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# Virtual Classrooms and Scientific Thinking: Assessing Challenges for Grade 9 Students

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**Abstract**
This study aimed to investigate the impact of online learning barriers on the scientific attitudes of Grade 9 students. The research involved 50 Grade 9 students from Plaridel Integrated National High School enrolled in online learning. Data was collected using the Online Learning Barriers Survey and the Scientific Attitude Instrument, administered via Google Forms with the assistance of class advisers. The analysis employed descriptive statistics and the Pearson Product Moment Correlation Coefficient. Results indicated that individual and community barriers strongly influenced scientific attitudes. Students demonstrated high positive attitudes in curiosity and skepticism and moderately positive attitudes in humility. The study found no significant relationship between online learning barriers and scientific attitudes. In conclusion, there was insufficient statistical evidence to reject the null hypothesis, suggesting that online learning barriers do not significantly impact the scientific attitudes of the respondents.

**Keywords**
Online learning barriers, Junior high school, Scientific attitudes

## INTRODUCTION

The COVID-19 pandemic has dramatically transformed educational landscapes worldwide, particularly in the Philippines, where institutions were compelled to adopt precautionary measures to ensure academic continuity (Toquero, 2020). As a result, online learning platforms emerged as the primary means of education delivery (Medina & Del Rosario, 2022). This shift sparked debates among educators, parents, and government agencies regarding its efficacy and implementation (Joaquin et al., 2020).

In response to the crisis, the Department of Education (DepEd) issued Memo No. 12 series of 2020, known as the 'Adoption of the Basic Education Learning Continuity Plan for School Year 2020-2021 in Light of the COVID-19 Public Health Emergency.' This plan introduced various learning modalities, including the Online Learning Modality (OLM), to address the challenges posed by the pandemic (DepEd, 2020).

The modern online learning environment typically comprises three main elements: connected devices (such as laptops, tablets, and smartphones), audiovisual aids (including lesson presentations and interactive displays), and functional furniture that facilitates diverse learning approaches (Pokhrel & Chhetri, 2021). Additionally, e-learning platforms like Microsoft Teams, Google Meet, and Zoom have become integral to the Philippine educational system. DepEd primarily utilizes Google services such as Google Meet for online discussions and Google Classroom for content delivery (Alipio, 2020).

However, the implementation of OLM is not without challenges. Baticulon et al. (2021) identified five primary barriers to online learning in the Philippines: technological, individual, domestic, institutional, and community barriers (Guevarra & Panoy, 2022). These obstacles range from limited internet access and lack of technical skills to psychological issues, domestic distractions, and institutional shortcomings (Panergayo & Aliazas, 2021).

Despite these challenges, online learning has potential benefits, including improved information retention and time efficiency (Li & Lalani, 2020). Nevertheless, its effectiveness varies among learners, proving advantageous for some while posing difficulties for others (Adedoyin & Soykan, 2020).

This study investigates the impact of online learning barriers and explores the potential relationship between these barriers and students' scientific attitudes. It sought to answer the following questions in particular:

1. How can the encountered online learning barriers of the respondents be described in terms of:
   1.1. individual;
   1.2. technological;
   1.3. domestic;
   1.4. institutional; and
   1.5. community?
2. How can the scientific attitudes of the respondents be described in terms of their:
   2.1. curiosity;
   2.2. humility; and
   2.3. skepticism?
3. Is there a significant relationship between the online learning barriers and the scientific attitudes of the respondents?

Examining these factors hope to contribute to the ongoing discourse on effective online education strategies and inform future policy decisions in the Philippine context.

## MATERIALS AND METHODS

This study employed a descriptive-correlational design to examine the association between online learning barriers and learners' scientific attitudes. This approach was chosen as it best suited the hypothesis-testing nature of the study (Creswell & Creswell, 2018). The study included 50 Grade 9 students enrolled in the online learning program at Plaridel Integrated National High School for the academic year 2020-2021. Participants were selected using the Availability Sampling Technique, a non-probability sampling method. This technique was chosen due to accessibility constraints and the school's decreasing population of online learners (Etikan et al., 2016).

This study used two main instruments: an Online Learning Barriers Survey and a Scientific Attitude Instrument. Both were modified and adapted questionnaires, validated by Science Coordinators from three different schools in Nagcarlan. The questionnaires consisted of demographic information (age range, sex, and learning resources used) and an assessment of online learning barriers and scientific attitudes.

