task or action out of personal interest and not being driven by external rewards (Cherry, 2019). An individual prefers having control over their own decisions as to what they would like to pursue (Lepper & Malone, 1987 as cited in Cherry, 2019).

2. METHODOLOGY

2.1 Research Design

The research study utilized Descriptive Quantitative Research Design. The aim of descriptive quantitative research studies is to be able to provide the status of one identified variable in an accurate and systematic way. This design is fitting for researchers seeking what, when, where, and how questions of a phenomenon (McCombes, 2020).

2.2 Population & Locale of the Study

The study was conducted within LORMA Colleges Senior High School in which the participants are the 12th grade students. The number of respondents was identified through random sampling. The grade 12 students were chosen to be the respondents since they are part of the transition of traditional learning to online learning. As student researchers in the 12th grade, a first-hand observation of the problem regarding online learning was observed. Thus, the researchers aim to provide a solution for the matter in a micro-to-macro manner.

2.3 Data Gathering Tools

Online survey was utilized as a platform to deliver the questionnaires. The survey includes questions pertaining to preferred kinds of online learning resources of the students. Through the survey, the researchers were able to gather information on how to help the students access convenient, reliable, and preferred Online Learning Resources.

2.4 Data Gathering Procedures and Ethical Considerations

The researchers prioritized the needed requirements for the data gathering, in which questions were formulated for the online survey. After which, the researchers created their letters for approval and was given to the respective research advisers for validation. After the validation process, the researchers administered the survey online.

2.5 Data Analysis

For the data analysis, the gathered data were examined and question regarding what online learning resources the students prefer were tallied and shown through a graph.

3. RESULTS AND DISCUSSIONS

The study obtained ninety-seven (97) responses respectively for the online survey questionnaire that the researchers have provided. Sixty-nine (69) respondents were from the STEM - HAS strand, twenty (20) respondents were from the STEM strand, five (5) respondents were from the ABM strand, and three (3) respondents were from the ICT strand.

The researchers gathered the respondents' preferences of OLRs and are presented in the pie graph below.
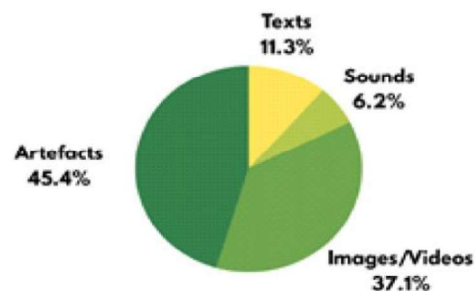

Figure 2: Students' Preferences

Artefacts were the most preferred OLR by the students gaining 44 out of the 97 responses. Mainly, convenience was the reason pointed out by the respondents since artefacts can be composed of the combination of the other 3 OLRs. This gives them the convenience of having text, sounds, and images/videos all in one learning resource. Since artefacts are the end results of students/teachers' activities then the user will have a basis on what their task is. Having a

basis is the other reason why the students preferred artefacts.

The available resources of students engaging in an online learning mode of education should be comprehensive and varying to improve the success of students (Kumar and Heathcock, 2014 as cited by Amiet et al., 2017).

Since artefacts are the past creations of students/teachers, then these artefacts can actually be combinations of other kinds of OLRs. This makes the collection of resources more varying and comprehensive which can serve as a basis for the next students on how to deal with a certain lesson or activity.

Images / Videos gained 36 responses. The major reason stated by the respondents is their learning style. Most of them stated that they were audio-visual learners. Convenience was also a major factor since the students can pause or replay the video anytime they want.

One of the aforementioned requirements of online learning stated in this study, in order to satisfy the problem about the lack of physicality, is having the possibility of replaying or rewatching recorded lectures (Dhawan, 2020). This requirement is now evidently seen within the statements of the respondents which identify images/videos as convenient because of its ability to be replayed.

Texts gained 11 responses. The major reason stated by the respondents is their learning style. There is a fraction of the total respondents who identified their learning style as a reading learner.

Sounds had the least responses having only six (6). The major reason why it had the lowest response is that most of the students stated that they can't learn effectively by just listening alone. Although the six students who chose sounds identified it as their learning style.

Putting aside the preferred OLRs of the students, when all of the reasons for their preference are taken into account, it is notable that the major reason is their learning style. Learning style is the term which describes the way an individual possesses, processes, and stores information (Chick, 2017). Plenty of learning style schemes had been devised throughout the years and the most suitable scheme for this study to relate to is the VARK learning styles. The main reason behind the relation is the reasons provided by the respondents when asked why they preferred their chosen OLR.

VARK learning style is categorized through the sensory approaches namely: Visual, Aural (Auditory), Verbal (Reading/Writing), and Kinesthetic (Chick, 2016). The identified kinds of OLRs in this study, when taken individually, actually has a corresponding learning style (i.e., Texts - Verbal, Images/Sounds - Visual, Sounds - Aural). The

respondents provided a direct link between their preferred OLR and their learning styles when they stated their reasons.

Given the identified preferred OLR of students and the established direct relationship between the preference and learning style, the researchers developed a prototype of the Lorma E-Library.

4. CONCLUSION AND RECOMMENDATIONS

The study found out that artefacts are the most preferred OLR of the grade 12 of LORMA Colleges Senior High School. Learning style is the major reason behind their preferences followed by their own convenience as the second major reason. This research paper indicated that for students to effectively engage in online learning, their individual learning needs must be achieved. This paper also indicated that relying only on the OLRs that are present in the LMS of the institution is insufficient. The findings of this study pointed out the individual learning of the students in the context of their learning styles.

Given these, the researchers came up with a LORMA E-Library, a prototype of the E-Library to establish a corpus of learning. The LORMA E-Library will enable students to have a convenient and reliable access to a variety of the different kinds of OLRs. The features of the Lorma E-Library are patterned according to the study of Ahmad et al. (2018) which provided the innovations for the environment of OLRs, these are availability, accessibility, and convenience.

As a recommendation, future researchers could conduct the study on a larger locale involving all strands of SHS and other grade levels to diversify the study.

5. ACKNOWLEDGMENTS

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Study Habits of LORMA Senior High School Students
Engaged in Online Learning

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Abstract: With the emerging paradigm shift as a result of the rise of the online learning framework during the COVID-19 pandemic, factors like study habits can change Herewith, this study aimed to determine the study habits the LORMA Senior High School students have developed in online learning, the significant changes in the study habits before and during the implementation of online learning, and the most effective study habits of students engaged in online learning. Twenty-five (25) students were selected using simple random sampling. Qualitative-Descriptive Research Design was used which allowed the respondents to explain their perceptions in their own terms and to understand how those behaviors developed. Thematization was used in the data analysis, in which the gathered responses were categorized into various themes. The research results revealed the different study habits developed using online learning. The findings also indicated substantial differences in practices before and after the introduction of online learning. Changes in schedule and learning materials, decreased enthusiasm, and other behaviors were discovered to have changed due to the transition to online classes. Furthermore, the researchers identified four (4) most effective study habits among various responses: time management, maintaining a healthy lifestyle, concentrating, and reviewing lectures.

Key Words: study habits; online distance learning; senior high school students; COVID-19; effective habits

1. INTRODUCTION

1.1 Background of the Study

COVID-19 has reshaped the gears that once made this world work. It has caused an unprecedented crisis in all aspects of human life around the globe. The rapid increase in COVID-19 cases led to the massive closure of face-to-face classes (UNESCO, 2020). Educational institutions have initiated the momentum of continuing education amid the pandemic through different means and modalities based on available human and material resources (Paudel, 2021).

Online learning appeared to be a viable solution to fill the void for classroom education (Kasrekar & Tapaswi, 2020). The emergence of this framework opened up new learning and teaching opportunities in a variety of fields outside of the conventional classroom setting (Rodrigues et al., 2019).

As stated in a study by Aristovnik et al. (2020), the COVID-19 pandemic has had a big impact on students' practices regarding academic work and life. This highlights different situations such as the switch to online lectures, closed libraries, changed communication channels for teachers, new assessment methods, different workloads, and performance levels. The flexibility of online learning through devices such as mobile phones can affect the implementation of new routines for learning. Rapid technological advances have encouraged institutions to concentrate their energies on improving and expanding existing educational methods.

With the emerging shift of paradigm, such as the student's mode of learning, routine, and environment, factors like study habits have a probability to alter. A study habit can be defined as an activity that students conduct frequently in order to complete the task of learning. Students need to develop appropriate studying habits to help them remain focused on their ultimate goal, which is academics (Atieno, 2019). Study habits can help them boost their self-confidence, be more competent at school, finish tasks easier, improve their ability to learn and retain knowledge, and does not put their mental health at risk (Wong, 2021).

This study obtained contextual data on the study habits of Lorma Senior High School Students and aimed to provide preferences to the future Senior High School students on the habits they can adapt to. The results of the study will also serve as a reference

material and a guide for researchers who wish to conduct the same study.

The general purpose of this study is to determine the different study habits the LORMA Senior High School students have developed in online learning and to know the significant changes before and during the implementation of online learning. Furthermore, it aims to identify the most effective study habit among the learners.

1.2 Statement of the Problem

This study seeks to answer the following questions:
1. What are the study habits of students in online distance learning?
2. What are the significant changes in the study habits of students before and during the implementation of online distance learning?
3. What are the most effective study habits of students engaged in online learning?

2. METHODOLOGY

2.1 Research Design

The researchers made use of the Qualitative-Descriptive Research design. The rationale for conducting this type of research is for the respondents to have the opportunity to describe their experiences and to have a clearer understanding of how those habits were formed.

2.2 Participants and Locale of The Study

In determining the respondents, simple random sampling was utilized. The respondents were 25 LORMA Senior High School students.

2.3 Data Gathering Tool

An online questionnaire made through Google Forms containing questions the researchers specifically seek for was sent to the respondents.

2.4 Data Gathering Procedure

A letter of permission to administer the study was sent to the School Director. After which, the researchers started to send the online questionnaire to the respondents.

2.5 Analysis of Data

In order to fulfill the objectives of this research, the responses gathered were grouped and analyzed using Thematic Analysis to achieve identifying and understanding patterns.

