STRENGTHENING RESEARCH PEDAGOGY: STUDENT'S ONLINE RESEARCH EXPERIENCES, CHALLENGES, AND EFFECTIVE TEACHING STRATEGIES

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Abstract

Given the growing trend of delivering classes through online and virtual environments, it is vital to gain a nuanced understanding of students' online research learning experiences, the factors that contributed to their choice of learning modality, the challenges they encountered, and the effective online research teaching practices and strategies that supported them in completing the course. Although some studies have looked into this area, there is limited literature on research courses conducted online. Thus, this study attempts to fill that gap. Using a mixed-methods approach, the results revealed that overall, there is a significant difference in the projected performance of 204 asynchronous students compared to their actual achievement. Likewise, a significant difference is also evident in the projected performance of the 67 synchronous students compared to their actual achievement. Furthermore, it is of note that the synchronous students projected higher performance and actually attained better marks, with a significant difference in actual achievement compared to their asynchronous counterparts. Analysis of qualitative data also revealed factors that influenced the disparity, including internet connection issues, communication challenges, learning environment, time management, and group dynamics. Additionally, effective teaching practices that facilitated the completion of collaborative research projects include clarity of learning materials, reasonable deadlines, teacher support and understanding, availability for consultation and feedback, and interactive and engaging teaching methods. Consequently, these results can be used to inform and improve research teaching practices, learning materials design, and assessment tool development. More significantly, it may be used as the basis for institutional policies about online research learning.
Keywords: *online research collaboration, online research experiences, quality education, research pedagogy, sustainable development goals*

Introduction

Online distance learning provides a pivotal opportunity for 21st-century students to succeed in the academe and society as it presents students with training on digital tools and creates an environment for digital interactions (Collins et al., 2022; Kim et al., 2005). Additionally, e-learning has empowered learners by instilling self-learning and the capacity to winnow and discriminate information from the large amounts of data available in the online setting (Chen et al. 2012; Day et al. 2021). Students may have the freedom to study at their own pace and focus on the information and concepts more significant to them (Koskela et al., 2005). This is especially true among students with a higher level of independence and self-regulation as they may allot the needed time for more challenging topics and less time on topics, they already have background knowledge (Gilbert, 2015). Responding to the growing trend of

delivering classes through online and virtual environments, this study delves into the factors that shape the choice of online research learning modalities – asynchronous or synchronous. Asynchronous online learning prioritizes flexibility as learning is mediated and supported by technologies such as emailing, learning management systems, and messaging apps. In this modality, the teacher and students may not be online at the same time. Teachers may post announcements, learning materials, tasks, and discussion questions which students may access anytime and anywhere, affording them enough time to complete projects and tasks (Hrastinski, 2008). Conversely, synchronous online learning is mediated by videoconferencing applications for real-time interaction between teachers and students. With the social and interactive nature of SOL, student inquiries and concerns are directly and immediately addressed, and engagement with lesson contents and learning materials is done in real time (Hrastinski, 2008). Although there is limited literature on online research learning practices and pedagogy, it is highly valued and necessary in upgrading the research capacity of higher education institutions (Durante, 2022). Moreover, in an online research learning environment, literature has shown that learners become more flexible and are able to overcome logistic and physical barriers so that they can participate in research collaborations anytime and anywhere (Collins et. al., 2022; Chin 2020). Factors that contribute to the effectiveness of online collaborative research learning experience include: (1) recognizing the diversity of values, experiences, and personalities of collaborators, (2) assigning roles of members of the collaboration team, (3) how the members build relationships and their interdependence with each other, (4) how ergonomic, flexible, and adaptable the processes used by the groups are, (5) how the members of the group learn knowledge, skills, and expertise, and (6) what motivates the members of the research team (Durante, 2022).