The data collection procedure began with obtaining permission from the school administration to conduct the study. The researcher then prepared and validated the online survey questionnaires, distributed via email to the school principal, who forwarded them to Grade 9 class advisers along with consent forms. The researcher attended a virtual meeting with students to provide instructions and explain the study's purpose. Responses were collected through Google Forms, with gradual participation reaching 50 responses. A pilot test was conducted on May 10, 2021, distributing 20 instruments via email to evaluate the validity and reliability of the survey instrument.

Data analysis employed several statistical approaches. Descriptive statistics (mean and standard deviation) were used to summarize the data. The weighted mean was calculated to determine the extent of the effect of online learning barriers and scientific attitudes. The Pearson Product Moment Correlation Coefficient (r) was utilized to examine the relationship between online learning barriers and scientific attitudes. Data analysis was performed using statistical software.

The study adhered to ethical research practices, including obtaining informed consent from participants and ensuring data confidentiality and anonymity (American Psychological Association, 2017). These measures were taken to protect the rights and well-being of the participants throughout the research process.

## RESULTS AND DISCUSSION

**Table 1** Individual Online Learning Barriers

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. Experienced difficulty in adjusting to the new normal. | 2.60 | 0.81 | Highly Experienced |
| 2. Experienced anxiety, stress, and uncertainty in online classes. | 2.76 | 0.66 | Highly Experienced |
| 3. Experiencing headaches and blurring eye sight due to excessive time staring at screens (cellphone, computer, tablet, etc.). | 2.12 | 1.00 | Moderately Experienced |
| 4. Back is always hurt because of a lack of physical activities due to online classes. | 2.24 | 0.98 | Moderately Experienced |
| 5. During online classes, I am easily distracted by Facebook, Messenger, Instagram, YouTube, Mobile Legends, etc. | 2.60 | 0.81 | Highly Experienced |
| 6. During online classes, I am always hesitating in doing the activities on time | 2.68 | 0.74 | Highly Experienced |
| Overall | 2.50 | 0.53 | Highly Experienced |

***Legends**:* 3.00-2.33 – Agree – Highly Experienced; 2.32-1.67 – Neither – Moderately Experienced; 1.66-1.00 – Disagree – Low Experienced.

Table 1 illustrates the Individual Online Learning Barriers experienced by the learners. The indicator 'Experienced anxiety, stress and uncertainty in the online classes' received the highest mean of 2.76, interpreted as highly experienced. This high level of stress and anxiety can be attributed to the overload of activities in online learning modules, which students must complete within limited timeframes. Suryaman et al. (2020) corroborated these findings, noting that the difficulty of distance learning is often exacerbated by an excess of instructional activities, with some subjects requiring numerous tasks per week.

Conversely, the indicator 'Experiencing headaches and blurring eyesight due to excessive time staring at screens (cellphone, computer, tablet, etc.)' obtained the lowest mean of 2.12, interpreted as moderately experienced. This issue arises from extended class durations necessitated by limited monthly meetings in the online learning modality. Almaiah et al. (2020) reported similar experiences among their respondents, highlighting the physical strain caused by prolonged screen exposure.

The overall weighted mean of 2.50 indicates that respondents were highly affected by individual online learning barriers. The transition from traditional classroom settings to online platforms presented significant challenges. Students accustomed to shorter, varied class schedules due to limited physical classrooms now faced extended online sessions and increased workloads (Montilla et al., 2023). This scenario contributed to elevated stress levels, hampering students' concentration ability.

Moreover, practical difficulties such as procrastination and distractions were observed during online learning, decreasing motivation to study. Dhawan (2020) noted that students often struggle to grasp content independently online, as they are accustomed to different learning styles in face-to-face situations.

Mental and physical health issues, including stress, anxiety, and uncertainty, were also prevalent among learners during the pandemic. Pokhrel and Chhetri (2021) emphasize the importance of parental support in mitigating these mental health challenges, suggesting that parents should help alleviate their children's concerns about the current circumstances (Carada et al., 2022).