3. RESULTS AND DISCUSSION

3.1 Study Habits of Students in Online Learning

3.1.1 Planning ahead of time

Planning plays a vital role in the students' habit towards online learning. This includes preparing a schedule, setting up a to-do list, and prioritizing tasks. This allows students to keep track and finish all their schoolwork on or before the deadline. One student said, *"I usually list down the things that I need to do based on their due dates so that I can schedule when I will do things."* According to Joubert (2020), without a teacher regularly checking in, committing to a list or schedule is an important way to leverage one's time management skills.

3.1.2 Finding comfort in their own space

A respondent stated, *"I try to find a comfortable study place or setup."* Setting up a space for learning sharpens the mind and improves concentration. By setting a study space, students can control lighting, temperature, and etc. This can also make way for a more flexible schedule based on the students' personal preferences (Guo & Chen, 2020).

3.1.3 Building a Routine

Considering the world's current situation with the pandemic and the new normal, having a routine makes it easier for students to adopt to change and have a sense of normality (Collier, 2020). One of the respondents shared, "*After waking up, I try to have my breakfast and take a bath so that I can no longer worry about these little things."* Moreover, a routine reduces stress and provides comfort that students need in order to remain focused on their studies.

3.1.4 Note-taking

As stated in a study by Goodwin (2018), note-taking increases learning retention and organizes information. The respondents expressed that it helps them improve active listening and aids them in transforming information in ways that lead to deeper understanding. *"I always take notes whenever there is a Zoom lecture to help me concentrate. It helps me retain the topics discussed by the teacher,"* stated by one of the respondents.

3.1.5 Being Active on Online Lectures

According to Schritter (2021), active class participation allows students to focus and retain the lessons better. Respondents stated that asking questions and interacting with Zoom discussions are

the ways they stay active and fully absorb a lesson. *"I always recite and clarify through asking questions and the like,"* and *"I try my best to feed my concentration's appetite by participating and interacting with the teacher in charge & classmates for clarifications,"* are a few of the responses students have said.

3.1.6 Avoiding Distractions

Distractions are more likely to be encountered now that classes are being held virtually because of the internet, according to Morrison (2020). A student stated, *"I try to not use my phone to avoid possible distractions and to just keep my focus sharp."* Another one responded, *"if the lesson is hard or new to me, I will not respond to any messages I receive and just focus on the zoom meeting."* These statements show that avoiding distractions is a step to study effectively at home.

3.1.7 Occasionally Asking for Peers' Help

Despite the set-up where students are in their homes without their classmates by their side, technology has bridged a way for them to still communicate. *"I prefer studying alone. Although I resort to my family and friends sometimes for references or insights,"* a student stated. Asking for help benefits students' learning, bolsters student engagement, and improves better accuracy in understanding instructions and problems (Tullis & Goldstone, 2020).

3.1.8 Reviewing

Reviewing is the key for long-term learning (Nobes, 2019). Similar to what the respondents have shared, scanning and skimming their notes, and other resources can already help them retrieve knowledge from memory. *"I go over the learning materials and research for the topics that I do not understand much through the learning materials provided by the school,"* and *"I backtrack on all our lessons and take in only the important details. Mostly, I just highlight the key details on my notes,"* are two of the data that the researchers received from the respondents.

3.1.9 Consuming Online Resources

The internet has become a key resource for students due to its availability and currency (Ahmed et al., 2017). The respondents mentioned that utilizing the internet has reshaped their educational practices in terms of improving academic learning. *"I visit our google classroom for the shared artefacts & pdf files and watch YouTube videos & zoom recordings for tutorials & additional notes,"* stated by one of the respondents.

3.2 Significant Changes in the Study Habits of Students Before and During the Implementation of Online Distance Learning

3.2.1 Diminished motivation

The motivation of the students has diminished from reviewing, writing notes, and being active in class. Lack of interaction with peers and teachers is one of the reasons why students are less motivated in online classes (Meşe & Sevilen, 2021). *"We are in a home set up, I don't even look at my notes at all."* and *"got a bit less active in asking questions because mostly in a zoom meeting, students tend to be passive because of lack of interest and connectivity problems"* are some of the responses the students had inputted.

3.2.2 Change in Learning Resources

In an article, O'Loughlin (2020) mentioned that effective learning comes with appropriate tasks and teaching materials that can meet the needs of students. *"I used to write loads of notes to review but because of online classes, I developed a habit of relying on the internet for reviews and answers,"* stated by a respondent. With the change in learning resources, the students' study habits changed as well.

3.2.3 Self-Dependence

According to Moore (2021), help is not always available that is why learning to live independently is important in one's life. One respondent stated, *"I think what changed most is that I no longer can talk to my peers face-to-face, limiting our interaction,"* while in others' perspectives are *"I felt more mature depending on my own knowledge and not those what they want us to know,"* and *"It helped me to be more independent and studious."* Respondents expressed that they have become more self-dependent during online learning. Through self-dependence, students learn their own strength and not having to rely on others anymore.

3.2.4 Altered routine

"I've had to get up so early before to prepare breakfast, my school uniform, and the minutes of walk to the school, but the setup now allows me to enjoy more of my bedtime, unlike before." These are the student's experiences regarding the changes in routine. Human beings are wired to perform better if one follows a regular schedule or routine (AltaMed, 2020). In today's set-up, students have changed routine from their sleeping schedule and even to their studying hours.

3.2.5 Time efficiency

A lot has changed in the students' study habits with the sudden transition to blended learning, and this includes their time efficiency. According to Lowvelder (2018), time is a vital factor in the students' productivity. *"The way I usually recall things that need to be done was adjusted; I always keep in mind the things that I need to do from time to time,"* mentioned by a respondent.

3.2.6 Attentiveness

Some students responded that they became more attentive. According to Rose (2015), being attentive makes students be more organized and be able to store their knowledge and skills in the long run. Attentiveness helps students understand and process the information better. *"I am more active in asking questions now because there are considerably a lot of things that I don't understand or get confused with because oftentimes, a lot of things are not explained in a clear manner,"* from one of the respondents.

3.3 Most Effective Study Habits of Students Engaged in Online Learning

3.3.1 Time Management

Time management refers to a range of behavioral skills essential to the organization of study and academic load (Kaminske, 2020). The respondents mentioned that planning ahead of time, organizing their study schedule, and delegating the tasks helped them deliver work on time and achieve greater levels of productivity. *"I make a list of my schoolworks. In that way, I can assess what needs to be done first,"* expressed by one of the respondents.

Responses from the students also include the use of the Pomodoro Technique as it helps them retain the lessons and avoid procrastination. A respondent answered, *"I use pomodoro technique when reviewing because it helps me fight procrastination and it is somehow effective for me."*

3.3.2 Maintaining a healthy lifestyle

According to Helton (2017), prolonged work results in a decline in academic performances; thus, it is important to have regular breaks and proper amounts of sleep to stay focused, increase productivity, and reduce stress (Terada, 2018). *"I make sure to have a bit of rest (5-15mins) every after a task to avoid getting burned out,"* said one of the respondents. Another respondent also mentioned that they always remind themself how they deserve a break every now and then.

3.3.3 Concentrating

This school year has been tougher than before and staying focused while studying is one of the challenges faced by the students (Dempsey, 2020). Thus, students have developed different study habits that help them with concentration. Responses from the students are as follows: *"Finding a comfortable and quiet study area," "Keeping myself alone,"* and *"I turn off my phone's WiFi and just allot a specific time as to where I should use my phone."*

3.3.4 Reviewing Notes and Recorded Zoom Lectures

Reviewing and recalling learning resources increases students' familiarity and understanding with content. It is important due to the process of memory retrieval (Rad, 2020). One of the respondents specified that they do the 3R system: read, recall, and review. *"I download the learning materials so whenever I encounter something that has to do with the lesson and I am reminded of the concept, I check the files to verify what I remember and recall what I forgot,"* stated by another respondent.

4. CONCLUSIONS

The research results revealed the different study habits that students engaged in during online distance learning. The researchers concluded that these habits allowed students to adjust and find their own pace in the online learning set-up.

The researchers also found that there were indeed significant changes comparing the habits before and during the implementation of online distance learning. Changes in routine and learning resources, diminished motivation, and the like are habits that were revealed to have altered in the process of switching to online classes. The most effective study habits for students were also mentioned. These have helped students on absorbing and keeping up with the given lessons and activities.

The implications of this study are important in connotation to the current educational set up, in which study habits are implemented to cope with online distance learning in light of the COVID-19 pandemic.

Future researchers are recommended to evaluate a larger population of students for better results. It is essential and recommended to survey other schools for more diverse answers. They are also recommended to interview different grade levels to further understand how the study habits vary from grade levels.

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The Perceptions of Incoming College Students from One of the Universities of the South on the Use of Biomimicry as a Method in the Field of Engineering

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Abstract: Biomimicry is a growing concept in science. Technologies that are developed nowadays are influenced by thorough studies on the structure and function of plants and animals. To bring innovative ideas that came from nature's own adaptation and apply this to the principles of engineering, the study aimed to gauge and understand the level of perception of incoming Engineering students towards the process and engineering of biomimetics technologies. It determined the level of knowledge of the respondents with regards to the utilization of biomimicry in the modern setting. The researchers used a descriptive quantitative survey research design to measure the awareness or perception of the respondents. The researchers also made use of a researcher-made questionnaire for the collection of data and applied the 4-point Likert scale. The respondents of this study are the Grade 12 STEM students of the University of Perpetual Help System DALTA. The study utilized the statistical tools of frequency, percentage, and weighted mean in interpreting the perception of the respondents. The results of the study showed that majority of the respondents are aware to more famous inventions/concepts inspired by biomimicry such as the Bullet Train and photosynthetic ability of plants. After analyzing the results, the researchers conclude that the respondents are aware of the modern the designs and concepts of biomimicry making way for professionals to apply biomimicry in the future. In addition, the results of this study provided the researchers insights for future reference and engineering designs.