However, despite the emerging trend of online research learning delivery, there are still challenges identified, including cognitive barriers such as information overload and lack of focus, communication barriers, and educational and environmental barriers arising from socioeconomic disparities (Kohan et al., 2017). Issues such as information overload, the heavy workloads from online courses, and increased demands on time management have been linked to heightened stress levels among students (Chen et al., 2012; Kohan et al., 2017; Moawad 2020). Similarly, mental health challenges among students, like anxiety and depression, have been associated with online learning environments (Day et al., 2021; Hillard et al., 2020; Kohan et al., 2017; Moawad, 2020). Factors identified that contribute to these mental health challenges include lack of guidance, information overload, and challenges in collaborative group settings (Hillard et al., 2020). To address this, reducing academic stress has been shown to enhance students' readiness for self-directed learning, crucial for navigating online learning environments effectively (Heo & Han, 2018). Other issues include constraints on hands-on laboratory and experiments for quantitative research (Chin, 2020), while qualitative data collection, such as interviews, may be a fundamentally different experience in an online setting (Deakin & Wakefield, 2014). According to a few studies (Carnegie Dartlet, 2020; Day et al., 2021; Price et al., 2020), many students, particularly those in the STEM fields, found it challenging to replicate virtual aspects of research involving laboratory and field studies.

Despite these, academic institutions still forge ahead in delivering research classes online to ensure the continuity of learning and provide thousands of students the chance to develop research skills and participate in research initiatives (Sloan et al., 2020). The locale of the current study is one of these academic institutions which continued to deliver research courses among senior high school students in Luzon, Philippines, as part of the curriculum requirement for the completion of secondary education and pre-requisite to higher education admission. As it was the first time that students engaged in research, and to be delivered online at that, this study aimed to identify students' expectations and anticipated performance in the online research course compared to their actual achievement, the factors that contributed to

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their choice of online learning modality, the challenges they encountered, and the effective online research teaching practices and strategies that supported them in completing the course. More specifically, this study aims to shed light on the effectiveness of online research teaching practices and strategies that were used to address the challenges experienced by students, as well as identify the factors that contributed to the students' online research learning experience. The nuanced understanding of effective teaching practices and strategies could provide relevant information to administrators and research teachers to better support students' needs in online research. The information gathered may be useful in revisiting the pedagogical practices in an online research learning environment.

The study may have a significant impact on the academic institutions' advocacy of delivering quality Education and Pedagogy for Filipino Learners. More specifically, this study sought to answer the following research questions:

1. What is the SHS students' anticipated performance in online research learning compared to their actual achievement?
2. Is there a significant difference in the SHS students' anticipated performance in online research learning and their actual achievement?
3. What are the factors that influenced the choice of senior high school students' learning modality?
4. What are the factors that shaped SHS students' experiences and achievements in online research learning?
5. What are the teaching practices and strategies utilized by the research teacher that enable the effective delivery of online research learning?

Research Methodology

General Background

The present study adopted the mixed methods embedded research design. This research approach enabled the researcher to collect both quantitative and qualitative data about the students' experience in the online research learning environment, with the latter providing a supportive role to clearly understand the phenomena under study (Creswell, 2006). The study is limited to the online research classes conducted during the academic year 2021-2022, amidst the height of the pandemic. It was implemented for five months, starting at the beginning of the first semester and was completed by the end of the same semester.

Sample Selection

The study involved 271 self-selected senior high school students of a government-run laboratory school in Luzon, Philippines with any one of the following experiences: (1) enrolled in online research learning for AY 2021-2022, (2) categorized under academic strands Humanities and Social Sciences (HUMSS), Accounting, Business and Management (ABM), and Science, Technology, Engineering and Mathematics (STEM); and (3) currently grade 12 level. The students have been engaged in online learning for two semesters in both synchronous and asynchronous modalities. The school empowered the students to choose which learning modality they would use in attending their classes. Responses from participants who did not meet any of the three criteria for participation were not included in the analysis. Informed consent was sought from the participants, and they were informed that they could withdraw their participation at any point during the conduct of the study.

Table 1 shows the specific learning modality chosen by the participants of the study.