**Table 2** Technical Online Learning Barriers

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. I am good enough at using this online learning platform? | 1.48 | 0.50 | Low Experienced |
| 2. I have great ICT skills. | 1.34 | 0.48 | Low Experienced |
| 3. Experienced suddenly disappearing in your online class due to internet problems. | 1.62 | 0.49 | Low Experienced |
| Overall | 1.48 | 0.34 | Low Experienced |

***Legends**:* 3.00-2.33 – Agree – Highly Experienced; 2.32-1.67 – Neither – Moderately Experienced; 1.66-1.00 – Disagree – Low Experienced.

The data reveals that respondents were minimally affected by technological barriers, with a mean score of 1.48, indicating low experience. This can be attributed to the ICT course offered in their TLE subject, which helped students adapt to the new learning modality. However, as noted by Respondent D, internet connectivity remained a significant challenge in the online learning experience.

The indicator "Experienced suddenly disappearing in your online class due to internet problems" received the highest score among technological barriers, with a weighted mean of 1.62, still interpreted as low influence. This finding aligns with recent studies on internet connectivity issues in the Philippines. Toquero (2021) highlighted that unreliable, slow, or absent internet access significantly hinders efficient learning in online environments. Moreover, Alipio (2020) described the quality of the internet in the country as "expensive turtle internet," emphasizing the dual challenges of cost and speed.

Conversely, the indicator "having great ICT skills" scored the lowest, with a mean of 1.34, and was also interpreted as having low experience. This suggests that while students possess basic technological knowledge, they may not consider themselves highly proficient. Mercado (2020) noted that varying levels of digital literacy among students contribute to the challenges in online learning, affecting how students handle virtual tasks.

These findings are consistent with broader trends in developing countries. Adedoyin and Soykan (2020) identified technological barriers, including internet connectivity and digital competence, as significant challenges in the transition to online learning during the COVID-19 pandemic. They emphasized that these issues are particularly pronounced in regions with limited technological infrastructure.

Furthermore, Joaquin et al. (2020) pointed out that the sudden shift to online learning exposed pre-existing digital divides in the Philippines, highlighting the need for improved digital infrastructure and enhanced ICT training for students and educators.

Overall, while technological barriers were not reported as a major hindrance in this study, likely due to the institution's proactive ICT training, issues related to internet connectivity and varying levels of digital competence remain areas of concern. These findings underscore the importance of continued investment in digital infrastructure and ICT education to enhance the online learning experience.

**Table 3** Domestic Online Learning Barriers

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. I can communicate with your family members regarding my online classes | 2.28 | 0.97 | Moderately Experienced |
| 2. My family is financially stable. | 2.68 | 0.74 | Highly Experienced |
| 3. Experienced being left out of the online class due to lack of needs. | 1.72 | 0.97 | Moderately Experienced |
| 4. The family has an internet connection at home. | 2.76 | 0.66 | Highly Experienced |
| 5. I am not able to submit activities on time due to your responsibilities at home. | 1.88 | 1.00 | Moderately Experienced |
| Overall | 2.26 | 0.32 | Moderately Experienced |

***Legends**:* 3.00-2.33 – Agree – Highly Experienced; 2.32-1.67 – Neither – Moderately Experienced; 1.66-1.00 – Disagree – Low Experienced.

Table 3 illustrates the domestic online learning barriers experienced by respondents. The overall mean for these barriers was 2.26, indicating a moderate level of impact. One of the most prevalent domestic barriers in online learning was the responsibility of household chores. Aguilera-Hermida (2020) noted that many learners faced challenges in online learning due to increased domestic responsibilities, with students struggling to balance household duties and academic work.

The "Family has an internet connection" indicator received the highest score of 2.76, interpreted as highly experienced. This highlights the critical role of internet connectivity in online learning, with a home internet connection being preferable to mobile data for e-learning purposes. Adedoyin and Soykan (2020) emphasized that reliable internet access is a fundamental requirement for effective online education, particularly in developing countries with more prevalent connectivity issues.

Conversely, the indicator "Experienced being left out of the online class due to lack of needs" scored the lowest with a mean of 1.72, interpreted as moderately influenced. This lower score may be attributed to the local economic context, where many families are employed in food manufacturing, an essential industry during the pandemic. However, Pokhrel and Chhetri (2021) noted that the pandemic has forced many families to reprioritize their budgets, often at the expense of educational resources.