Key Words: biomimetics, biomimicry, engineering methodology, perceptions, sustainability

1. INTRODUCTION

Biomimicry is the term to describe the design process of Biomimetics, the study that deals with observing and examining the functions of living organisms as models for creating products and inventions to benefit human society. The term 'biomimetics' was coined by Dr.-Otto Herbert-Schmitt, an American biophysicist, in 1957 after developing a device that mimicked the electrical reactions of human nerves. The field is focused on understanding and application of biological functions of living organisms to be used with engineering to develop commercial devices (Bhushan, 2009). Biomimetics comes from the Latin words: *bios,* meaning "life," and *mimesis* meaning "to imitate" (2020). Biomimetics is similar to Bionics, (Muderis & Ridgewell, 2016). Glaser et al., (2013) illustrates that biomimicry is not the literal replicating of these functions as there are limitations and consequences, rather it is a process of selective learning

Benyus (1997) popularized the term "biomimicry" with her book, "*Biomimicry: Innovation Inspired by Nature*". Benyus discussed nature as

having three importance to the method of biomimicry, these being: (1) Nature as a Model; (2) a Measure; and (3) a Mentor.

These signify the inspiration of man to replicate nature's biological processes and incorporate it to society. Biomimicry is seen in the world of architecture and engineering as it functions as a methodology in the field when creating infrastructures to suit society's needs. One example is the Japanese Bullet Train in 1964. The bullet train took inspiration from the kingfisher's pointed narrow beak which allows it to gracefully dive into the water without much disruption. The bullet trains achieved this structure through creating a smoother and "pointed" design for its front to reduce the sonic boom it causes when going through tunnels. A historical instance were the sketches created by Italian polymath, Leonardo da Vinci. His sketches of the Ornithopter took innovation from the flapping motion of a bird's wings which allowed them to lift from the ground with their hollow skeletal structures.

Sustainable usages of biomimicry were adapted to counteract the adverse effects of the industrial age. The use of the humpback whales'

tubercles reduces stall caused by underwater movement to increase speed when travelling through fluids. When employed in wind turbines, the same effect is found. A study conducted by Fish et al. (2011) explored the usage of tubercles in wind turbines and found the use of tubercle-lead blades produced higher performance in generating electricity while maintaining stability as opposed to smooth-lead blades.

There is Philippines has less utilization of biomimetics, causing a need for sustainability. Romolo Nati, CEO of Italpinas, pointed out that there is a great imbalance in the use of resources as many have the misconception that natural resources are infinite and continue to abuse these (2014). Similarly, Nati (2013) emphasized the need to switch to an eco-friendlier method of infrastructure by applying biomimetics methods. Stating that cities occupy 2% of landmass, but produce 70% of green-gas-emissions, he asserted that there is need to have a sustainable solution by employing sustainable development tools through biomimicry and performance-based strategies.

This study aimed to know the perceptions of incoming engineering students towards biomimicry. The study sought to determine the knowledge regarding biomimicry in products for improvement in a person's lifestyle through use of a survey questionnaire to obtain fixed responses from the respondents.

The study determined the perceptions of incoming Engineering students on the use of biomimicry as a methodology. Specifically, the study obtained the following details through the questions: First, the respondents' profile: age, sex, and previous academic performance. Second, the respondents' level of perception to biomimicry designs as to structure and biological function of plants and animals. Third, the level of perception of respondents as to the inventions using biomimetics. Lastly, insights to be drawn by the researchers from the results.

2. METHODOLOGY

2.1. Data Gathering Tool

The study made use of the research-made questionnaire for data-gathering. The research questionnaire was floated to the respondents, Grade 12 STEM Students, who will be taking engineering courses, through an online setting.

The researcher-made questionnaire was in two parts. The first part presented the profile data of the respondents, their age, sex, and previous academic performance. The second part of the questionnaire determined the perception of respondents as to biomimicry designs.

It determined the level of perception of the respondents to the structure and biological function of plants and animals and inventions that used biomimicry designs.

Table 1. Interpretation Scale

Scale	Limits	Verbal Interpretation	Word Description
4	3.50-4.00	Strongly Aware	The respondents are fully aware and are familiar on the use of Biomimicry as a methodology in the field of engineering as well as the functionality it has on everyday technology
3	2.50-3.49	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
2	1.50-2.49	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
1	1.00-1.49	Strongly Unaware	The respondents have no knowledge or have only known of biomimicry as a method in the field of engineering

Table 1, shows the interpretation scale. It used a statistical trait using Microsoft Excel-generated interval of 3.5-4, which has the highest scale of 4, and has a verbal interpretation of "Strongly Aware". Followed is the interval of 2.5–3.49, with a rating scale of 3, and a verbal interpretation of "aware". The statistical trait of 1.5-2.49, follows with an equivalent scale rate of 2, and a verbal interpretation of "Unaware". Last is the statistical trait of 1–1.49, with the lowest scale of 1, and a verbal interpretation of "strongly unaware".

2.2. Population and Sampling Design

The study solicited data from Grade 12 students enrolled in the STEM strand focused in the engineering course of the University. There are nine (9) sections comprising the STEM strand composed of forty (40) students each. Five (5) of those sections are composed of students who will be taking Engineering programs. Four (4) of these sections were the sources of the respondents.

Purposive sampling was utilized as it was deemed appropriate by the researchers to have respondents who may be familiar with a topic of biomimetics in engineering. Purposive sampling is a non-probability method of gathering a sample which, according to Black, K. (2010), occurs when "*elements selected for the sample are chosen by the judgment of the researchers*". The selection of respondents is based on their knowledge and expertise towards a certain topic, or concept (Robina, 2014). This form of sampling is accomplished through logical assumptions and expert knowledge of a given population, elements are selected nonrandomly from the population (Lavrakas, 2008).

For the population, the study utilized selected Grade 12 students from the University of Perpetual Help System-DALTA, Las Piñas Campus currently in the STEM strand focused on engineering. It included respondents who were willing to participate in the study.

2.3. Data Gathering Procedure

The study utilized a descriptive quantitative design, the Descriptive Survey research design. A descriptive quantitative research measures the subjects in question and finds the association between the chosen independent and dependent variables (Hopkins, 2000). This is due to the study gathering data from the perceptions of respondents towards biomimicry as a methodology in engineering. Creswell (2003) states that quantitative research design "*employs strategies of inquiry such as experiments and surveys, and collect data on predetermined instruments that yield statistics data*".

The Descriptive Research design is used when researchers' goal is to measure the behavior and characteristics of a sample (Dudovskiy, 2011). This research design answers what, where, when, and how (McCombes, 2020) through observation and descriptive analysis with instruments such as surveys (Koh & Owen, 2000).

Uses of descriptive-surveys are to find the "*range and distribution*" of the demographic or psychographics of individuals to see if there is any relation of it to behavior patterns and/or attitudes (Zurmuehlen, 1981). The Descriptive Survey Research design was utilized in the study to investigate the awareness of the respondents towards biomimicry as an engineering methodology.

The first phase was the formulation and validation of research made questionnaire. The researchers formulated the research questionnaire and have it verified through experts. Second, writing a letter to the administrators of the Senior High School Department to ask for permission and approval to conduct a study. Lastly, distribution of the questionnaire, wherein the researchers sought the consent of the respondents before distributing the questionnaire. The respondents were given one week to answer the distributed questionnaire. The researchers collected the questionnaire and interpreted the data through 4-point Likert scale.

2.4. Data Analysis Plan

The researchers analyzed and interpreted the data after collation. In analyzing the data, the researchers used statistical treatment. They used statistical tools of percentage, frequency and weighted mean. After getting the weighted mean, the researchers analyzed the data based on the Likert scale formulated by the researchers. The last part was the interpretation of the data.

3. RESULTS AND DISCUSSION

Table 2. Profile of respondents as to Age

Corresponding Age	Frequency (f)	Percentage (%)
17	21	20.6
18	**67**	**65.7**
19	11	10.8
20 and above	3	2.9
Total	102	100

From Table 2, it could be gleaned that majority of the respondents, sixty-seven (67) or sixty-five and seven tenths (65.7 %) are aged eighteen (18).

It can be said that most of the respondents falls on the age of eighteen as this is the typical age of Filipinos who are enrolled in the grade 12 program.

Table 3. Profile of respondents as to Sex

Sex	Frequency (f)	Percentage (%)
Male	**63**	**61.8**
Female	39	38.2
Total	102	100

From Table 3 it can be derived that more than half of the respondents' sex is male with a frequency of sixty-three (63) or a percentage of sixty-one and eight tenths (61.8 %).

This is due to the preference of male students to enroll in engineering programs. As the chosen locale of the study is in the engineering STEM strand, this has been the case.

Table 4. Profile of respondents as to Previous Academic Performance

Grade	Frequency (f)	Percentage (%)
93-95	20	20
90-92	29	28
87-89	**31**	**30**
84-86	15	15
81-83	6	6
75-77	**1**	**1**
Total	102	100

From Table 4, it can be extracted that majority of the respondents, thirty-one (31) respondents, a percentage of thirty (30%), have their previous academic performance to be in the range of 87-89.

It is inferred that majority of the respondents have above average academic performance in the sciences and mathematics.

Table 5.
Perception of respondents as to biomimicry designs as to structure of plants and animals.

Indicator	Weighted mean	Verbal interpretation	Word Description
1. I am aware that the improved blades of wind turbines are based on the fin structure of humpback whales	2.37	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
2. I am aware that the modern Japanese bullet train's front nose design to the beak of a Kingfisher bird.	**2.64**	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
3. I am aware that a commercial building in Melbourne, Australia, Council House 2, utilizes design strategies of termite mounds for natural cooling	2.36	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
4. I am aware that inspiration for Velcro were burdock burrs hooked-spikes that are able to latch onto objects	**2.30**	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
5. I am aware that the spandex swim suits are inspired on the hydrophobic nature of shark skins.	2.62	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
Average	2.46	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.

Table 5 presented the perception of respondents as to biomimicry designs on the structure of plants and animals. Indicator 2 has the highest weighted mean of two and sixty-four hundredths (2.64) with a verbal interpretation of "Aware". While Indicator 4 has the lowest weighted mean of two and three tenths (2.3) with a verbal interpretation of "unaware". Results of table 5 show the respondents' weighted average is two and forty-six hundredths (2.46) with a verbal interpretation of "Unaware".

Table 5.1.
Perception of respondents as to biomimicry designs as to biological function of plants and animals

Indicator	Weighted mean	Verbal interpretation	Word Description
1. I am aware that the solar cells were inspired by the process of photosynthesis by the leaves.	**3.29**	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
2. I am aware that the bird wing inspired aircraft to aid in aerodynamics.	3.19	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
3. I am aware that the biological function and structure of a firefly's bulb is the inspiration for the efficiency found in LED Light Bulbs	2.79	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
4. I am aware that tubercle-lead blades produced higher performance in generating electricity for wind turbines	**2.62**	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
5. I am aware that the flapping motion of birds to gather lift is inspiration for how helicopters increase lift	2.74	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
Average	2.93	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.