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Table 1

Summary of Participants' Profile

Academic Strand	Number of participants *N* (%)	Chosen Learning Modality	Total *N* (%)
Humanities & Social Sciences	50 (18.45)	SOL AOL	11 (22) 39 (78)
Accountancy, Business & Management	61 (22.51)	SOL AOL	12 (19.67) 49 (80.33)
Science, Technology, Engineering & Mathematics	160 (59.04)	SOL AOL	44 (27.50) 116 (72.50)
Total	271 (100)	Total SOL Total AOL	67 (24.72) 204 (75.28)

Instrument and Procedure

The data were collected using retrospective self-report questionnaires. A retrospective self-report questionnaire was considered appropriate because participants were asked to characterize their subjective experiences in online research learning (Robinson, 2014; Schwarz, 2004). The first questionnaire administered at the beginning of the semester was divided into four sections (1) participants' academic strand, (2) their choice of learning modality, (3) their anticipated performance, and (4) the open-ended section asking about the reason behind the choice of modality. Likewise, the second questionnaire administered at the end of the semester was divided into four sections (1) participants' academic strand, (2) their choice of learning modality, (3) their actual achievement, and (4) the open-ended section asking about their experiences and challenges that contributed or constrained their performance in the online research course, as well as the teaching practices and strategies that addressed them. The clarity, accuracy and content validity of the questionnaires were reviewed by three experienced research teachers and researchers.

The research was reported to the academic institution's research management office for approval to conduct as well as to the head of the institution supervising the laboratory school. The questionnaires were administered online via Google Forms. It took approximately 10-15 minutes to complete each questionnaire. The online survey was used because of the lockdown in the country.

Data Analysis

To address the research questions, both quantitative and qualitative analyses were used. Specifically, the first and second research questions were answered with data gathered and analyzed using quantitative techniques while research questions 3, 4, and 5 utilized qualitative methods. For the quantitative analysis, the data was encoded in Microsoft Excel and Statistical Package for Social Sciences v. 22. The mean score ($\bar{x}$) and standard deviations (*SD*) for anticipated and actual achievement by students during online learning were computed. The mean score was interpreted using the following verbal interpretations: 5.50 to 6.0 (Excellent), 4.50 to 5.49 (Very Good), 3.50 to 4.49 (Good), 2.50 to 3.49 (Satisfactory), 1.50 to 2.49

(Conditional Pass), and 1.0 to 1.49 (Fail). Afterwards, the mean scores were subjected to Paired Samples T-Test to see if there is a significant difference between the anticipated and actual achievement in online research learning of students in synchronous and asynchronous classes. For the qualitative data, they were analyzed using NVivo version 10 and Clarke and Braun's Thematic Analysis protocol. Open codes and axial codes were identified, categorized, and then themes were drawn to answer the research questions 3, 4, and 5.

Research Results

Anticipated Performance and Actual Achievements in Online Research Learning

The first research question was to find out what the SHS students' anticipated performance in online research learning is compared to their actual achievement. The results, as shown in Table 2, have revealed that among the students under HUMSS, those who attended synchronous modality research classes had a higher anticipated performance at the beginning of the semester, $\bar{x} = 5.36$, compared to their actual achievement at the end of the semester, $\bar{x} = 5.00$. Their asynchronous modality counterparts, on the other hand, had higher actual achievement, $\bar{x} = 4.97$, compared to their anticipated performance, $\bar{x}=4.38$.