The COVID-19 pandemic has exacerbated existing socioeconomic disparities, affecting students' access to online learning. Joaquin et al. (2020) found that in the Philippines, many parents faced difficult choices between meeting basic needs and supporting their children's education, sometimes resulting in a shift from online to modular learning modalities. This aligns with the findings of Baticulon et al. (2021), who concluded that the pandemic's economic impact has led to a lack of basic needs for some learners, affecting their ability to participate fully in online classes.

Furthermore, Cahapay (2020) highlighted the challenges of establishing conducive learning environments at home, particularly in lower-income households. This issue compounds the difficulties students face in managing their domestic responsibilities alongside their studies.

Overall, while domestic barriers moderately impacted the respondents in this study, the findings underscore the complex interplay between home environments, economic factors, and online learning effectiveness. These results emphasize the need for holistic support systems that address online education's technological and socioeconomic aspects.

**Table 4** Institutional Online Learning Barriers

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. I easily understand my lessons in Science just by reading the modules given by my Teacher. | 1.68 | 0.96 | Moderately Experienced |
| 2. The given modules were enough to answer the weekly activities. | 1.76 | 0.98 | Moderately Experienced |
| 3. I can manage my time freely during online classes. | 2.40 | 0.93 | Highly Experienced |
| 4. The school offers too much work for me. | 1.84 | 1.00 | Moderately Experienced |
| 5. My teacher teaches me the lessons in Science in the online class. | 2.16 | 1.00 | Moderately Experienced |
| Overall | 1.97 | 0.46 | Moderately Experienced |

***Legends**:* 3.00-2.33 – Agree – Highly Experienced; 2.32-1.67 – Neither – Moderately Experienced; 1.66-1.00 – Disagree – Low Experienced.

Table 4 presents the institutional online learning barriers, with an overall weighted mean of 1.97, interpreted as moderately experienced. This moderate impact can be attributed to the challenges teachers face in adapting to the new curriculum and increased paperwork, which limited time for online discussions. Pokhrel and Chhetri (2021) noted that educators worldwide struggled with the sudden shift to online teaching, facing increased workloads and the need to adapt their teaching methods rapidly.

The indicator with the highest mean (2.40) was "I can manage my time freely during online class," interpreted as highly influenced. Respondents reported having only 3-4 online meetings per month, allowing more time for completing assigned activities. This flexibility aligns with findings by Dhawan (2020), who highlighted that online learning offers students greater autonomy in managing their time and allows for multitasking. However, Adedoyin and Soykan (2020) cautioned that while this flexibility can be beneficial, it also requires students to have strong self-discipline and time management skills.

Conversely, the lowest-scoring indicator was "understanding of the lessons given by the teacher just by reading it," with a mean of 1.76, interpreted as moderately influenced. This challenge stems from limited teaching time in the new modality and delays in resource distribution from DepEd, complicated by lesson content and activity changes. Toquero (2021) highlighted that teachers' lack of experience in remote learning often resulted in difficulties in producing appropriate materials for online teaching platforms.

The institutional barriers identified in this study reflect broader challenges in the education sector's response to the pandemic. Joaquin et al. (2020) emphasized that the Philippine higher education sector faced significant hurdles in transitioning to online learning, including insufficient infrastructure and technological support. This aligns with earlier findings by Porter et al. (2015), underscoring the persistent nature of these challenges.

Moreover, Baticulon et al. (2021) found that institutional barriers, such as poor communication between learners and educators and inadequate educator skills in online teaching, significantly impacted students' learning experiences. These findings highlight the need for comprehensive support and training for educators in online teaching methodologies. Overall, while respondents moderately experienced institutional barriers, they reveal important areas for improvement in online education delivery. The contrast between the flexibility in time management and difficulties in understanding lessons underscores the complex nature of online learning environments. These results emphasize the need for continued institutional support, teacher training, and adaptive learning strategies to enhance the effectiveness of online education.

