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Challenges in Inquiry-Based Science Learning in Online Distance Learning Modality: Input to Action Plan

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Abstract

The K-to-12 science curriculum promotes the use of Inquiry-Based Science Learning (IBSL) as a pedagogy to achieve scientific literacy. However, the COVID-19 pandemic has disrupted the conventional education approach in migration to new normal. This sequential explanatory research was conducted to explore the students' challenges encountered in IBSL in Online Distance Learning Modality (ODLM) at a public integrated high school. Stratified random sampling was used to select the 261 students as respondents from Grades 7 to 12. Researchers-developed survey questionnaires was administered online. Descriptive statistics was employed to analyse the collected data. Results revealed that majority of the students encountered not much challenges in learning resources, competence to technology tools, online self-efficacy, teachers' pedagogy, motivation, and support system. However, specific indicators received higher mean, implying that certain challenges still existed. To further explore such challenges, in-depth interview was conducted among 12 purposively selected participants. Thematic analysis was utilised to interpret the data. Results disclosed other domains of challenges. Some students experienced limited interaction and received minimal assistance among peers. Meanwhile, lack of constant communication impeded continuous science learning. Fundamental science topics were not rigorously discussed, while the absence of experiments resulted to poor laboratory skills. Furthermore, online science pedagogies were not fully utilised. Challenges are evident; hence, these findings provide pedagogical insights to enhance the use of IBSL in new learning modality. An action plan is hereby proposed to reduce the challenges in IBSL in ODLM.

Keywords: challenges; inquiry-based science learning; online distance learning modality; sequential explanatory research

Introduction

The COVID-19 pandemic has changed the conventional teaching and learning practices of schools adopting the emergency remote education (Ancheta & Ancheta, 2020). This abrupt shift (Tria, 2020) has set off changes evident in the operationalisation of the Basic Education Learning Continuity Plan (BE-LCP) of the Department of Education (DepEd) in which alternative learning delivery modalities are implemented (Hernando-Malipot, 2020). One of which is the Online Distance Learning Modality (ODLM) which is the most preferred learning modality in schools as it provides a platform to conduct live interaction and student engagement using online educational resources, platforms, and tools accessed through the internet (DepEd, 2020; Bartlett & Warren, 2021).

Science education provides a crucial role to succeed in today's global knowledge

environment (Sunga & Hermosisima, 2016). The science curriculum of the K to 12 program aims to develop scientific literacy which serves as a measure of success evident in students' learning gains and achievements (Codon & Polong 2020). Hence, the K to 12 curriculum highlights the use of pedagogical approaches such as Inquiry-Based Science Learning (IBSL) which provides learners the opportunities to investigate a problem, ask questions, test out ideas, seek for possible solutions, make observations, and manifest creative thinking (DepEd, 2019). This pedagogical approach supports good science teaching and active learning (Constantinuo et al., 2018) that promotes students' engagement, interest, and motivation. Previous studies revealed that IBSL created better learning opportunities (Chu et al., 2017), enhanced critical thinking (Destino & Cunningham, 2020), as well as improved conceptual understanding, 21st-century skills, and learning attitude of students (Abaniel, 2021).

Despite its beneficial implications, challenges have surfaced as teachers are confronted with complexities (Koyunlu Unlu & Dokme, 2020) in preparation, planning, and execution. This is further compounded by prevalent issues in science education (Sadera et al., 2020) including scarcity of science teachers, lack of motivation and interest among learners, low self-assurance in learning science, absence of science laboratories and facilities, congested curriculum, and poor quality of learning resources. Furthermore, the COVID-19 pandemic enlarged the situation on how to deliver IBSL in ODLM. The instant adoption of online teaching (Hodges et al., 2020) results to lack of creativity, resourcefulness, and innovation (Doucet et al., 2020) leading to difficulties and complexities in instructional delivery and assessment. As a result, students reported poor interpersonal connection (Driver, 2018), absence of sense of community (Reedy, 2019), and lack of motivation (Manalo et al., 2022). Science should be learned as a way of inquiry; however, by blending the teaching strategy with ODLM can hampers its success without adequate skills as well as rigorous ICT training and resources (De Villa & Manalo, 2020).