Table 2
Comparison of Anticipated Performance with Actual Achievement in Online Research Learning

Strand	Learning Modality	Academic Achievement	$\bar{x}$	SD	Interpretation
Humanities & Social Sciences	SOL	Anticipated	5.36	0.67	Very Good
		Actual	5.00	0.00	Very Good
	AOL	Anticipated	4.38	0.78	Good
		Actual	4.97	0.16	Very Good
Accountancy, Business & Management	SOL	Anticipated	4.67	0.49	Very Good
		Actual	5.83	0.58	Excellent
	AOL	Anticipated	4.94	0.66	Very Good
		Actual	5.00	0.00	Very Good
Science, Technology, Engineering & Mathematics	SOL	Anticipated	4.91	0.64	Very Good
		Actual	5.14	0.55	Very Good
	AOL	Anticipated	4.61	0.70	Very Good
		Actual	4.91	0.34	Very Good
OVERALL	SOL	Anticipated	4.94	0.65	Very Good
		Actual	5.24	0.58	Very Good
	AOL	Anticipated	4.65	0.73	Very Good
		Actual	4.95	0.27	Very Good

5.50-6-Excellent 2.50-3.49-Satisfactory
4.50-5.49-Very Good 1.50-2.49- Conditional Pass
3.50-4.49-Good 1.0-1.49- Fail

Moreover, ABM students under synchronous modality have higher actual achievement, $\bar{x}$ = 5.83, compared to their anticipated performance, $\bar{x}$ = 4.67, whilst their asynchronous modality counterparts have a very small margin of difference between anticipated, $\bar{x}$ = 4.94, and actual achievements, $\bar{x}$ = 5.00.

Additionally, STEM students taking up synchronous modality research learning have an anticipated performance of $\bar{x}$ = 4.91, lower than their actual achievement of $\bar{x}$ = 5.14, similar to the data culled from their asynchronous modality counterpart with the anticipated performance of $\bar{x}$ = 4.61, lower compared to their actual achievement of $\bar{x}$ = 4.91.

Overall, students in both synchronous modality and asynchronous modality actually performed better than they had anticipated, although it is of note that students under synchronous modality generally have higher anticipated performance and actual achievement compared to their asynchronous modality counterparts.

Table 2 illustrates the paired differences among the different groups of SHS students' anticipated performance and actual achievement.

Table 2

Results of Paired Sample Test on Difference between Anticipated and Actual Achievement of SHS Students in Online Research Classes

	$\bar{x}$	SD	t	p	Decision Rule
Pair 1 AOL Anticipated – AOL Actual	-.299	0.76	-5.58	.0001	Reject the N_o
Pair 2 SOL Anticipated – SOL Actual	-.298	0.85	-2.86	.006	Reject the N_o
Pair 3 HUM SOL Anti – HUM SOL Actual	.366	0.67	1.78	.104	Fail to reject the N_o
Pair 4 ABM SOL Anti – ABM SOL Actual	-1.166	0.57	-0.79	.0001	Reject the N_o
Pair 5 STEM SOL Anti – STEM SOL Actual	-.227	0.77	0.007	.058	Fail to reject the N_o
Pair 6 HUM AOL Anti – HUM AOL Actual	-.589	0.75	-0.34	.0001	Reject the N_o
Pair 7 ABM AOL Anti – ABM AOL Actual	-.061	0.65	0.127	.518	Fail to reject the N_o
Pair 8 STEM AOL Anti – STEM AOL Actual	-.301	0.78	-0.157	.0001	Reject the N_o

Overall, a significant difference was observed in the anticipated performance ($\bar{x}$ = 4.65) and actual achievement ($\bar{x}$ = 4.95) of SHS students learning research under asynchronous modality with a p-value of .0001 at α = .05. Likewise, a significant difference was also observed in the anticipated performance and actual achievement of SHS students learning research under synchronous modality with p = .006 < α = .05.

However, within the strands, there were three pairs where no significant difference in anticipated performance and actual achievement was observed. These include the HUMSS strand under synchronous modality with a lower actual performance ($\bar{x}$ = 5.00) compared their anticipated performance of $\bar{x}$ = 5.36, a mean difference of 0.366 and p = .104. The second is the STEM strand under synchronous modality with a higher actual performance ($\bar{x}$ = 5.14) compared their anticipated performance of $\bar{x}$ = 4.91, a mean difference of -0.227 and a p-value = 0.058. Finally, the ABM strand under asynchronous modality with a very slightly higher actual performance ($\bar{x}$ = 5.00) compared their anticipated performance of $\bar{x}$ = 4.94, a mean difference of -0.061 and p = .518.

