Acquisition of Science Process Skills through Alternative Learning Modalities among Senior Secondary School Students

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ABSTRACT. The Philippine Department of Education provided Self-learning Modules accompanied by alternative learning modalities, such as modular and online learning, to ensure that learning continues amidst the pandemic. This study assessed the level of acquired basic and integrated science process skills (SPS) of senior high school STEM students. Likewise, this study identified which among the two alternative learning modalities best contributes to the acquisition of science process skills. Through descriptive and inferential analyses, results showed that both online and modular distance learning modality contributes to the acquisition of SPS, indicating the adherence to the mandate of the DepEd in delivering quality education in the new normal. However, the significantly lower level of acquired integrated SPS among learners taking modular learning modality suggests the need to integrate SPS in modules using supplementary instructional materials.

1.0. Introduction

Science education aims to build a scientifically literate society wherein students can solve problems, make evidence-based decisions, and evaluate information logically (Glaze, 2018). Acquiring scientific knowledge is vital in modern contemporary society, for its application helps satisfy basic human needs and improves the standard of living (Rull, 2014). By advancing education and developing new knowledge, science's procedures and concepts are critical to everyone's ability to participate in informed societal decisions and respond positively to changing circumstances (Das & Singh, 2014). Learning science promotes the development of students' various skills, focusing on acquiring knowledge and skills that help students communicate and evaluate scientific knowledge (Heitmann et al., 2017).

Teaching students how to engage in inquiry is one of the essential goals of science education. This means that knowledge and skills must be integrated by students to fully understand scientific concepts (Kimba et al., 2018). Science process skills (SPS) are practical skills necessary to develop scientific knowledge (Fugarasti et al., 2019). Acquiring science process skills is required to create and use scientific data, conduct scientific research, and solve problems (Zeidan & Jayosi, 2015). Acquiring science process skills is essential to help students learn through critical thinking and utilize information creatively through observing, organizing, analyzing, reasoning, evaluating, interpreting, and predicting (Rauf et al., 2013). Science process skills also play an essential role in providing significant challenges in identifying ways to improve teaching-learning outcomes (Maranan, 2017).

In the K to 12 Science Curriculum Guide, learners are expected to be provided with experiences that would enable them to learn and perform the science process skills of observing, communicating, comparing, classifying, measuring, inferring, and predicting to understand the concepts deeply, thus, emphasizing the understanding and application of scientific knowledge in real-life situations (Department of Education [DepEd], 2016a).

Learning science as a subject is better when done face-to-face as it engages learners and elicits active participation in person (Kemp & Grieve, 2014). However, in December 2019, SARS-CoV-2

(COVID-19) had an outbreak in China, spread globally, and was declared a pandemic (World Health Organization [WHO], 2020). Several extraordinary challenges brought by the coronavirus 2019 had posed problems, especially to the educational sectors, making face-to-face classes impossible (Tria, 2020).

In the Philippines, alternative learning modalities such as modular, TV-based, radio-based instruction (RBI), blended, and online are extensively utilized by the Department of Education (DepEd) to ensure that high-quality education is provided. Through alternative learning modalities, students can access quality education amid the COVID-19 pandemic (DepEd, 2020). Through alternative learning modalities, knowledge acquisition becomes flexible as it provides a platform that enables learners to take charge of their learning at their own pace (Malonzo et al., 2021). Specifically, a school division in Northern Negros Occidental is implementing distance learning modalities, such as modular and online learning integrated with Self Learning Modules (SLMs), to respond to the pandemic.

Recent studies on SPS delved more on investigating the link between student attitude toward physics and science process skills (Kimba et al., 2018), the interaction between science process skills and scientific attitudes of students towards technological pedagogical content knowledge (Juhji & Nuangchalerm, 2020), basic procedural skills and a positive attitude toward science as inputs to improve learners' cognitive performance (Maranan, 2017), guided quick labs and academically challenged learners' predicting, observing, and inferring skills (Salanatin, 2020), and the impact of teacher candidates' science process skills on analytical chemistry (Juniar et al., 2021). To date, however, there is a dearth of meaningful research assessing the level of acquired SPS of STEM students through alternative learning modalities in the context of the new educational norms, most especially at the Senior High School level.