This situation has led the researchers to explore the challenges encountered by learners in IBSL in ODLM to provide a platform for science teachers which inform about the students' issues and concerns to create intervention programmes and sustain quality science teaching and learning amidst the emergency remote education.

Objectives of The Study

This study attempts to explore the students' perceived challenges in IBSL in ODLM, specifically to answers the following queries:

1. What are the students' perceived challenges in IBSL in ODLM as to:
   1.1. learning resources,
   1.2. competence to technology tools,
   1.3. online self-efficacy,
   1.4. teachers' pedagogy,
   1.5. motivation, and
   1.6. support system?
2. What are the students' lived experiences in IBSL in ODLM?

What action plan may be proposed to minimise students' challenges in IBSL in ODLM?

Methodology

The study employed sequential explanatory design, a type of mixed method research which starts with the collection and analysis of quantitative data followed by qualitative data (Creswell & Creswell, 2017). For the quantitative phase, a total of 261 students from junior and senior high school programmes at San Pablo City Science Integrated High School were randomly selected in strata as respondents. A researcher-developed questionnaire called "*Challenges in IBSL in ODLM Questionnaire"* was used as the main instrument. This underwent expert validation and reliability test. The survey questionnaires encoded in Google Forms were administered among the respondents online. Descriptive

statistics such as mean and standard deviation were computed to analyse the students' responses. For the qualitative phase, 12 participants were purposively selected for in-depth interviews that were conducted via online platforms. Thematic analysis was used to analyse the participants' responses.

Results and Discussion

Students' Perceived Challenges in IBL ODLM

Table 1. *Perceived Challenges in IBSL as to Learning Resources*

Indicators	Mean	SD	Remarks
1. Digital and/or printed copies of learning modules	1.41	0.75	Not at all
2. Supplementary materials	1.54	0.88	Not much
3. Stable internet connection	1.28	0.53	Not at all
4. Support devices or equipment	1.19	0.49	Not at all
5. Access to online libraries	1.50	0.80	Not much
6. Access to online simulation and virtual laboratory sites	1.73	0.86	Not much

Learning resources supported student learning. This has become even more critical nowadays while remote learning was implemented (Reimers et al., 2020). Results showed that learners were equipped with necessary resources used in ODLM. Internet connectivity, devices, and digital modules were available. However, indicator 6 received the highest mean perception which concerned on learners' access to online simulations and virtual laboratories.

Authentic science learning was attained through experiments and investigations. However, it has become more challenging to conduct laboratory work during remote learning (Gamage et al., 2021). Moreover, indicator 5 also obtained a high mean perception. Online libraries have become the learners' study partners to get credible information in ODLM (Zhou, 2021), but limited access may hinder students' drive to learn.

Table 2. *Perceived Challenges in IBSL as to Competence to Technology Tools*

Indicators	Mean	SD	Remarks
1. Videoconferencing applications	1.50	0.72	Not much
2. Virtual classroom	1.36	0.58	Not at all
3. Office productivity tools	1.60	0.77	Not much
4. Social media	1.38	0.67	Not at all
5. Online collaboration tools	1.33	0.61	Not at all
6. Messaging tools	1.28	0.55	Not at all
7. Video sharing sites	1.34	0.61	Not at all
8. Online simulation and virtual laboratory	2.27	1.04	Not much
9. Video and image editing tools	1.71	0.89	Not much

Educational technology tools have made learning become more accessible, simpler, and less laborious (Bala, 2020). Results revealed that majority of the students were competent in using technology tools. Websites, e-programs, and online applications were necessary in ODLM. However, indicator 8 revealed that there were learners who struggled in using online simulations and virtual laboratories. This was parallel to the significant findings in Table 1 in which access to online simulations and virtual laboratories has become a challenge too. Science teachers should also empower learners to develop their competencies in operating technology tools.