Conversely, there were also three pairs where a significant difference in anticipated performance and actual achievement in online research learning was observed. The first are ABM students under synchronous modality with an excellent actual performance ($\bar{x}$ = 5.83) compared their anticipated performance of $\bar{x}$ = 4.67, a mean difference of -1.166 and a p-value = 0.000. Likewise, HUMSS students under asynchronous modality with a very good actual performance ($\bar{x}$ = 4.97) compared their anticipated performance of $\bar{x}$ = 4.38, a mean difference

of -0.589 and p = .000. Finally, STEM students under asynchronous modality with a higher actual performance ($\bar{x}$ = 4.91) compared their anticipated performance of $\bar{x}$ = 4.61, a mean difference of -0.301 and p = .0001.

The disparities in how the groups of students performed may be explained by the factors that influenced their choice of learning modality and shaped their experiences in the online research classroom.

Factors Influencing Choice of Learning Modality

To better understand the disparities between the anticipated performance and the actual achievement of SHS students, the results of NViVo v. 10 and Clarke and Braun's thematic analysis protocol yielded *Internet connection issues* as one of the primary reasons behind the learner's choice. This is true for students under both asynchronous modality and synchronous modality, claiming that they have limited access to the internet, or that there are fluctuations in internet connectivity. Likewise, the students' *Learning preference/ Learning style* also contributed to their decision-making. Another significant theme that arose from the analysis of data is the students' *Home Financial or Economic Situation,* where siblings needed to share devices and laptops, and the kids share responsibilities and tasks at home. Additionally, students also took stock of their *Cognitive, emotional and psychological capacity* to manage the online research lessons and tasks. *Peer influence* and *Teacher-factor* also came out as themes shaping the students' decision on whether they will study online research under synchronous or asynchronous. Meanwhile, participants also identified several factors that shaped their online research learning experiences and achievements. After responses were analyzed using NViVo v. 10 and thematic analysis was performed, the data were coded and classified into five major themes – *Internet connection, Communication challenges, Learning environment, Time management, and Group dynamics*

Figure 1a illustrates the factors identified that have influenced students' choice of learning modality, while Figure 1b shows the factors that have shaped students' online learning experiences and achievement.