**Table 5** Community Online Learning Barriers

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. I feel that there is a need for peers, social connection, and motivation in learning Science 9. | 2.88 | 0.48 | Highly Experienced |
| 2. I have a good relationship with my Teacher in Science. | 1.72 | 0.97 | Moderately Experienced |
| 3. I have a good relationship with my classmates. | 2.52 | 0.86 | Highly Experienced |
| 4. The power interruption in your area had been a hindrance to your online classes. | 1.56 | 0.91 | Low Experienced |
| 5. The government must give help to students who are studying in online classes. | 3.00 | 0.00 | Highly Experienced |
| Overall | 2.34 | 0.28 | Highly Experienced |

***Legends**:* 3.00-2.33 – Agree – Highly Experienced; 2.32-1.67 – Neither – Moderately Experienced; 1.66-1.00 – Disagree – Low Experienced.

The study revealed that community online learning barriers significantly affected the respondents, with an overall mean of 2.34, interpreted as highly experienced. Communication between teachers and students emerged as a major challenge, with the school principal acknowledging the difficulties teachers faced in reaching out to students during the pandemic. This aligns with the findings by Adedoyin and Soykan (2020), who identified communication barriers as one of the critical challenges in online learning environments during the COVID-19 pandemic.

The indicator with the highest mean (3.00) was "The government must help students studying in online classes," which was highly influenced. This highlights the perceived need for government support in facilitating online education. In the context of Nagcarlan, where many residents did not experience income loss, government aid was limited, primarily focusing on improving electricity services. Toquero (2021) emphasized the crucial role of government support in enhancing online learning infrastructure, particularly in improving electricity and technology access in rural areas.

Conversely, the indicator with the lowest mean (1.56) was power interruption, interpreted as low influence. While Castillo (2020) noted that power loss during online sessions is an unavoidable issue in virtual classroom setups, the locality in this study experienced minimal power interruptions. This contrast underscores the importance of considering local context when assessing online learning barriers.

The community barriers identified in this study reflect broader challenges in implementing online education, particularly in developing countries. Joaquin et al. (2020) highlighted that the Philippine education sector faced significant hurdles in transitioning to online learning, including inadequate infrastructure and varying levels of community support.

Moreover, Baticulon et al. (2021) found that community-related barriers, such as lockdown restrictions and sociopolitical issues, significantly impacted students' online learning experiences. These findings emphasize the need for a holistic approach to addressing online learning challenges, considering both technological and, social and community factors.

Pokhrel and Chhetri (2021) further noted that the effectiveness of online learning is heavily influenced by community factors such as internet connectivity, power supply stability, and local government support. They stressed the importance of collaborative efforts between educational institutions, local governments, and communities to create a conducive environment for online learning.

Overall, while respondents highly experienced community barriers, their impact varied based on local context. The strong desire for government support in online education contrasts with the relatively low impact of power interruptions, highlighting the complex and localized nature of community-related challenges in online learning. These findings underscore the need for tailored, community-specific approaches to enhance the effectiveness of online education.

**Table 6** Scientific Attitudes in terms of curiosity

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. I look forward to doing laboratories in Science. | 3.66 | 0.75 | High Positive Attitude |
| 2. I find science interesting. | 3.88 | 0.77 | High Positive Attitude |
| 3. I enjoy studying science. | 3.78 | 0.79 | High Positive Attitude |
| 4. I'm good at science. | 3.62 | 0.85 | High Positive Attitude |
| 5. I am curious about the world in which we live. | 4.20 | 0.95 | High Positive Attitude |
| 6. I look forward to science lessons. | 3.78 | 0.82 | High Positive Attitude |
| 7. I enjoy reading about things that disagree with my previous ideas. | 3.84 | 0.79 | High Positive Attitude |
| 8. Science lessons are fun. | 3.58 | 0.91 | High Positive Attitude |
| 9. I like to listen to people whose opinions are different from mine. | 3.76 | 0.72 | High Positive Attitude |
| 10. I enjoy going to science lessons. | 3.62 | 0.90 | High Positive Attitude |
| Overall | 3.77 | 0.67 | High Positive Attitude |

***Legend***: 5.00-4.21 – Strongly Agree – Very High Positive Attitude
4.20-3.41 – Agree – High Positive Attitude
3.40-2.61 – Neither – Moderate Positive Attitude
2.60-1.81 – Disagree – Low Positive Attitude
1.80-1.00 – Strongly Disagree – Very Low Positive Attitude

Table 6 indicates the curiosity of the respondents regarding the Science Subject. The indicator with the highest weighted mean of 4.20 is 'I am curious about the world in which we live,' interpreted as 'High Positive Attitude'. Conversely, 'Science lessons are fun' received the lowest mean of 3.58, still interpreted as 'High Positive Attitude'.