Table 3. *Perceived Challenges in IBSL as to Online Self-Efficacy*

Indicators	Mean	SD	Remarks
1. Fixing technical problems and issues	1.87	0.76	Not much
2. Using new type of technology easily and efficiently.	1.54	0.70	Not much
3. Learning well in an online learning environment.	2.07	0.98	Not much
4. Managing time effectively during online learning.	2.20	0.98	Not much
5. Completing online tasks on time	1.69	0.89	Not much
6. Seeking online materials and resources in the web	1.67	0.76	Not much
7. Searching information online	1.45	0.69	Not at all
8. Using synchronous and asynchronous technologies efficiently	1.73	0.85	Not much
9. Using online messaging tools and/or social media platforms for easy communication	1.63	0.79	Not much
10. Accomplishing individual tasks and/or group projects online.	1.75	0.82	Not much

Self-efficacy was a crucial component of students' skills in ODLM (Yavuzalp & Bahcivan, 2019) since they were expected to take responsibility of their own learning. Results uncovered that majority of the learners had high level of online self-efficacy. This implied that students could utilise technology effectively. Learners are adaptable to online platforms and digital tools since they are part of Gen Z who are called digital natives.

Yet, some students were not at ease learning in an online environment and could not manage their time effectively as shown in indicators 3 and 4 respectively. There were a lot of distractions in ODLM since house and school boundaries became unclear. As a result, this may interrupt learning goals among students. Therefore, they need to improve their time management skills to finish the tasks ahead of time so that they can still enjoy their leisure time (Joubert, 2020).

Table 4. *Perceived Challenges in IBSL as to Teacher's Pedagogy*

Indicators	Mean	SD	Remarks
1. Giving self-paced activities	1.47	0.66	Not at all
2. Encouraging questions and discussions	1.20	0.53	Not at all
3. Providing guided activities	1.38	0.58	Not at all
4. Providing collaborative tasks	1.33	0.59	Not at all
5. Using online simulation and virtual laboratory activities	1.98	0.92	Not much
6. Exploring different facets of online learning environment.	1.40	0.61	Not at all
7. Contextualizing lessons	1.46	0.65	Not at all
8. Providing personalized activities	1.56	0.80	Not much

9. Using different assessment methods.	1.53	0.71	Not much
10. Providing feedbacks	1.68	0.84	Not much

Distance learning does not guarantee the complete adoption of teaching strategies that are routinely utilised in face-to-face classes (De Villa & Manalo, 2020). Hence, teachers continue to reinvent their pedagogical goals which are appropriate to ODLM by utilising relevant online tools (Calixto et al., 2021). Science teachers allow students to enjoy online learning opportunities through active participation in class discussions, raising questions, provision of self-paced, as well as guide individual and group tasks. Lessons and activities are personalised and contextualised, while assessment methods are varied. However, as shown in indicator 5, it appeared that some students believed that their science teachers employed limited online simulations and virtual laboratories. This can be attributed to teachers' lack of resources and skills due to the abrupt shift of learning modalities. Moreover, indicator 10 revealed that some students agreed that teachers' provision of feedback served as a challenge. The demands for teachers' presence are raised during ODLM in which they are expected to always present and give quicker responses. Providing immediate feedback assists learners to bridge the gap between where they are and where they need to go (Hattie et al., 2021).

Table 5. *Perceived Challenges in IBSL as to Motivation*

Indicators	Mean	SD	Remarks
1. Interest in learning science concepts	2.23	1.11	Not much
2. Drive to accomplish science activities	1.97	0.98	Not much
3. Individual accountability in self-paced activities	1.97	0.92	Not much
4. Enjoyment in group tasks	1.78	0.90	Not much
5. Enthusiasm in learning science	1.92	1.01	Not much
6. Persistence to finish science tasks on time	1.54	0.78	Not much
7. Willingness to perform better	1.52	0.77	Not much

Motivation reassures learners to be more engaged in science learning. Their drive, interest, enjoyment, persistence, and willingness to learn are set by motivation. Results showed that majority of the students were motivated to learn despite the change of learning modalities. However, it could be gleaned that indicator 1 received the highest mean perception which implied that some of them tended to lose interest to learn science in ODLM. This may be attributed to the lack of hands-on activities, experiments, and investigative projects which were considered as the keys of science learning to maintain their motivation and engagement (Manalo, 2021) by considering learners' contexts such as their personality, situations at home, and fondness.