This study aimed to describe the level of acquired science process skills of senior high school students when grouped according to sex and exposed to alternative learning modalities, either online or modular, and identify which alternative learning modality promotes the better acquisition of science process skills. The findings of the study were used as the foundation for the creation of supplementary instructional materials, such as contextualized learning activity sheets integrated into SLMs, to improve the teaching-learning process in the new normal.

2.0. Framework of the Study

This study theorized that the level of acquired basic and integrated science process skills vary according to sex and alternative learning modality exposed to learners, as anchored on the Social Role Theory, Experiential Learning Theory, and Dale's Cone of Experience. Mainly, social role theory states that because men and women are physically different, the work they do in society also differs (Eagly & Wood, 2010). In addition, social role affects the choice of academic majors and careers as the child reaches adolescence and adulthood (Olsson & Martiny, 2018). Similarly, Thompson (2004) explained that social role in sex differences was being enculturated through various experiences associated with social positions in the family, making men more inclined to leadership than women. Relating social role theory in the acquisition of science process skills, Yamtinah et al. (2017) rationalized that in the acquisition of science process skills, males have an eye in seeing facts while having direct observation, leading them to make conclusions, while females are good in constructed questions since they have better verbal skills.

Meanwhile, the experiential learning theory believes that the best way to learn is doing as it demands reflection and abstraction in conceptualizing meaning through concrete experiences (Kolb, 2020). Similarly, Dale's Cone of Experience states that the learning process becomes better when students have direct experience to it, so they retain more information by what they "do" as opposed to what is "heard," "read," or "observed" (Janoska, 2017). Relating experiential learning theory in acquiring science process skills through alternative learning modalities, Shuja et al. (2019) rationalized that online learning engages students to perform innovative activities, allowing maximum interaction and cooperation that opens up avenues of learning to enhance educational performance. Moreover, modular learning greatly helps learners acquire knowledge as it initiates self-paced learning even in the distant learning setup (Naboya, 2019). This is also supported by Parrish (2019) that through learners' exposure to opportunities, active learning and the liberty to learn in a social context are elicited, thus creating more retained information.

Relating with Dale's Cone of Experience, providing learners with concrete experiences makes them remember more than just reading it as it involves more senses (Janoska, 2017). In addition, it makes learning more meaningful when more senses perceive it and where there is an increase in the degree of abstraction (Lee & Reeves, 2017). Dale's Cone of Experience likewise employs a positive impact on students' learning. It generates authentic and tangible experiences that the child can use to retain more information, thus increasing academic performance (Davis & Summers, 2015).

The level of acquired basic and integrated SPS varies according to sex and alternative modes of learning exposed to students. Through the social role, experiential learning, and cone of experiences theories, this study assessed the level of acquired science process of learners through alternative learning modalities. Moreover, social role, experiential learning, and cone of experiences theories provided a framework on the factors that affect the acquisition of SPS through learning alternatives in the new normal.

3.0. Methodology

This study employed the descriptive-comparative design, which determined the level of acquired basic SPS of observing, measuring, classifying, predicting, and communicating and integrated SPS of controlling variables, defining operationally, formulating a hypothesis, interpreting data, and experimenting of senior high school students in a large secondary school in Northern Negros Occidental during the school year 2020-2021 when respondents were grouped according to learning modality and sex.

Table 1 shows the profile of the respondents. Using a stratified random sampling method, the 104 Grade 11 senior high school students under the Science, Technology, Engineering, and Mathematics (STEM) track answered an electronically generated instrument.

Table 1. Profile of the Respondents

Variable	f	%
Learning Modality		
Online	51	49.0
Modular	53	51.0
Sex		
Male	41	39.4
Female	63	60.6
Total	104	100.0

Table 2 presents the distribution of science process skills in a standardized instrument on the 55 items Science Process Skills Test (SPST), developed by Rabacal (2016), that tests the basic and integrated SPS. It is composed of two parts: a 30-item test on basic SPS with five items for each skill of observing, inferring, measuring, communicating, classifying, and predicting and a 25-item test on integrated SPS, five items for each skill of controlling variables, defining concepts, forming a hypothesis, interpreting data, and experimenting.

Content and face validity were used to ensure the instrument's validity. The test included 30 basic science process skills and 25 integrated science process skills. It is a multiple-choice type with four options for respondents to choose from as its basis for providing adequate sampling, a good item pool, relative ease of test administration, scoring efficiency, and scoring reliability. The four stages of development were planning, preparing the test items, trying out the test items, and evaluating the instrument. A one-way grid table of specifications was utilized to create the table of specifications. The test items were distributed based on the topics covered.