The overall mean for Scientific Attitudes-Curiosity is 3.77, interpreted as 'High Positive Attitude'. This suggests that the learners' curiosity was active. The respondents in this study were not part of the science section, which may explain why their interest in learning science was slightly lower than expected. Nevertheless, it still indicates a positive curiosity towards the science subject.

Respondent A mentioned that science lesson activities were fun, but some laboratory activities were challenging in online learning due to lack of materials. Respondent C disliked the science subject, describing it as 'complex,' and noted that her mother was also not fond of the subject. These perspectives highlight how students' interests can differ based on individual experiences and influences.

Recent research supports these findings. A study by Vedder-Weiss (2018) found that students' interest in science is significantly influenced by their home environment, including parental attitudes towards the subject. This aligns with Respondent C's experience, where parental disinterest may have impacted the student's perception of science.
Furthermore, Kang et al. (2019) reported that curiosity in science tends to be higher compared to other scientific attitudes. Their study showed that most students strongly agreed with curiosity-related indicators, which is consistent with our findings where curiosity received the highest mean score.

The challenge of engaging students in online science learning, as mentioned by Respondent A, is also reflected in recent literature. Baber (2020) highlighted the difficulties in conducting practical science activities in remote learning environments, emphasizing the need for innovative approaches to maintain student interest and engagement in science subjects during online education.

Table 7 presents the Humility of the respondents regarding the Science Subject. The indicators with the highest weighted mean of 3.74 are 'I think things through in science until they're clear to me' and 'Learning science is important for getting a job in the future', both interpreted as 'High Positive Attitude'.

Notably, some respondents' future career interests were unrelated to science. The instructors observed that the respondents had a low positive attitude towards learning science, as mentioned by Teacher B. This aligns with recent research by Sheldrake et al. (2017), which found that various factors, including perceived difficulty and relevance to future careers influence students' attitudes towards science.

The indicator with the lowest mean (2.50) is 'I can easily learn science concepts without help', interpreted as 'Low Positive Attitude'. This reflects the respondents' learning styles and perceived difficulty of the subject. Respondent C disliked science, describing it as 'complex', and mentioned that her mother was also not fond of the subject. This

intergenerational influence on science attitudes is supported by recent studies, such as Sha et al. (2016), who found that parental attitudes significantly impact students' science engagement and self-efficacy.

**Table 7** Scientific Attitudes in terms of Humility

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. Understanding the science, we're doing is important to me. | 3.60 | 0.97 | High Positive Attitude |
| 2. I think things through in science until they're clear to me. | 3.74 | 0.80 | High Positive Attitude |
| 3. I can easily learn science concepts without help. | 2.50 | 1.20 | Low Positive Attitude |
| 4. Even the topic is hard; I still pursue to learn it because it is science. | 3.32 | 1.11 | Moderate Positive Attitude |
| 5. I would like to belong to a science club. | 3.26 | 1.32 | Moderate Positive Attitude |
| 6. In science experiments, I like to use new methods which I have not used before. | 3.62 | 0.88 | High Positive Attitude |
| 7. I am interested to take courses related to science. | 3.38 | 1.09 | Moderate Positive Attitude |
| 8. Learning science is important for getting a job in the future. | 3.74 | 0.90 | High Positive Attitude |
| 9. I would like to do science experiments at home. | 3.36 | 1.08 | Moderate Positive Attitude |
| Overall | 3.39 | 0.82 | Moderate Positive Attitude |

***Legend***: 5.00-4.21 – Strongly Agree – Very High Positive Attitude
4.20-3.41 – Agree – High Positive Attitude
3.40-2.61 – Neither – Moderate Positive Attitude
2.60-1.81 – Disagree – Low Positive Attitude
1.80-1.00 – Strongly Disagree – Very Low Positive Attitude

The overall mean for Scientific Attitudes-Humility is 3.39, interpreted as 'Moderate Positive Attitude'. This suggests that learners' humility in science learning varies. The transition from face-to-face classes, where instructors reportedly used a more direct teaching approach, to a learning environment requiring more self-directed exploration of science concepts, appears to have challenged the students.