Table 5.1 presented the perception of the respondents towards biomimicry designs as to the biological function of plants and animals. Indicator 1 having the highest weighted mean of three and twenty-nine hundredths (3.29) with a verbal interpretation of "Aware". While

Indicator 4 has the lowest weighted mean of two and sixty-two hundredths (2.62) with a verbal interpretation of "Aware". Results of table 2.3 show the respondents' weighted average of two and ninety-three hundredths (2.93) with a verbal interpretation of "Aware".

Table 6. *Perception of respondents as to inventions using biomimicry designs*

Indicator	Weighted mean	Verbal interpretation	Word Description
1. I am aware that the Japanese bullet train's front nose is based on the narrow beak of the kingfisher bird to maximize speed and lessen noise pollution.	2.73	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
2. I am aware that the solar cells are based on the photosynthetic ability of plants in producing energy from light-energy sources	**3.08**	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
3. I am aware that the second council house in Melbourne, Australia was based on termite mounds for temperature regulation	**2.25**	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
4. I am aware that the improvement of structure in wind turbines increases efficiency in generating electricity	2.88	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.
5. I am aware that the American B2 Spirit Bomber was based on the ability of hawks to maintain aerodynamic speed and mobility through having a packed body.	2.3	Unaware	The respondents have little knowledge on the use of biomimicry as a method in the field of engineering.
Average	2.66	Aware	The respondents are aware and are somewhat familiar with the use of biomimicry as a method in engineering and its use on some devices.

As seen on Table 6, Indicator 2 has the highest weighted mean of three and eight hundredths (3.08) with a verbal interpretation of "Aware". While Indicator 3 has the lowest weighted mean of two and twenty-five hundredths (2.25) with a verbal interpretation of "unaware". Results of table 6, the respondent's weighted average is two and sixty-six hundredths (2.66) with a verbal interpretation of "Aware".

4. INSIGHTS DRAWN BY THE RESEARCHERS

According to the data, the respondents of the study were most aware of the designs inspired by the biological functions of nature. This may be due to the curriculum of the respondents surveyed, as students who took science classes with biological concepts. Results show that the students were more aware of the design, function, and inspiration which created

the Bullet Train and Council House 2 from Melbourne, Australia.

The biomimetic technologies with the highest weighted mean are what the respondents are most aware of due to the commonality of these inventions in their life to counteract effects of industrial-based technologies.

Likewise, the researchers are able to gauge the level of perception the respondents have regarding the topic of Biomimicry. The results gave insights towards the things that should be implemented to suffice the lack of knowledge that is essential in pursuing engineering. It signifies the pursuit of the implementation of biomimetics research in the future engineering programs the researchers will be enrolling in. Some of these inventions are not widely used in modern homes. Factors to consider are previous academic experiences regarding the topics such as photosynthesis and aerodynamics.

4.1. Summary of the Findings

Majority of the respondents of the study are within the age range of 17 to 18 years of age. Most of them are males and their previous academic performance, above average. As to perception to the structure of biomimicry inventions, majority of the respondents are aware that the Bullet Train was inspired by the kingfisher bird, which has the highest weighted mean. As to the biological function as to plants and animals, majority of the respondents are aware that the photosynthetic ability of leaves became the inspiration in the creation of solar cells. As to the perception as to inventions using biomimicry designs, majority of the respondents are aware of solar cells inspired from the photosynthetic ability of plants to create energy from solar-light. The researchers were able to come up with the insights based on the results of the study. These insights include the importance on the use of biomimicry design and how it will play in pursuing future careers.

4.2. Conclusions of the Study

Based on the findings of the study, the following conclusions are drawn:

Most of the respondents are within the age range of 17 – 18 years of age. Majority who are taking Engineering focus stem strand are males and have grades of above average and excelled in the fields of Science and Mathematics. Most of the respondents are aware on the existence of the bullet train and solar cells. Since these technologies are well-marketed and being used for convenience in transportation and electricity-generation. Majority of the respondents are aware of photosynthesis being the inspiration for the invention of solar cells to generate electricity from the

sun's solar-light. From the increase of efficient and sustainable power-generating from the use of solar cells, most of the respondents are familiar of the existence of these technologies. The researchers adhere to the conclusion that most of the respondents are aware that some modern technologies are products of biomimicry design and concept. These insights gleaned by the researchers from the study provide a wider perspective in designing future technologies by studying the structure and function of plants and animals. Furthermore, through the data gathered, these inspired the researchers to make more in-depth studies about biomimicry.

4.3. Recommendations

Based on the findings and conclusions drawn from the study, the following recommendations are hereby made:

There should be a follow-up study on biomimetics for efficiency in household chores. Future studies must involve a larger range of respondents of a specific engineering field that may utilize biomimetics in the future. The Department of Science and Technology (DOST) must allocate funding for researches for biomimicry designs. Likewise, the Commission-on-Higher Education (CHED) and Department of Education (DepEd) must include in the STEM and Engineering curriculum the designing of technologies using biomimetics. Engineering companies should invest on biomimetics research, through the study of the structure and biological function of organisms to mitigate pollutants produced by modern machinery. Engineering schools may consider in creating or drafting a curriculum prioritizing technologies that follow biomimicry designs that would be sustainable. The study made use of respondents from the engineering-focused field of the STEM Strand. Future studies may include biology-based fields in order to increase depth of the study on the perception of respondents towards biomimetics.

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Aspects Contributing to the Underemployment of the Top 3 Fields of Engineering in Las Piñas City, and Muntinlupa City

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Abstract: Up to this day, underemployment continuously becomes a significant contributor to poverty, and it happen to any other industry, including the engineering industry. As an attempt to contribute to the body of knowledge regarding underemployment, this study investigated the leading causes of underemployment in engineers at Las Piñas City and Muntinlupa City. The study used an online survey questionnaire with non-probability sampling to collect the necessary data from various licensed engineers. Descriptive statistics was the data analysis method of the study. The results indicate that the leading causes of underemployment in different engineering fields are lack of experience, limited job opportunities, many competitions, and the substandard education system. Mechanical Engineering, Electronics Engineering, and Electrical Engineering are
the top three engineering fields that often experience underemployment. The study concluded that experience is highly needed to attain employment in the engineering industry.

Key Words: underemployment; engineering fields; Las Piñas city; Muntinlupa city; college programs

1. INTRODUCTION

The Field of Engineering has been a respected industry since the 1500s. It is one of the significant components of the civilization of the human race. However, despite engineering being vital to the continuity of civilization and the tremendous number of people who choose to take engineering as their college program, the engineering industry still suffers from underemployment, just as engineers are underemployed. it still experiences underemployment just like other career fields. According to Chen (2020), underemployment is *"a measure of employment and labor utilization in the economy that looks at how well the labor force is being utilized in terms of skills, experience, and availability to work."*

There are two types of underemployment, namely: visible underemployment and invisible underemployment. Amadeo (2020) states that visible underemployment includes employees who are working fewer hours than is typical in their field. They are usually the ones who work part-time jobs. On the other hand, invisible underemployment includes workers in full-time jobs that do not use all their skills (Amadeo, 2020).

In the United States, the U.S. Bureau of Labor Statistics (BLS) prepares employment growth for 18 engineering occupations in the year 2016-2026, with Civil Engineering being the largest engineering occupation, followed by Mechanical Engineering and Industrial Engineering. Likewise, the engineering industry is thriving in Australia. The 2018 Graduate Outcomes Survey (GOS) report stated that engineering graduates have above-average employment outcomes, with a full-time employment rate of 83.1% in 2018. In addition to this, 71.9% are categorized as "professionals." According to the survey, civil engineers had the highest chances of having full- time employment with a percentage of 88.2%, followed by Electrical, and Electronics Engineers (85.5%). Despite these enticing figures, it is still uncertain whether an individual will fall under the desirable 83.1% or the remaining 16.9%. Brown (2019) stated that it is also not a guarantee that an engineering degree means an engineering-related job.

This research study principally focused on the aspects contributing to the underemployment of different engineering fields in Las Piñas and Muntinlupa City. Specifically, the researchers hope to address the main causes of underemployment of engineers in the Las Piñas and Muntinlupa City and the reasons resulting from these causes, as well as the engineering branches that often experience underemployment. Students, engineering students, government and engineering sectors, and future researchers may benefit from this study.

2. METHODOLOGY

2.1. Data Gathering Tool

According to Bhat (2020), "*survey is a research method used for collecting data from a predefined group of respondents to gain information and insights into various topics of interest.*" The researchers used an online survey questionnaire to collect the data. The survey was divided into three parts namely: the respondent's profile, semi-structured questionnaire, and a -point Likert scale. This questionnaire was distributed through Google Forms to different licensed engineers, who are the principal respondents of the study.

The researchers also used a Likert scale with given criteria of 4 strongly agreeing, 3 agreeing, 2 being disagreed, and 1 strongly disagreeing. Using the data collection tools, the researchers conducted their research using semi-structured questionnaires.

Before commencing the actual data collection, the researchers conducted a pilot testing where the mock respondents were students of Grade 12 STEM (engineering sections). The researchers conducted pilot testing to detect major and/or minor errors that may have been overlooked by the researchers. The researchers evaluated the time it took for a mock respondent to answer the whole survey, the data collection method, survey strategy, and the general aspects of the survey to further improve it.

2.2. Sampling Design

Purposive sampling and Snowball sampling were the chosen sampling designs for this study. Purposive sampling is believed to be the most suitable sampling design for this study, as the attributes that the researchers were looking for from the respondents were very specific. Through this, the researchers handpicked the participants who fit the specified criteria, that being: (1) a Filipino citizen of any age and gender, (2) a graduate of any engineering degree in the Philippines, (3) an engineering graduate that is residing and/or working in Las Piñas City or Muntinlupa City, and (4) a licensed engineer. After utilizing the Purposive Sampling, the participants referred to other people, who also fit with the given criteria, and were invited to be respondents of the study (Snowball Sampling).

2.3. Data Gathering Procedure

The researchers underwent three stages of data gathering procedure. The first stage is the preparation of the survey questionnaire, as well as the arrangement of proper credentials (i.e., acquisition of consent). The second stage is the distribution of the survey questionnaire to the respondents, and the last one is the collection and interpretation of the gathered data. Each stage entails different processes to fulfill the data gathering procedure.