Reading and scanning of Science publications that deal with science process abilities as well as teaching it, and other related references, were done in framing the test items for the curriculum areas accompanied by an informal consultation with high school and college science teachers and experts in the field, focusing on the content areas and degree of difficulty of the test. In analyzing the test item, the upper-lower index method was used. Marginal items with moderate difficulty were retained and improved, while those not good were rejected. The jury validation shows a very high degree of validity with a mean of 3.62. Creswell and Creswell (2018) defined reliability as the consistency of the

measuring instrument. The KR 21 research instrument reliability was used and obtained 0.72, which showed a high degree of reliability.

Table 2. Distribution of the Science Process Skills

Science Process Skills	**Items**
Basic	
Observing	1, 2, 3, 4, 5
Inferring	6, 7, 8, 9, 10
Measuring	11, 12, 13, 14, 15
Communicating	16, 17, 18, 19, 20
Classifying	21, 22, 23, 24, 25
Predicting	26, 27, 28, 29, 30
Integrated	
Controlling variables	31, 32, 33, 34, 35
Defining Operationally	36, 37, 38, 39, 40
Formulating Hypothesis	41, 42, 43, 44, 45
Interpreting data	46, 47, 48, 49, 50
Experimenting	51, 52, 53, 54, 55

In interpreting the data for both the level of acquired basic and integrated SPS, the following scale was used: 0.00-6.00 Very Low, 6.01-12.00 Low, 12.01-18.00 Average, 18.01-24.00 High, 24.01-30.00 Very High. Meanwhile, the following scale was utilized to determine the level of acquired SPS for basic and integrated skills: 0.00-1.00 Very Low, 1.01-2.00 Low, 2.01-3.00 Average, 3.01-4.00 High, 4.01-5.00 Very High. To ensure the study's ethical soundness, the researcher focused on the general ethical principles of respect for others, beneficence, and fairness. Mean and Standard Deviation were utilized to determine the degree of acquired SPS while examining the data. The Kolmogorov-Smirnov test determined the variables' normality for the comparison analysis. Further, the Mann-Whitney U test was utilized to examine whether there was a significant difference in the level of acquired basic and integrated SPS when grouped according to learning modality and sex.

4.0. Results and Discussion

Level of Acquired Basic and Integrated SPS

Generally, Table 3 shows that the level of acquired basic and integrated SPS of the Grade 11-STEM students is high (M=3.53, SD=0.42). This implies that students have learned the basic SPS of observing, inferring, measuring, communicating, classifying, and predicting, and integrated SPS of controlling variables, defining concepts, forming a hypothesis, interpreting data, and experimenting to understand the concepts deeply (DepEd, 2016b) in adherence to the mandate of the DepEd; thus, they can produce and use scientific information and solve scientific problems (Zeidan & Jayosi, 2015). The rest of the population subgroups have also acquired a high level of basic and integrated SPS.

Notably, students under the online learning modality acquired higher basic SPS (M=22.39, SD=3.29) than those in the modular learning modality (M=20.89, SD=2.66). On the other hand, the integrated SPS of students in the online learning modality is lower (M=16.45, SD=2.83) than those in the modular learning modality (M=17.94, SD=2.96).

The results indicate that the Science Framework for Philippine Basic Education set by the DepEd in developing scientifically, technologically, and environmentally literate and productive members of the society has been successfully strengthened (DepEd, 2016a). Generally, the result reflected that the Grade 11 STEM students have acquired basic and integrated science processes skills, as expected of STEM students. They should master these skills because these will engage them in scientific and mathematics practices and prepare them for a STEM-based job market (Stehle & Peters-Burton, 2019). These findings show the acquisition of SPS amid the global health crisis as quality education continuity is strengthened.

In addition, the high level of basic SPS of observing, inferring, measuring, communicating, classifying, and predicting revealed that Grade 11 STEM students can assign items and events using

spoken and written words, graphs, symbols, drawings, or diagrams, as well as quantitatively describe objects. This implies that they can read and comprehend graphs and predict what will happen in the future. More specifically, students should have a strong grasp of these core abilities, as they are considered requirements for the integrated SPS, which is a more difficult skill (Rabacal, 2016).