Figure 1
(a) Factors Influencing Students' Choice
of Online Learning Modality
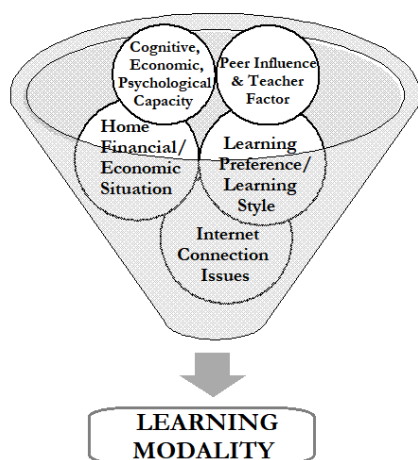
(b) Factors Shaping Students' Online
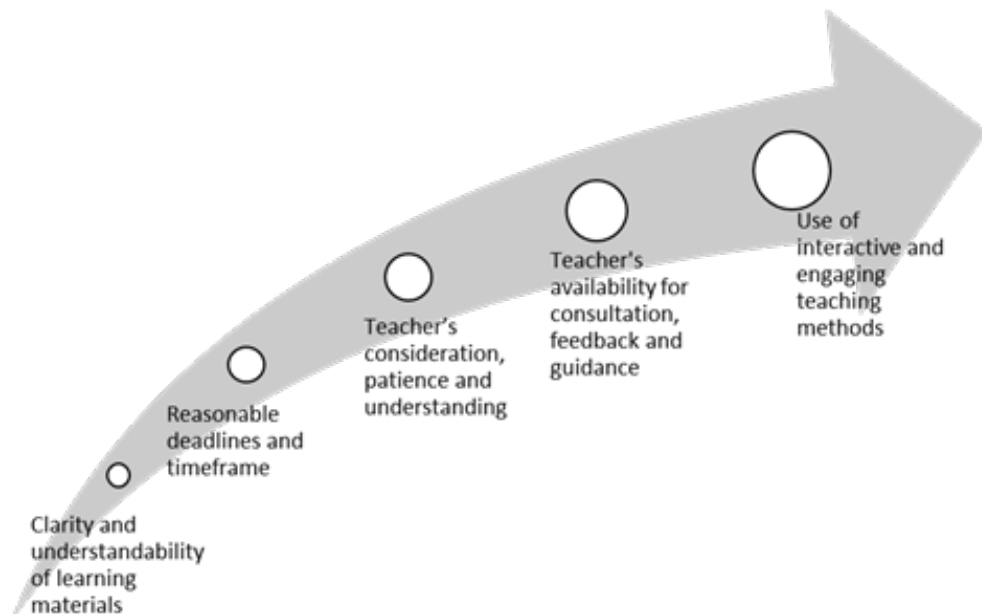*Learning Experiences and Achievement*
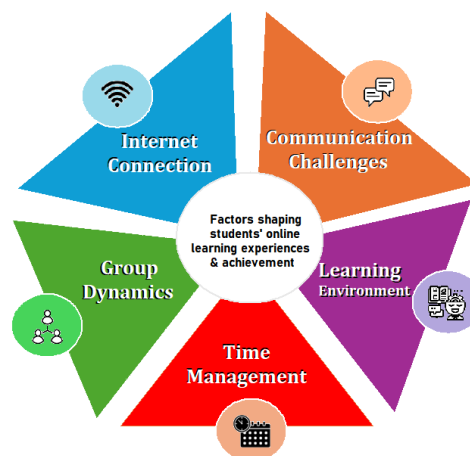
Effective Teaching Practices in Online Research Learning

Based on the results, the participants of the study identified five teaching practices and strategies used by the research teacher that enabled the effective delivery of the research class in the online setting. The first theme identified is the use of c*lear and understandable learning materials* specially among Asynchronous students who navigate the materials independently. The second theme is *reasonable deadline and timeframes.* Since research requires submission of the different parts of the research project, giving ample time to work on the project was necessary. The third theme is the *teacher's consideration, patience, and understanding.* These teacher attitudes were identified to positively influence students' experiences and achievements in online research learning. Likewise, *teacher's availability for consultation, feedback, and guidance* were significant themes that contributed to students' learning. Finally, among students attending synchronous learning, the *use of interactive and engaging teaching methods* contributed positively to their learning experience.

Figure 2 shows how the identified themes contributed to enable students to progressively focus in online research learning toward the completion of their research project and achievement of the course objectives.

Figure 2
Teaching Practices and Strategies Utilized by Research Teachers in the Delivery of Online Research

Discussion

The current study explores the anticipated and actual achievement of students in an online learning environment, the factors that influence their choice of learning modality and shape their experiences and achievement, as well as the effective teaching strategies used by the research teacher. The findings revealed that the students from different academic strands and learning modalities vary in their anticipated performance and actual achievement during the online research learning delivery. Specifically, students under the synchronous modality have

higher anticipated performance and actually perform better than students under the asynchronous modality. With reference to previous studies, the results complemented the findings of the study of Nkoala and Matsilele (2021), stating that unequal access to technologies experienced by students results in unequal learning outcomes.