Recent research by Tan et al. (2019) emphasizes the importance of developing self-directed learning skills in science education, particularly in online or blended learning environments. Their study suggests that students accustomed to traditional teaching methods may struggle when required to explore science concepts independently.

Furthermore, Archer et al. (2020) found that students' perceptions of science as 'complex' or difficult can significantly impact their engagement and attitude towards the subject. Their research highlights the need for educators to address these perceptions and develop strategies to make science more accessible and engaging for all students.

The varying perspectives among respondents, with some looking forward to learning science while others don't, reflect the diverse attitudes towards science education observed in recent literature. For instance, DeWitt and Archer (2015) noted that complex personal, social, and educational interactions shape students' science aspirations and engagement.

**Table 8** Scientific Attitudes in terms of skepticism

| Indicators | Mean | SD | VI |
|---|---|---|---|
| 1. The science we learn at school is useful in other subjects. | 3.78 | 0.86 | High Positive Attitude |
| 2. I can usually manage the science we do at school. | 3.62 | 0.99 | High Positive Attitude |
| 3. Many of the things we learn in science are useful elsewhere. | 3.82 | 0.83 | High Positive Attitude |
| 4. School science is relevant to life in today's world. | 4.06 | 0.71 | High Positive Attitude |
| 5. I would prefer to find out why something happens by experimenting than by being told. | 3.64 | 0.90 | High Positive Attitude |
| 6. Science can help to make the world a better place in the future. | 4.14 | 0.67 | High Positive Attitude |
| 7. Working in a science laboratory would be an interesting way to earn a living. | 3.56 | 1.03 | High Positive Attitude |
| 8. Scientific discoveries are doing more harm than good. | 2.76 | 0.94 | Moderate Positive Attitude |
| 9. I would rather agree with other people than an experiment to find out for myself. | 3.44 | 0.95 | High Positive Attitude |
| 10. Science helps to make life better. | 4.24 | 0.74 | Very High Positive Attitude |
| Overall | 3.71 | 0.65 | High Positive Attitude |

***Legend***: 5.00-4.21 – Strongly Agree – Very High Positive Attitude
4.20-3.41 – Agree – High Positive Attitude
3.40-2.61 – Neither – Moderate Positive Attitude
2.60-1.81 – Disagree – Low Positive Attitude
1.80-1.00 – Strongly Disagree – Very Low Positive Attitude

Table 8 shows the skepticism of the respondents regarding the Science Subject. The indicator with the highest weighted mean of 4.24 is 'Science helps to make life better', interpreted as 'Very High Positive Attitude'. Despite some learners not being fond of science, they still agreed that science can improve life quality. Respondent D noted that the new learning modality would not have been possible without science. This aligns with recent research by Nadelson et al. (2019), who found that students generally recognize the positive impact of science on society, even if they don't personally enjoy studying it.

The indicator with the lowest mean (2.76) is 'Scientific discoveries are doing more harm than good', interpreted as 'Moderate Positive Attitude'. The study's timing might influence this lower score during the COVID-19 pandemic, when some people were questioning whether the virus was laboratory-made. Recent research by Agley and Xiao (2021) has explored the prevalence and impact of such beliefs during the pandemic, highlighting how global events can influence perceptions of science.

The overall mean for Scientific Attitudes-Skepticism is 3.71, interpreted as 'High Positive Attitude', suggesting active skepticism among learners. The respondents' views on skepticism vary based on their interests and how they examine the world, which can lead to misunderstandings or misinterpretations of scientific concepts. This aligns with findings by Sinatra and Hofer (2016), who discussed how personal epistemologies and beliefs can influence scientific understanding and skepticism.

It's important to note that healthy skepticism is crucial to scientific thinking. However, as Drummond and Fischhoff (2017) point out, there's a delicate balance between skepticism and denial of scientific evidence. Their research suggests that science curiosity can help mitigate politically motivated reasoning about science.

Furthermore, recent studies have explored the relationship between scientific skepticism and science education. For instance, Farias et al. (2019) found that improving science literacy and critical thinking skills can help students develop a more balanced approach to scientific skepticism, allowing them to distinguish between warranted skepticism and unfounded doubt.

The varying perspectives among respondents reflect the complex nature of scientific attitudes in education. As Kahan (2017) argues, science curiosity appears to counteract political biases in evaluating scientific evidence, suggesting that fostering curiosity could be a key strategy in science education.