Meanwhile, the high level of the integrated SPS of managing variables, defining concepts, forming a hypothesis, evaluating data, and experimenting means that they have acquired the set of complex science processes that enables them to solve problems and think logically. They also know how to manipulate properties and variables, draw inferences, and give tentative generalizations from experiments conducted. However, the results that show that the integrated SPS of students under the modular learning modality is much lower than students under the online learning modality suggest the need for additional supplementary instructional materials to be integrated with modules to equip learners with SPS through enjoyable laboratory activities.

Table 3. Level of Acquired Basic and Integrated Science Process Skill

Variables	Basic Science Process Skill			Integrated Science Process Skill			Overall		
	M	SD	Int	M	SD	Int	M	SD	Int
Learning Modality									
Online	22.39	3.29	High	16.45	2.83	High	3.53	0.46	High
Modular	20.89	2.66	High	17.94	2.96	High	3.53	0.38	High
Sex									
Male	22.24	3.13	High	17.02	3.22	High	3.57	0.46	High
Female	21.22	2.98	High	17.33	2.83	High	3.51	0.39	High
Whole	21.63	3.07	High	17.21	2.98	High	3.53	0.42	High

Note: M=mean, SD=Standard Deviation, Int=Interpretation

Difference in the Level of Acquired Basic and Integrated Science Process Skill according to Learning Modality

As seen in Table 4, there is a significant difference in the level of acquired basic [U=813.500, p=0.000] and integrated science process skills [U=943.000, p=0.008] of senior high school students when they are grouped according to learning modality. As a result, there is enough evidence to reject the null hypothesis. Also, the working theory that the acquisition of SPS varies according to the demographics of the students, such as learning modality, is accepted. This indicates that the level of acquired basic and integrated SPS differs depending on the learning modality employed to them.

Table 4. Difference in the Level of Acquired Basic and Integrated SPS according to Learning Modality

Variable	Learning Modality		U	z	p
	Online	Modular			
Basic Science Process Skill	22.39 (3.29)	20.89 (2.66)	813.500*	-3.525	0.000
Integrated Science Process Skill	16.45 (2.83)	17.94 (2.96)	943.000*	-2.671	0.008

Note: *the difference is significant when $p \leq 0.05$

Generally, the findings indicate that students under the online learning modality have significantly higher basic SPS than students under the modular learning modality. In addition, students under modular learning modality have significantly higher integrated SPS than students under online learning modality. The findings proved that online learning greatly helps students improve their skills as it becomes more interactive than modules alone. However, students with varying levels of cognitive reasoning displayed a wide range of process skill abilities.

On the other hand, the level of acquired basic science process skills of senior high school students taking modular learning modality is lower than students who are taking online learning modality. Hence, learners may be provided supplementary instructional materials, such as the review of basic SPS and integrating basic SPS in modules.

Notably, online learning modality is suggested in bringing quality education in the new normal, incorporated with methodologies like student-centered approach, inquiry-based learning, feedbacking, and creativity as online modality enhances instructional materials using new online platforms and applications, which make learning interactive, thus promoting timely response of teachers to learners' queries (Arrieta et al., 2020). The study of Osman and Vebrianto (2013) on using a variety of media to improve science process skills and achievement asserts that there is a significant effect of teaching with the use of technology towards the development of science process skills and students' achievement in learning science as it helps improve not only students' performance but also their science process skills. Furthermore, online learning via mobile phones or gadgets had a favorable association with students' academic performance, which boosted academic productivity. Mobile-assisted learning plays a key positive effect in increasing students' total educational results (Shuja et al., 2019).

On other recommendations made by Jalil et al. (2018) and Fugarasti, Ramli, and Muzzazinah (2019) in assessing the quality of the science process skills test (SPST), the test contains the sub-dimensions as classifying, communicating, inferring, measuring, observing, predicting, controlling variables, hypothesizing, experimenting, defining operationally, and data interpreting (Feyzioglu et al., 2012). It is carefully planned and contains plausible alternatives (Rabacal, 2016). The high level of acquired basic and integrated science process skills of the Grade-11 students from the result of the SPST adheres to the science framework for Philippine basic education where skills were acquired as it focuses on knowledge relevant to the real world and encompasses methods of inquiry, thus promoting the construction of ideas and application of science process skills (DepEd, 2016b). Hence, the findings that show the higher level of acquired basic science process skills of students under the online learning modality compared to students in modular learning suggests that teachers can still be given specific training through the conduct of learning action cell to enhance basic science process skills by its integration in the modules.