2.4. Data Analysis Plan

The researchers used descriptive statistics as their data analysis method to analyze and provide the results in the survey data. The percentage and weighted mean were presented using pie charts to present the data under research questions 1 and 2, while bar chart for research sub- question a.

Formula of Percentage

$\% = f/N \times 100$

$\%$ = Percent

f = Frequency

N = Total number of respondents

FORMULA OF WEIGHTED MEAN

$$\bar{X} = \frac{\sum_{i=1}^{n} Wi \cdot Xi}{\sum_{i=1}^{n} Wi} = \frac{W_1 X_1 + W_2 X_2 + \cdots + W_n X_n}{W_1 + W_2 + \cdots + W_n}$$

Where $\bar{x}$ = Weighted Mean

w = weight

x = frequency

The formula of percentage was used to analyze the collected data under research question number 1 and 2, while the formula of the weighted mean was used to interpret the degree of agreement or disagreement of a respondent, used under research sub-question a.

3. RESULTS AND DISCUSSION

3.1. Leading causes of underemployment of engineers in Las Piñas City and Muntinlupa City

With the set of data collected, the results have shown that the leading cause of underemployment of engineers in Las Piñas City and Muntinlupa City is lack of experience, with a

percentage of 40%. Followed by limited job opportunities, many competitions, and a substandard education system. This indicates that experience is the utmost priority in the engineering industry. Meaning more experience, more chances of being employed.

Figure 1. Leading Causes of Underemployment of Engineers in Las Piñas City and Muntinlupa City
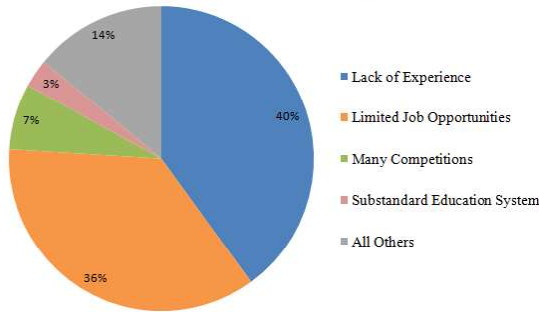
Table 1. Gender as a Factor of Underemployment (n = 65)

Response	Gender		
	Male	Female	Prefer not to say
Yes	19	3	1
No	34	8	0
Total	53	11	1

Table 1 shows the number of respondents who confirmed that they have experienced underemployment. Out of 65 respondents, 23 of them experienced underemployment—19 males, 3 females, and 1 who preferred not to say their gender. The engineering industry seems to be perceived as a male-dominated field; such notion can be also observed from the number of female respondents of the study. Despite this, the percentages of those who experienced underemployment per gender oppose that the engineering industry is more favorable to the male gender. The rate of female underemployment was juxtaposed with the percentage of male underemployment and as a result, male underemployment is higher, with a percentage of 35.48%, than the rate of female underemployment, which is 27.27%.

Table 2. Age as a Factor of Underemployment

Field of Engineering	Age (in years)					Total Column
	21-30	31-40	41-50	51-60	61-70	
Mechanical	6	1	1	1	1	10
Electronics	4	1	0	0	0	5
Electrical	0	1	1	1	0	3
Civil	2	0	0	0	0	2
Computer	2	0	0	0	0	2
Materials	1	0	0	0	0	1
Total Row	15	3	2	2	1	23

As shown in Table 2, most of the engineers who are under the age bracket of 21-30 years old confirmed that they have experienced underemployment. This age bracket is most likely to be prone to underemployment as most of them are fresh graduates who, more often than not, lack work experience. Some on the other hand are not qualified for the job description needed by companies. These results show that engineers from ages 31 and above do not often experience underemployment and have stable jobs in their respective fields.

Some respondents have also specified other reasons for underemployment. Prominent responses included, "*few engineering positions required in the industry*", "*lack of specialization offering*", "*cyclic condition of oil and gas industry which impacts the requirement of manpower in hire and release*", and "*low paying companies that results to low salary.*"

3.1.1. Reasons resulting from these causes

Figure 2. Weighted Means of the Data for Sub-Question A
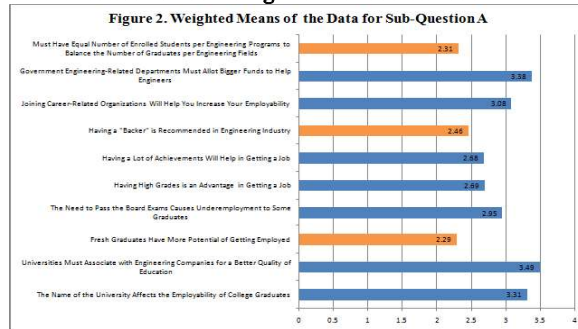
The respondents were also asked to scale their agreeance in a statement in which each statement is also linked and aligned to the reasons that result in the aforementioned causes of underemployment. Figure 2 from the previous page shows the weighted means of their responses.

3.1.1.1. Reasons that result to lack of experience

Table 3. Having an Engineer Relative is Beneficial to an Engineering Graduate's Career (n = 65)

Response	Frequency	Percentage (%)
Yes	40	61.5
No	25	38.5
Total	65	100

The respondents were asked if they think that having an engineer relative will help them get a job related to their field of engineering easier. Table 3 shows that 61.5% of the respondents answered yes which therefore implies that it is beneficial to have an engineer relative. But because not everyone has the same advantage as those who have an engineer relative, this same reason results in a lack of experience.

On the other hand, the majority of the respondents disagreed that having a "backer" is recommended when planning to pursue any field in engineering, as seen in Figure 2. This implies that an engineering graduate does not necessarily need connections to thrive in the engineering industry.

3.1.1.2. Reasons that result in limited job opportunities

The results in Figure 2 show that the respondents agree that government engineering-related departments must allot bigger funds to help struggling engineers. This includes higher paygrade, more job opportunities in the country, and such. Respondents also agree that the need to pass the board exams can be a cause of underemployment as some fail to pass the board examinations. It can also be perceived from Figure 2 that experienced engineers are more likely to get employed rather than fresh engineering graduates. This limits the opportunity of fresh engineering graduates to gain and build experience, which eventually leads to a lack of experience.

3.1.1.3. Reasons that result in competition

As shown in Figure 2, the respondents agree that the name of the university affects the employability of engineering college graduates. This gives more advantage to those who graduated from prestigious and excelling engineering universities. The respondents also agree that having high grades and a lot of achievements will increase the employability of an engineer, as well as joining career-related organizations. These results all lead to having many competitions.

3.1.1.4. Reasons that result in a substandard education system

According to the results also shown in Figure 2, engineer respondents agree that universities must associate with engineering companies for a better quality of education. However, the respondents disagree in restricting each engineering college program to also have a balanced number of students to also have an equal number of graduates per college program. This indicates that engineering students must already have firsthand experience and knowledge from experienced engineers while they are still in college.

Along the process of the data collection, it has also come to the researchers' attention that only a few universities here in the Philippines have undergraduate engineering programs that are ABET-accredited—and to name one of these few and fortunate universities is the De La Salle University-Manila. According to ABET's website, *"ABET accreditation assures confidence that a collegiate program has met standards essential to prepare graduates to enter critical STEM fields in the global workforce."* This could be a wake-up call to universities around the Philippines that are not doing the bare minimum to assure that engineering programs here in the country are leveled as those of other foreign countries. Graduating from an ABET-accredited program could make a significant impact on an engineering graduate's career.

3.2. Top three fields of Engineering that often experience underemployment

Figure 3. Top Three Engineering Fields that often Experience Underemployment in Las Piñas City and Muntinlupa City
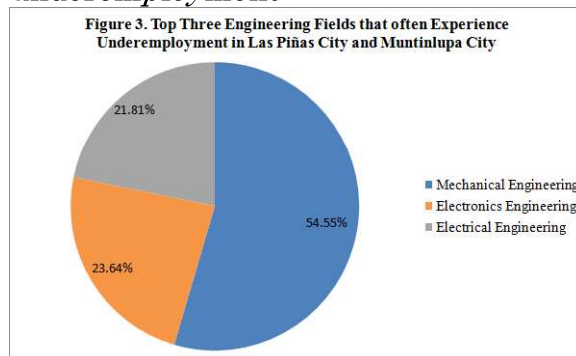
The results have shown, as seen in Figure 3, that the top three engineering fields that often experience underemployment are as follows: Mechanical engineering, Electronics Engineering, and Electrical Engineering. This data is derived from the (1) college degree of the respondents, which is indicated in their profile, and if they have experienced underemployment in that field of engineering, and (2) the respondent's knowledge of which field of engineering mostly experiences

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underemployment. The researchers combined both data and constructed a unified interpretation.

4. CONCLUSIONS

Underemployment continuously happens around the world, most especially in the Philippines, regardless of the industry an individual is in. But just like any other discoveries made by many individuals, a once unsolvable problem is now susceptible to a solution.

The main cause of underemployment in Las Piñas City and Muntinlupa City is lack of experience. Followed by limited job opportunities, many competitions, and a substandard education system. The results from the Likert scale that the researchers used are also considered as driving factors of the main causes of underemployment. It has been discovered from the results that the name of the university affects the employability of engineering graduates, even the grades and achievements an engineering graduate attained during their student years. Fresh engineering graduates must also be more proactive since experienced engineers are more likely to be employed in the engineering industry.

The researchers have discovered that the top three engineering fields that often experience underemployment in Las Piñas City, and Muntinlupa City are: Mechanical Engineering, Electronics Engineering, and Electrical Engineering. It is recommended that engineering-related departments and agencies of the government must put more attention to these fields, as well as strategize on possible ways that can help struggling engineers of these fields, like collaborated projects, incentive awards, perks, benefits, and such to also avoid brain drain.

It is thereby concluded that experience is one of the vital weapons an engineer can and must-have in the engineering industry. It is suggested that universities and engineering firms and associations must work together to provide basic experience to engineering students. External help from the engineering departments of the government would also be beneficial in lessening underemployment in the country. Universities are also recommended to have ABET-accredited engineering programs. Employers are also recommended to set more realistic job qualifications and expectations for entry-level applicants.