Table 6. *Perceived Challenges in IBSL as to Support System*

Indicators	Mean	SD	Remarks
1. Monitoring, counselling, and remediation	1.50	0.73	Not much
2. Using technology tools and online platforms	1.47	0.69	Not at all
3. Learning resources	1.18	0.47	Not at all
4. Conducive learning space at home	1.44	0.74	Not at all
5. Assistance during science activities.	1.44	0.73	Not at all
6. Help in doing challenging tasks	1.47	0.76	Not at all
7. Support in mental and emotional struggles	1.90	1.06	Not much

Support system is a critical component of students' learning so that they are able to cope with academic and personal demands of remote learning (Shikulo & Lekhetho, 2020). Results revealed that majority of the students received the support they need in terms of the provision of resources and learning space, accomplishing tasks, using unfamiliar tools, and supervision. However, indicator 7 obtained the highest mean perception. This implied that some students received minimal support in coping with mental and emotional problems. Anxiety and stress are evident among learners' experiences in remote learning (Watermeyer et al., 2020) due to isolation, no boundaries between home and school, fear of the pandemic, etc. Hence, the situation calls for more compassion, empathy, and positive well-being support from family and school. Considerations, kindness, patience, and understanding should be given among learners to alleviate adverse feelings (Calixto et al., 2021).

Students' Lived Experiences in IBSL in ODLM

Theme 1. Limited interaction among peers during collaborative tasks

Collaboration is a crucial skill in IBSL. Learners collaboratively work with their peers through engaging activities which allow them to manifest cooperation, listen to others' views, and being open-minded (Korkman & Metin, 2021). A sense of community among students can satisfy leaners' overall online learning experiences (Fuller et al., 2015). However, the results revealed that some learners could not fully collaborate with their peers during online science activities. It has become challenging to communicate with peers instantly during group activities, hence, resulting to lack of interest and vitality to accomplish the task. They just tended to divide the tasks without genuine teamwork in discussing the pieces of information contributed by each learner. Some tasks are complicated, but learners cannot easily get to work with their classmates due to poor internet signals, conflicts in schedules, and varied issues at home. Lack of communication, hence, impede continuous science learning among students. This case has lost their motivation to learn in groups and tended to learn independently instead.

Theme 2. Fundamental science topics were not rigorously discussed

DepEd has released the Most Essential Learning Competencies (MELCs) in order to focus on teaching and learning the most relevant topics that the learners must acquire, thus, developing them into life-long learners (Gonzales, 2020). These competencies were fit in the provided number of days per quarter in accordance with the suggested Budget of Work (BOW). However, the results revealed that students faced difficulty in understanding some of the science lessons provided during online classes. Since lessons were fixed already to conform with the indicated number of days, there were still requisite topics which were not rigorously discussed. Furthermore, teachers and students only met two hours per week during synchronous sessions. The rest of the hours are allotted to asynchronous sessions in which video lessons and activities are given. Hence, it has become difficult for teachers to unpack the competencies. This resulted to more problems such as less mastery of the foundational concepts which served as building blocks of higher science skills.