**Table 9** Relationship between the Online Learning Barriers and the Scientific Attitudes of a learner

| Online Learning Barriers | Scientific Attitudes | | |
|---|---|---|---|
| | Curiosity | Humility | Skepticism |
| Individual Barriers | 0.135 | 0.255 | 0.211 |
| Technical Barriers | -0.150 | -0.129 | -0.278 |
| Domestic Barriers | -0.048 | -0.059 | 0.131 |
| Institutional Barriers | -0.061 | -0.086 | -0.015 |
| Community Barriers | -.381 | -.399** | -.368** |

****.** Correlation is significant at the 0.01 level (2-tailed).

The results in the table above show no significant relationship between the variables of Online Learning Barriers and the Scientific Attitudes of the respondents. This study was limited to Grade 9 online learners of Plaridel Integrated National High School in the researcher's locality, which may contribute to these results.

Individual Online Learning Barriers have a negligible relationship with curiosity and a weak positive relationship with Humility and Skepticism. This may be due to individual tendencies to approach subjects with pre-existing mindsets, including beliefs, values, and preferences, which can affect learning and attitude changes. Bettinger et al. (2020) note that individual characteristics and mindsets significantly influence online learning outcomes and attitudes.

Technological Online Learning Barriers show a negligible relationship with Curiosity and Humility, and a weak negative relationship with skepticism. This weak negative relationship might be because ICT skills don't necessarily affect an individual's curiosity. Bergdahl et al. (2020) found that while technological issues can create barriers, they don't significantly impact students' overall attitudes towards learning.

Domestic Online Learning Barriers demonstrate a strong negative relationship with Curiosity and Humility, but a negligible relationship with skepticism. This may be attributed to how group norms and home environment affect a person's attitudes. Borup et al. (2019) highlight the crucial role of parents and the home environment in shaping students' attitudes and engagement in online learning.

Institutional Online Learning Barriers show a negligible relationship with all three components of scientific attitudes. This could be because attitudes are not innate but learned, and institutional barriers may prevent teachers from effectively engaging students' interest. Tømte et al. (2019) emphasize the importance of institutional support and teacher training in fostering positive attitudes in online learning environments.

Community Online Learning Barriers have a moderate negative relationship with all three components of scientific attitudes. This aligns with the understanding that attitudes are learned within a community context. Greenhow and Galvin (2020) discuss how community factors and social learning environments significantly influence students' attitudes and engagement in online science learning.

These findings underscore the complex interplay between online learning barriers and scientific attitudes. As Henrie et al. (2015) suggest, a multifaceted approach considering individual, technological, domestic, institutional, and community factors is necessary to fully understand and improve online learning experiences and attitudes toward science.

## CONCLUSION

Based on the findings of this study, there is insufficient statistical evidence to reject the null hypothesis stating there is no significant relationship between online learning barriers and the scientific attitudes of the respondents. Therefore, the hypothesis is sustained. However, it's important to note that the lack of a significant relationship does not necessarily mean these factors are unrelated. The rapid transition to online learning during the pandemic created a unique educational context that may have influenced these results.

Future studies should involve a larger and more diverse sample, including students from different grade levels and educational contexts. This broader scope would provide a more comprehensive understanding of the relationship between online learning barriers and scientific attitudes across various educational settings.

Future researchers should investigate effective strategies to mitigate these challenges due to the focus on online learning barriers. This could include exploring adaptive learning technologies or investigating the role of self-regulated learning skills in overcoming online learning barriers. Such research could lead to practical solutions for improving the online learning experience.

Educational institutions should implement more engaging and interactive activities to stimulate learners' curiosity and scientific attitudes. This approach could help foster a more positive attitude towards science, even in the face of online learning challenges. Activities that promote active learning, inquiry-based approaches, and real-world applications of scientific concepts could be particularly effective.

While this study did not find a significant relationship, future research could explore potential indirect effects or mediating factors between online learning barriers and scientific attitudes. This approach could uncover more nuanced connections that weren't apparent in the current study.

Consider conducting longitudinal studies to track changes in scientific attitudes and the impact of online learning barriers over time. This approach could provide valuable insights into the long-term effects of online learning on scientific attitudes, helping educators and policymakers make more informed decisions about online science education.

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