Derived results are also similar to what the researchers have provided as choices in the survey questionnaires. Some respondents might have settled for what was provided rather than share from experience. For further research, a few modifications and improvements can still be made such as more items in the survey questionnaires, wider research locale, and a bigger number of respondents to also obtain more diverse responses.

5. ACKNOWLEDGMENTS

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The Benefits of Taking Math and Science Enrichment to the STEM Strand in Senior High School

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Abstract: This study was about the benefits of Junior High School Math and Science (AGHAMON) Enrichment in the Senior High School STEM (Science, Technology, Engineering, and Mathematics) Strand. This was conducted to determine the advantages of Junior High School Enrichment Programs in relation to the student development and behavior in the STEM Strand of Senior High School. The development of students was measured by percentage on personal response to different situations encountered in Senior High School with the guidance of previous courses taken in Junior High School. This was done through the measurement of Google Forms.

This study showed that the effects of Math Enrichment and AGHAMON has no significant benefits on the experience of students taking the STEM Strand in Grades 11 and 12. From the transition from Junior High School to Senior High School, the Math and Science Enrichment programs provided the students with background knowledge in preparation to the concepts discussed in Senior High School, though there was a given difference in the level of difficulty in new topics introduced in the STEM curriculum. However, the students were still able to apply and relate what they had previously learned to the intermediate subjects of the strand and obtain an open mindset to the willingness to learn and collaborate in a new working environment.

Key Words: Science; Mathematics; Curriculum; Learning; Enrichment

1. INTRODUCTION

1.1. Rationale

The Republic Act 10533 and the Enhanced Basic Education Act of 2013 introduced the K-12 Program in the Philippines. The STEM curriculum has been integrated into the Philippine educational system as one of the academic tracks available for students to follow in Senior High School. To meet the specific skills one would need in the desired career, the Department of Education developed a program consisting of science and mathematics-oriented courses. This includes the subjects of Pre-Calculus, Basic Calculus, General Biology 1 and 2, General Physics 1 and 2, and General Chemistry 1 and 2 (Department of Education, n.d.). Furthermore, these subjects practice the adeptness of students in research and analysis.

Assumption College Makati City has implemented the Science (AGHAMON) and Math Enrichment programs to help the students improve their skills both mathematically and scientifically. In the Philippines, this is known as "gifted education", which allows academically gifted students to develop their needed skills. Though deemed as a privilege given the high cost to implement the program in some schools, providing exemplary students with advanced education is their right (Pawilen & Manuel, 2018). To make STEM Education more accessible in the country, the government has ensured to place different initiatives in line with the students' academic needs. First, the government has implemented acceleration programs, enrichment activities, advanced classes, and the like to strengthen STEM knowledge (Pawilen, 2018).

However, the gifted students who are invited to partake in the Math and Science Enrichment Programs in Assumption College are not much knowledgeable on the specific benefits this may contribute to their learning skills and attitudes in Senior High. Therefore, the researchers conducted a research on the advantage of taking Junior High School Science and Math Enrichment Classes in preparation for Senior High.

1.2. Statement of the Problem

This study evaluated the advantage of taking Science and Math Enrichment in Junior High School to their learning experience in taking the STEM strand.

1. To what extent can taking Science and Math Enrichment be an advantage in taking the STEM strand?

2. Do Enrichment Programs have a significant effect on one's learning process in Senior High School?

3. What are the curriculum-based skills that students have developed from taking Junior High Enrichment Programs toward Senior High STEM-related subjects?

1.3. Hypothesis

Taking AGHAMON and Math Enrichment Programs in Junior High School do not have a significant effect on one's learning process in Senior High School.

2. METHODOLOGY

2.1. Research Design

The study held a descriptive research design as it includes the evaluation of the benefits of students in the STEM strand from formerly attending Science and Math Enrichment programs.

2.2. Sample and Sampling

The researchers used the technique of stratified random sampling in selecting the respondents of the study. The researchers were able to proportionally select samples from different groups for the study, attaining a variety in the representation of the population. The respondents selected for this study were the Grade 11 and 12 students of Assumption College Senior High School. This was limited to seventeen (17) students of the STEM strand, following the criteria of formerly attending both AGHAMON and Math Enrichment programs in Junior High.

2.3. Research Instrument

The researchers created their own research tool. This was a survey conducted through Google Forms. This was administered to have a survey regarding how the Math and Science Enrichment programs had helped the students in their learning environment in Senior High School (SHS). This was able to determine the extent of the advantages brought about by the Enrichment classes offered by Assumption College.

The survey was a twenty-four (24) item set questionnaire. In addition, the set made use of the Likert scale and multiple choice questions. It is divided into six main parts, which are as follows:

1. Experiences in Math Enrichment
2. Experiences in Science Enrichment
3. Learning & Adaptive Skills from Math and Science Enrichment
4. Curriculum-based Skills from Math and Science Enrichment

5. The General Benefits gained from the programs
6. The Effectiveness of the Programs to the Learning Environment and Behavior in Senior High School.

All by which pertained to the ability of the researchers to measure the benefits the students were able to gain from participating in the enrichment programs, and to determine the curriculum-based enrichment skills that the students were able to develop from Junior High School (JHS) as they transition towards Senior High STEM-related subjects.

2.4. Data Gathering Procedures

Preparation of the Research Instrument/Adapted Survey Questionnaire

The researchers made their own survey instrument about the benefits and advantages brought about by the JHS Science and Math Enrichment Programs to the learning process, learning environment, and the perceived advantages of retaining curriculum-based skills in SHS. After that, the researchers wrote a consent letter to the selected Grade 11 and 12 students. This was signed and noted by the Research Adviser.

Administration of the test to the respondents

The researchers administered the created survey to seventeen (17) students from both Grade 11 and Grade 12 through an online Google Forms survey. The outcome was gathered by the researchers. The data was interpreted and evaluated, and then the results were analyzed by the researchers.

2.6. Data Analysis

The researchers used the statistical treatment of descriptive statistics for the study. This was used to analyze the perception of students among the Grade 11 and 12 STEM strand based on their experiences from AGHAMON and Math Enrichment classes, adapted skills, and learning environment and behavior. Moreover, the researchers used this to evaluate the benefits of the enriched programs from the JHS setting to the SHS setting.
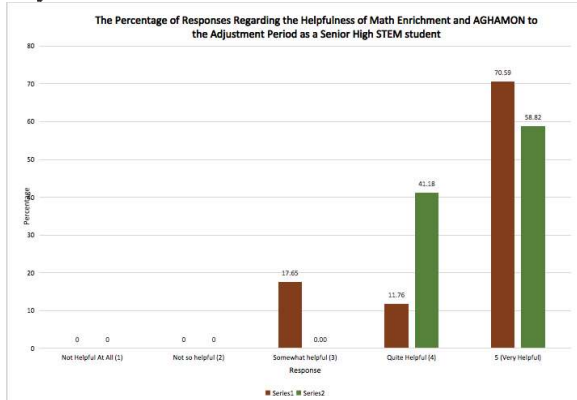
3. RESULTS AND DISCUSSIONS

Problem 1

To what extent can taking Science and Math Enrichment be an advantage in taking the STEM strand?

Adjustment Period

Fig. 1.1 The Percentage of Responses Regarding the Helpfulness of Math Enrichment and AGHAMON to the Adjustment Period as a STEM student

Figure 1.1 showed the usefulness of both Math and AGHAMON to the students' adjustment period for Senior High School based on their answers on Question 4 and 8 of the survey. With this, one can infer that Math Enrichment and AGHAMON greatly benefitted the students in their transition periods, posing as a great advantage in taking the STEM strand.

	QUESTION 4	QUESTION 8
Mean	3.4	3.4
Variance	24.8	22.8
Observations	5	5
Hypothesized Mean Dif	0	
df	8	
t Stat	0	
P(T<=t) one-tail	0.5	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	1	
t Critical two-tail	2.306004135	

Fig. 1.2 Question 4 and 8 under Research Question 1 presented through a Likert Scale regarding the Level of Helpfulness from 1 (Not helpful at all) to 5 (Very Helpful)

The researchers made use of the mean to compare two separate variables: Math Enrichment and Science Enrichment to one specific factor, which is the advantage towards the transition period in Senior High. The researchers wanted to see if there is a difference in the usefulness of Math and Science Enrichment to the transition period in SHS. Furthermore, the data above show that the mean of number 4 and number 8 are equal, with the value of 3.4. With the mean values showing no difference, the researchers can conclude that the enrichment programs are equally useful to the transition to SHS.
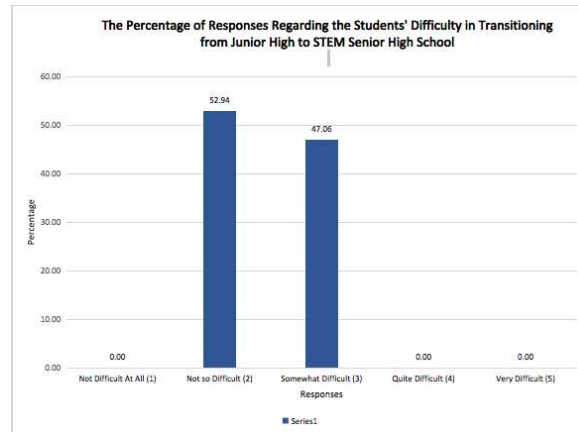

Fig. 2.1 Students' Difficulty in Transitioning from Junior High School to STEM Senior High School

Figure 2.1 shows the percentage of difficulty in transitioning from Junior High school to STEM in Senior High school. Given choice 2 and choice 3, it can be said that students have experienced some manageable difficulties in their transition as STEM students in Senior High school.

Problem 2

Do Enrichment Programs have a significant effect on one's learning process in Senior High School?

Learning Process
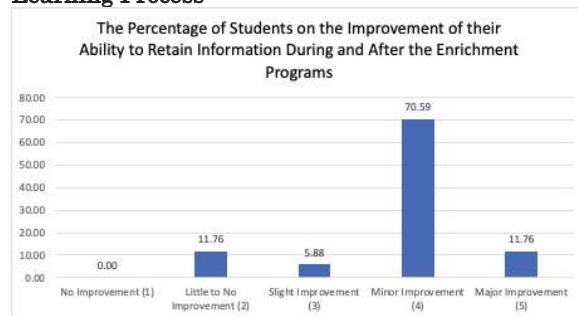
Fig. 3.1 The Percentage of Students on the Improvement of their Ability to Retain Information During and After the Enrichment Programs

Figure 3.1 presents the number of students on the improvement of their abilities in retaining information during and after Math Enrichment and AGHAMON by their respective percentages. From this, it can be seen that the majority of the students had developed skills in their way of thinking throughout their JHS experiences in Math Enrichment and AGHAMON, and were able to further develop their methods on retaining information beyond the circumstances.