Overall findings on the factors that influence students' choice of learning modality reveal several factors. Students' responses suggest that internet connection issues remain largely a major factor both in choosing the learning modality and in shaping their experiences and achievement in online research learning. These results illustrate similarities with other studies (see Hodges et.al., 2020; Nkoala & Matsilele, 2021) indicating that those with more access to digital technologies and the internet influence the students in how they engage actively or passively in education to the point where they could or could not demonstrate responsibility, accountability, and their sense of autonomy. Moreover, those with more access derived more benefits (Nkoala & Matsilele, 2021). The data also suggests that students found it difficult to discuss the research project with groupmates online. Many students, both from synchronous and asynchronous, still iterated the need to have face-to-face interaction with their respective research collaborators. These results illustrate the need to create effective communication channels in an online learning environment as the lack of face-to-face interaction can become a hindrance to student engagement and collaboration (Means et al., 2010).

As shown in the data, since the students are studying at home, their diverse backgrounds and learning environments contributed to their experiences. The importance of a conducive home environment for learning is emphasized to set students up for success in a research online course (Derrick, 2003). Likewise, the data also suggest that time management influenced the experience of students in online research learning. One possible explanation for this is that some students may not have good self-regulation strategy in an online learning setting, while those who managed their time effectively were able to exhibit better outcomes. Another finding complemented studies by Graham (2002), Fung (2004), Häkkinen (2004), and Taylor (2005) which stated that group dynamics has a significant influence on students' online research learning. Nevertheless, further studies are required to validate the impact of the home environment, time management, and group dynamics in the online research learning of students.

Nonetheless, the students identified a variety of teaching strategies that supported their online research learning experiences. For instance, the use of clear and easily understood learning materials, reasonable deadlines and timeframe, teacher's consideration, patience, and understanding, teacher's availability for consultation, feedback, and guidance, and the use of interactive and engaging teaching methods enabled the students to progressively focus and work toward the completion of their research project in the online setting. The varying teaching strategies confirmed earlier reports (see Kehward, 2008; Kwarteng, 2014; Ruzic et. al., 2021; Office of Educational Technology, 2017). The implications of these results illustrate the usefulness of learning materials to make learning more accessible for students so that they will be able to grasp concepts more easily (Kwarteng, 2014). Likewise, the significance of teachers' affective actions toward students in online learning environments is also supported (Kehward, 2008). Another critical piece of information from the data is the significance of teacher's availability for consultation, feedback, and guidance. The extent of availability of the teacher was not measured in the study though. Finally, the use of interactive teaching methods such as technology integration, use of gamification and other engaging tasks and activities advance the relationship between the teacher and students (Office of Educational Technology, 2017). Even so, further studies are required to validate the results.

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Conclusion and Recommendations

In the context of the online research learning, based on the results, students in synchronous online research learning are more likely to have better anticipated performance and higher actual learning achievement compared to their counterparts undergoing asynchronous online research learning. This gap between the learning achievement of students under synchronous and asynchronous online research learning has been shaped by their choice of learning modality, influenced by their experiences and the teaching practices of the research teachers. Internet connection issues were primarily identified as a factor influencing the choice of learning modality and the experience of students that influenced their learning achievement. Other factors include communication difficulties, the students' learning environment at home, their capacity to manage time, and the group dynamics of the members of the collaborative research project where they belong. Moreover, teacher-factor was shown as a salient influence in students' online research learning experience, with the use of clear and comprehensible materials, flexibility of deadlines and timeframe, availability for consultation, and use of engaging teaching methods identified as integral practices and strategies that enable students to progressively focus and work toward the completion of their research project.

Given these results, it is recommended that in terms of online research learning instruction, the university work on policies and programs that will enable the equitable provision of access to internet resources for all students, especially the marginalized and underprivileged. Second, continuously provide faculty training on learning materials development and interactive and engaging research pedagogy, as well as the development of social and affective skills to build empathic relationships with students. Finally, with the global expansion of education mitigated by the internet and digital tools, advocating for international research collaborations among students and teachers of different local and international educational institutions may be more possible than ever. Thus, the creation of institutional partnerships and collaborations may be forged. Finally, for future researchers, the study may be replicated in other subject areas or disciplines among external campuses and colleges in the university to further establish, affirm or negate the results of the study.

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