Theme 3. Absence of hands-on experiments resulted to poor laboratory skills

Hands-on experiments provide students the opportunity to acquire practical and manipulative skills as well as learn experimental techniques. These are essential to obtain science process skills which are the foundations of quality science learning. However, students uncovered that its absence made their science learning experiences inadequate. They just knew the theoretical concepts but lack of practical applications. However, previous studies mentioned that the online laboratory experience was the same as or better than the conventional approach since such was convenient,

accessible, and stress-free (Rowe et al., 2018). However, this was not the case, as students mentioned that teachers utilised limited online simulation and virtual laboratory. Thus, the students received only minimal online science experiences. Individualised instruction and access to laboratory education had been compromised causing adverse impacts on student engagement in scientific experimentation (Achuthan et al., 2021).

Theme 4. Online science pedagogies were not fully utilized

Live interaction among teachers and students and the learning resources have become widely accessible and available (Yang, 2013). However, the results showed that some students found that it was difficult to learn science topics in ODLM. They attributed it to science teachers' practices and methods used in online classes. Video lessons and reading materials were just sent in the virtual classroom. Though recitation was still evident, most of the time, lecture method was employed. However, teachers could not be blamed since the emergency of online migration was unprecedented. Only little had been done to develop effective instructional strategies for online classes (Akdemir, 2010). Hence, teachers found it difficult to teach topics which require hands-on activities and live demonstrations. With limited knowledge and skills on facilitating online instruction, teachers embraced the modality even without adequate training.

Proposed Action Plan

Project, Program or Activity	Objective	Duration and Persons Involved	Success Indicators
Creating contextualised and localised learning resources	To create contextualised and localised science learning materials to be used in ODLM	Quarterly Subject coordinator Science teachers Validators	100% of science teachers produced science learning materials for distribution among learners
Learning Action Cell (LAC) sessions on digital learning	To conduct training sessions to enhance teachers' and students' on utilizing educational technology tools and improving online self-efficacy	Monthly Resource speaker Science teachers Students	100% of the science teachers and students improved their digital skills
Capacity building program for science teachers' pedagogical content knowledge	To enhance science teachers' pedagogical content knowledge in employing IBSL in ODLM	Quarterly Resource speaker Science teachers	100% of the science teachers enhanced their pedagogical content knowledge in using IBSL in ODM
Kumustahan: A psycho-social support	To provide a psycho-social support for students'	Quarterly	100% of the students were guided accordingly as to

program for students	mental and emotional concerns	Guidance counsellor School head Science teachers Students and their parents	psycho-social support needed.
	To help students elevate their motivation and engagement amidst emergency remote education		100% of the students were highly motivated and engaged in science learning.
Stakeholders' Power-up: Strengthening support and linkage	To provide a stronger support system in students' educational undertaking in emergency remote education	All-year round School stakeholders (internal and external)	100% of the target stakeholders provide support in various capacities to address students' needs in science learning.

Conclusions

Based on the findings of the study, the following conclusion are derived.

1. The implementation of ODLM amidst COVID-19 pandemic poses challenges in IBSL. However, minimal challenges are experienced by most learners in terms of learning resources, competence to technology tools, online self-efficacy, teachers' pedagogy, motivation, and support system. Moreover, certain challenges still exist as revealed by specific indicators.
2. Challenges are still bound to exist as IBSL is drastically implemented in a different learning modality such as ODLM. Limited class interaction, minimal assistance from peers, lack of communication, limited discussion of fundamental science topics, absence of experiments, and inadequate online science pedagogies are the challenges experienced by the learners.
3. ODLM has been the most preferred modality during remote learning. Despite its benefits and opportunities, challenges are manifested. Hence, the proposed action can be looked into, considered, and implemented to help science teachers in sustaining IBSL in ODLM amidst the emergency remote education.

Recommendations

The following recommendations are stated for future considerations.

1. Training programs on the use of IBSL in ODLM may be developed based on the domains of challenges. This may help to minimise the challenges faced by learners as well as teachers.
2. Challenges may be revisited in order to create plans of action. This may serve as relevant inputs to enhance the implementation of the schools' BE-LCP particularly in teachers' upskilling and reskilling and improvement of learning environment.

Similar research studies may be conducted to examine other domains of challenges amidst the student diversity and different learning modalities.

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