The Percentage of Students on the Effectiveness of their
Ability for Self-learning and Collaboration from Junior
High School to Senior High School

Fig. 3.2 The Percentage of Students on the
Usefulness of their Ability for Self-learning and
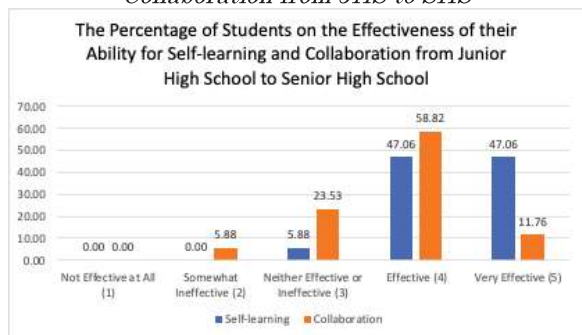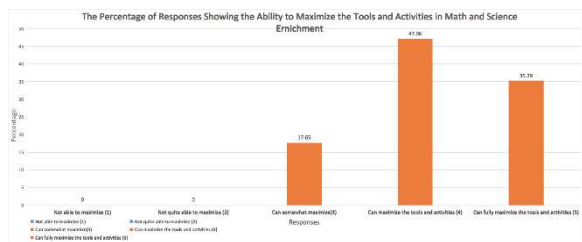Collaboration from JHS to SHS

Figure 3.2 is a summary of the percentages of
students on the usefulness of Junior High School
Enrichment programs on their abilities among self-
learning and collaboration in the experience of Senior
High School.

Perceived Advantages

The Percentage of Responses regarding the Effectiveness of Enrichment Programs in Self-learning Behavior
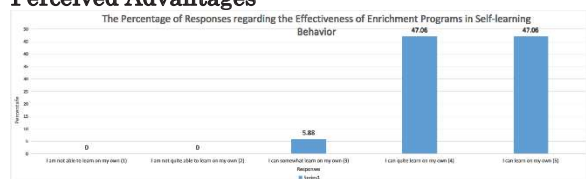
Fig. 3.3 Effectiveness of Enrichment Programs in
Self-Learning Behavior

Figure 3.3 shows the percentage regarding
the effectiveness of the enrichment programs in self-
learning behavior. Given that the two responses fall
under the positive response towards self-learning, the
researchers concluded that the enrichment programs
have greatly benefitted the students in terms of their
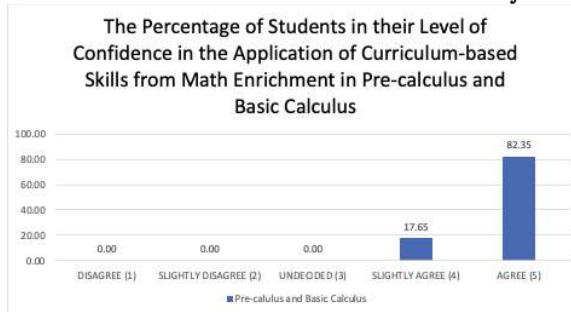ability to learn on their own.

The Percentage of Responses Showing the Ability to Maximize the Tools and Activities in Math and Science Enrichment

Fig. 3.4 Ability to Maximize Tools in Enrichment
Programs

Figure 3.4 pertains to Question 12 in the
survey which talks about the ability of the students to
maximize the tools and activities in the enrichment
programs. From the graph, it can be said that the
students are generally able to maximize the tools and
activities of the said programs.

Problem 3

What are the curriculum-based skills that
students have developed from taking Junior High
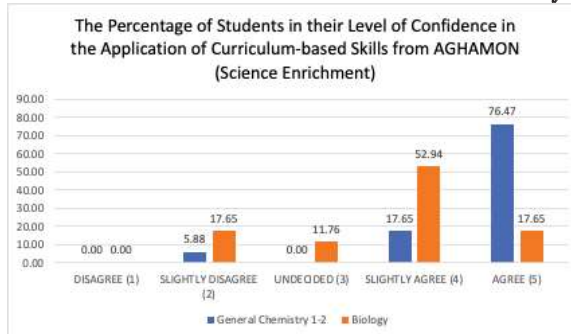Enrichment Programs toward Senior High STEM-
related subjects?

Curriculum-based Skills in Math-related Subjects

The Percentage of Students in their Level of
Confidence in the Application of Curriculum-based
Skills from Math Enrichment in Pre-calculus and
Basic Calculus

Fig. 4.1 The Percentage of Students in their Level of
Confidence in the Application of Curriculum-based
Skills from Math Enrichment in Pre-calculus and
Basic Calculus

Figure 4.1 presents the percentage of the level
of confidence STEM students have in their personal
application of curriculum-based skills from Math
Enrichment in the specified courses for specialized
subjects under the DepEd syllabus. Majority of the
students agreed to the statement of having the ability
to apply simple advanced mathematical skills and
concepts learned from Junior High Math Enrichment
in Senior High subjects.

Curriculum-based Skills in Science-related Subjects

The Percentage of Students in their Level of Confidence in
the Application of Curriculum-based Skills from AGHAMON
(Science Enrichment)

Fig. 4.2 The Percentage of Students in their Level of
Confidence in the Application of Curriculum-based
Skills from AGHAMON (Science Enrichment)

Figure 4.2 summarizes the number of Grade
11 and 12 STEM students in their level of confidence
in applying Science-related curriculum-based skills
developed from AGHAMON in the specialized courses
of the STEM strand. The majority of the Grade 11 and
12 students agree to their ability to apply previous
lessons from AGHAMON to their specified classes for
SHS, while others may find difficulty in doing so.

4. SUMMARY AND CONCLUSIONS

4.1. Summary of Findings

1. There is no significant difference between taking Math Enrichment and Science Enrichment in terms of gaining an advantage in taking up the STEM strand.
2. The results regarding the benefit of Math Enrichment and AGHAMON to the SHS adjustment period yield a percentage of 70.59% for Math Enrichment and 58.82% of Science Enrichment, thus considering their respective programs to be an advantage in their transition to STEM.
3. Grade 11 and 12 students were effectively able to develop their skills and mindset in retaining new information during and after Junior High Enrichment Programs.
4. A tie was seen between the respondents' answer. 47.06% of the respondents said that they can quite effectively learn on their own, whereas 47.06% of the other respondents said that they can effectively learn on their own.
5. Among the respondents, 82.35% fully agree to having the ability to relate and apply previous concepts introduced in the Math Enrichment program to the Pre-Calculus and Basic Calculus subjects.
6. Majority of the students were well-equipped with skills and background knowledge retained from previous experiences in the AGHAMON program and were able to implement these in Chemistry 1 and 2, and Biology.

4.2. Conclusions

1. Math and Science Enrichment allowed the students to gain a positive perspective on being able to retain information, collaborate with others, and learn the lessons in Senior High on their own.
2. There is no significant difference between the independent effects of Math and Science Enrichment in being an advantage when taking the STEM strand in Senior High. The topics taken in these subjects could help as a primer towards the students' future lessons in the academic strand. However, there are given differences towards the topics discussed in the academic curriculum between the two subjects in Junior High and Senior High, and in the level of difficulty between the Math and Science Enrichment programs and the Senior High STEM curriculum.

3. The Grade 11 and 12 students efficiently developed background knowledge on Science and Math related concepts from AGHAMON and Math Enrichment. In the Senior High School setting, the students were able to integrate what they had previously learned to new lessons introduced in the STEM strand.

4.3. Recommendations

1. Considering that the survey only focused mainly on the learning skills learned from the Enrichment Programs in Junior High, the future researchers are encouraged to identify the academic benefits by comparing the curriculum in Math Enrichment and AGHAMON to the STEM strand.
2. With only 17 respondents included in the sample of the study, the future researchers are encouraged to broaden the number of students and the criteria used to select respondents. For the basis used for the qualifications of research participants, it is encouraged to include students who did not attend the Science and Math Enrichment programs in order to further identify the benefits of the specified programs, differentiate the learning behavior and curriculum based skills applied in the STEM strand.
3. This research only included two out of the four Enrichment programs provided in Assumption College Junior High School. The future researchers are encouraged to study the English/Grammar and Filipino Enrichment programs and identify its benefits to the core and contextualized subjects included in the STEM curriculum.

5. ACKNOWLEDGMENTS

High School to answer our survey and participate in our study.

Lastly, to our classmates, friends and all the other people who were always there to encourage and help us in all possible ways, we would like to extend our utmost thank you.

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Exploring the Viability of Augmented Reality as a Supplementary Material for Learning Cell Biology and Photosynthesis for Grade 12 Students

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Abstract: Augmented reality (AR) is one of the many emerging digital technologies that specializes in gaming, medicine, entertainment, and education. AR-assisted technologies have undergone studies and were claimed to provide a better learning experience for students and lecturers who integrate its features in modern-day classrooms. An example is Google Expeditions, a cost-effective and accessible alternative; however, further research may be needed on such applications, especially when used solely as a supplement. This study assesses AR's effects on Grade 12 students' academic performance and motivation when used as a supplemental learning material for cell biology and photosynthesis. Assessment scores between those who used augmented reality and those who did not reveal a greater improvement in academic performance of the former group. Furthermore, students reported through the Instructional Materials Motivation Survey (IMMS) that they were motivated by the AR tours used during the experiment. These findings point to the potential benefit of integrating AR-based supplementary materials to promote student learning and motivation.

Key Words: augmented reality; academic performance; motivation; cell biology; photosynthesis

1. INTRODUCTION

Digital technology, which refers to all types of electronic devices, equipment, and applications, has been integrated into various schools as educational technologies to facilitate learning and education. These include educational software, learning platforms, and more recently, augmented reality (AR) and virtual reality (Lo & Miller, 2020).