Difference in the Level of Acquired Basic and Integrated Science Process Skill according to Sex

There is no significant difference in the level of acquired basic [U=1024.500, p=0.074] and integrated SPS [U=1218.000, p=0.623] of senior high school STEM students grouped according to sex. As a result, there is insufficient evidence to disprove the null hypothesis. The working theory that students' acquisition of science process skills varies depending on their demographics, such as sex, is also disproved.

Table 5. Difference in the Level of Acquired Basic and Integrated SPS according to Sex

Variable	Sex		U	z	p
	Male	Female			
Basic Science Process Skill	22.24 (3.13)	21.22 (2.98)	1024.500	-1.789	0.074
Integrated Science Process Skill	17.02 (3.22)	17.33 (2.83)	1218.000	-0.492	0.623

Note: the difference is significant at p<0.05

This generally implies that the basic and integrated SPS of the Grade 11-STEM students is not specific to sex. Male and female students employ the same level of acquired basic and integrated SPS. This also signifies that regardless of sex, the students acquire the same capability level of SPS.

The findings show that students, regardless of their sex, acquired the same level of basic and integrated SPS. Findings of this study affirm the results of the study conducted by Rabacal (2016), which yielded the t-ratio of 0.89 at p=0.37, and Ekon and Eni (2015), which computed the value of of 1.02, which is lower compared to 7.81 at 0.05 probability level and 3 degrees of freedom. This means that there is no significant difference in the level of acquired basic and integrated SPS according to sex. This also implies that both male and female students have equal aptitude in terms

of science process abilities. Hypotheses stating that when senior high school STEM students are grouped according to sex, there is no substantial difference in their degree of acquired basic and integrated SPS are therefore accepted. This means that Grade 11-STEM students' level of acquired basic and integrated SPS is not particular to sex.

On the contrary, the findings of the study conducted by Yamtinah et al. (2017) on gender differences in students' attitudes toward science, which analyzed students' science process skills using a testlet, negate the results wherein differences of science process skills of female and male students have been noted, which prove that male students have a relatively higher level of acquired SPS than female students. Meanwhile, Yuliskurniawati et al. (2019) asserted that female students do better on SPS assessments than male students with a value of (p 0.002) in an unpaired t-test showing a significant difference between male and female students' SPS.

In addition, as mandated by the Department of Education, science teachers can improve students' performance by emphasizing basic SPS and providing them with group activities that encourage collaboration by emphasizing basic SPS and providing them with group activities that encourage collaborative effort (Maranan, 2017). Therefore, teachers should create a collection of questions on SPS to initiate a science exploration or activity (Jack, 2018) and give more attention to SPS to reinforce scientific and critical thinking amongst students in promoting SPS and their application (Al-Rabaani, 2014).

5.0. Conclusion

Acquiring SPS is a shift from traditional learning, where students utilize their intellect and apply their ability in engaging themselves in thinking and reasoning in a more dynamic way (Jack, 2018). Attaining a higher level of acquired basic and integrated SPS promotes individual development for using scientific knowledge that may have social, health, or environmental consequences. It incorporates science and technology with the civic, personal, social, and economic aspects of life and the moral and ethical dimensions (DepEd, 2016b).

Also, the difference in basic SPS level of senior high school students who take online learning, which is higher than those who take modular learning, implies that the basic SPS and their integration in modules need to be reviewed. This is best addressed by using supplementary instructional materials given to learners to receive additional activities that will equip them with the basic SPS using the printed modular modality. Therefore, the delivery of quality education is not hampered by any pandemic as quality learning is strengthened and implemented in the succeeding school years no matter what modality best suits the learner.

Therefore, it is recommended that curriculum experts be provided with an idea of the advantages of giving supplementary materials to students as a learning intervention needed to improve the teaching-learning process, leading to students' higher academic achievement aligned with the Most Essential Learning Competencies (MELCs), and suggest ways to integrate SPS in modules. Similarly, science teachers may be provided with the necessary training, which includes the review of SPS and its integration in modules. They may be tasked to craft contextualized activity sheets that enhance the SPS of learners through enjoyable home experiments. Also, they may undergo training adapting to the new normal learning platforms to develop flexibility when it comes to delivering instruction in distant learning.

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