AR-assisted technologies not only give students a new perspective on learning but teachers as well. They provide a platform for experiential learning where students are partially immersed in a physical environment layered with digital elements, allowing them to view objects and models for better visualization and interactive experiences (Shapovalov et al., 2018). A meta-analysis conducted by Radu (2014) attributed AR to increased content understanding, long-term memory retention, improved physical task performance, improved collaboration, and increased student motivation.

One example of AR technologies is Google Expeditions, a platform that aims to bring both AR and VR to educational institutions. It contains a freely accessible catalog of "tours" that discuss a wide range of topics from various subjects. Though head-mounted devices are required for VR tours, AR tours simply require a smartphone with a camera.

Although numerous studies have reported the benefit of using AR in students' learning, the majority of these experiments utilize dedicated equipment and feature the full-time use of AR. Limited studies regarding more cost-effective and accessible applications such as Google Expeditions are found in literature. In this paper, we describe our experiment in assessing the impact of Google Expeditions on students' academic performance and motivation when used as supplementary material in learning about *cell biology* and *photosynthesis* in Grade 12 General Biology 1 class. We compare the assessment scores of students who used augmented reality as a supplement with those who solely relied on traditional learning methods. We also quantify learner motivation and share feedback from students on their perception of the use of AR technology to motivate them in their study.

2. RELATED WORK

Google Expeditions is a free immersive education app that features various AR and VR environments known as "tours." The app contains

1000 VR tours and 100 AR tours (Google, n.d.), allowing teachers and students alike to use their mobile devices to bring three-dimensional (3D) objects into life by virtually exploring different worlds through the different VR/AR tours.

Cell biology is the study of cells' structure and functions, focusing on both a cell's general properties and a specialized cell's unique features (Pentimalli & Giordano, 2017). It is one of the topics covered in the *General Biology 1* course mandated by the Department of Education. Four related AR tours were identified as relevant by University biology professors, namely tours about plant cells, the type of cells, cell organelles, and photosynthesis. Google Expeditions presents these as static 3D cross-sectional or complete models of particular cell types, organelles, or components. The *Photosynthesis* tour presents similar models of agents involved, including molecular models of some substances.

3. METHODOLOGY

This study adopted a quantitative approach to measure academic performance and a mixed qualitative-quantitative approach to elicit learner's motivation.

3.1. Participants

Fifty-five participants from two sections of Grade 12 Science, Technology, Engineering, and Mathematics (STEM) students to comprise the experimental and the control groups, respectively, gave their consent to participate in the study. Both sections have the same professor who was assigned to teach their General Biology 1 class. The experimental or AR group consisted of 33 students, while the control or non-AR group consisted of 22 students.

3.2. Procedure

Prior to the experiment proper, a *Learner Profile Questionnaire* was given to all participants to gather demographic information such as age, gender, and general average. A pre-test was then administered to both groups in order to assess their existing knowledge about cells and photosynthesis. It consisted of 15 multiple choice questions about cell types, cell structure, cell organelles, and photosynthesis sourced from various existing resources. Both the pre-test and post-test questionnaires were validated by biology professors of the university.

For both the AR and non-AR groups, the class professor conducted synchronous lectures and delivered the same content using the same visual aids. After 3 weeks, both groups were given a supplementary refresher class—in contrast with earlier lectures, the AR group was taught with a live screencast of Google Expeditions instead of traditional lecture materials. A post-test was answered by the two groups after two (2) days. As recommended by a University biology coordinator, paraphrased versions of the 15 items of the pre-test comprised the post-test.

For the AR group, a revised version of the *Instructional Materials Motivation Survey* (IMMS) by Keller (2010) was given prior to the post-test. The survey is composed of thirty-six 5 point Likert-scale items created by the author with reference to his ARCS model for learner motivation; the model and survey comprises four subscales: *attention*, *relevance*, *confidence*, and *satisfaction*. These were used to quantify participant motivation during the use of the AR application. To support the numerical data, six (6) open-ended questions were added at the end of the questionnaire to solicit qualitative feedback.

3.3. Data Analysis

To determine academic performance, results from the pre-test and post-test questionnaires were compared by calculating the percent changes of the mean scores. A higher positive percent change indicates a greater improvement between pre-test and post-test scores. The number of individual participants who garnered positive, negative, and no changes to their test scores was also displayed using a cluster analysis table. To further assess the statistical significance of one group's improvement compared to the other, an independent samples *t*-test between their respective score changes was conducted through the statistical software Jamovi. Assumptions such as normality and homogeneity of variances were tested to determine the type of *t*-test used.

Data from the IMMS, on the other hand, were analyzed by computing the mean score and standard deviation for each ARCS subscale and its items; a value closer to 5 corresponds to a higher level of motivation. The descriptive statistics of each subscale and their highest-scoring and lowest-scoring items are presented. Responses from the open-ended questions were also associated with the appropriate subscale and used to support the yielded results.

4. RESULTS AND DISCUSSION

Out of 33 participants, 19 from the AR group were able to attend the supplementary refresher class. Along with 20 out of 22 participants from the non-AR group, they were able to complete all data collection instruments. In this section, we present our findings and corresponding analyses of the data gathered from the pre-test, post-test, and IMMS.

4.1. Academic Performance

Comparison of the scores of the AR group and non-AR group is presented in Table 1. The percent

change represents the improvement of students' scores after the lesson was taught to the students. Based on Table 1, the average score that the AR group improved by 22.11% while the non-AR group gained only a 5.84% elevation in score. A cluster analysis of the positive, negative, and neutral changes of each students' scores is also presented in the table.

The AR group had the most number of positive changes in scores (13 students or 68%) while the non-AR group had 10 students (50%). In terms of negative change, the AR group only had three students (16%), while the non-AR group had nine (45%). Only three students (16%) from the AR group and one student (5%) from the non-AR group had no change in scores.

Table 1. Comparison of academic performance per group

Group	Average			Frequency		
	Pre-test Score	Post-test Score	% Change	Negative Change	No Change	Positive Change
AR ($n = 19$)	9.63	11.11	22.11%	3	3	13
No AR ($n = 20$)	10.85	11.10	5.84%	9	1	10

Table 2 presents the results of the independent samples t-test for the mean score change (i.e., post-test score minus pre-test score) between both groups. Data were successfully tested for normality and homogeneity of variances. According to Student's t-test, $t(37.0) = 1.92$, $p < 0.05$ (one-tailed), the AR group had a statistically significant greater score change compared to the non-AR group. On average, the AR group's post-test score was 1.47 greater than their pre-test score, while the non-AR group's score only increased by 0.25.

Table 2. Independent samples t-test

		Statistic	df	p
Score Change	Student's t	1.92	37.0	0.031

Note: H$_a$ AR > No AR

4.2. Motivation

Descriptive statistics for each motivation subscale of the IMMS are presented in Table 3. All four motivation subscales yielded a mean above 3.5, indicating that, on average, the AR group found it *moderately true* that the Google Expeditions induced motivation. Descriptive statistics for the highest-rated and lowest-rated items per subscale are presented in the table.

Among all the motivation subscales, the *attention* criterion obtained the highest mean ($M = 3.88$) and least-dispersed data ($SD = 0.53$). This implies that Google Expeditions did best in capturing the interest and prompting the curiosity of the participants. As seen in Table 2, the highest-scoring item ($M = 4.45$, $SD = 0.59$) referred to *attention* as well. Several participants affirmed this with comments such as, *"It was cool and refreshing because it's new,"* and *"I was amazed when our teacher showed us the cell through a camera."*

Relevance obtained the lowest overall mean, indicating that Google Expeditions was least compatible or connected to the learners' goals. For instance, some participants commented that the application was *"unnecessary as all the information and content may have been presented in a textbook"* and *"no different to other reading materials that had pictures."*

Table 3. Descriptive statistics for IMMS subscales and their highest-rated and lowest-rated items

IMMS Subscale	M	SD
Attention	**3.88**	**0.53**
15. The AR application is interesting and appealing.	4.45	0.59
28. The variety of the lessons in the AR application helped keep my attention on the lessons.	3.27	1.11
Relevance	**3.60**	**0.71**
6. It is clear to me how the content in the AR application is related to things I already know.	4.05	1.00
16. The content in the AR application is relevant to my interests.	3.18	0.98
Confidence	**3.63**	**0.50**
34. I could understand quite a bit of the material in the AR application.	4.18	0.72
25. After using the AR application for a while, I was confident that I would be able to pass a test on the material.	3.09	1.14
Satisfaction	**3.64**	**0.90**
36. It was a pleasure to use such a well-designed AR application.	3.95	1.00
5. Completing the exercises in the lessons after using the AR application gave me a satisfying feeling of accomplishment.	3.27	1.16

Nonetheless, the application was shown to have increased the participants' *confidence* or expectations of successfully understanding the lesson, as seen in item no. 34 ($M = 4.18$, $SD = 0.72$). Participants have noted that AR could *"make the learning of students easier"* and that the visualizations make the biology lesson *"comprehensible."*

In terms of *satisfaction*, participants moderately agree that Google Expeditions was well-designed ($M = 3.95$, $SD = 1.00$). The said criterion

received the most-dispersed results ($M = 3.64$, $SD = 0.90$). Related comments from the participants vary positively and negatively, from *"It has everything I need"* to *"Using Google Expeditions currently sucks. If we give it more time to develop into a more robust application, then it could be worthwhile to use the tech."*

5. CONCLUSION AND RECOMMENDATIONS

Based on the findings presented, this study shows that AR as a supplementary tool has a positive effect on student academic performance and motivation. The group who used AR achieved greater improvement in their test score, reflecting better academic performance. Meanwhile, the resulting statistics on the motivation subscales which include attention, relevance, confidence, and satisfaction indicate that AR induced the learning motivation of those who have used it. With these promising results along with other existing studies, it can be established that implementation of AR as a supplementary material is certainly viable and has a big potential in revolutionizing the learning experience of students.

Findings reported in this study can serve as a foundation for future research needed in the development of more effective strategies and learning methods that will optimize AR in the educational field. The use of other AR applications can be explored to determine the best fit for various purposes, and the research sample size can be expanded to cover more diverse study groups. The length of time using the AR application can also be extended to capture more conclusive results, and instead of merely finding out whether the AR group was motivated, the motivation of both groups can also be compared.

Despite many pointing out AR's advantages, its application in the educational arena is still at its infancy stage. There remains a lot more to discover and learn about next-generation AR technologies and how they will transform the future of learning.

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