

FACTORS AFFECTING THE EFFECTIVENESS OF SCIENCE TEACHING DURING COVID – 19 PANDEMIC

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**Abstract:** Due to the impact of COVID-19 pandemic, the world is facing the new setup of the education system, where blended learning will be used. The teachers' challenges are integrating the innovative programs in different subject areas effectively, how to motivate the students' learning process and ensure that learning continues for all the students. This descriptive survey assessed different factors affecting the effectiveness of Science teachers during COVID-19 pandemic. A total of 44 Science teachers from the schools of Subic National High School, Castillejos National High School and San Guillermo National High School responded to the researcher-crafted survey questionnaire ( $\alpha=0.962$ ). Results of the study showed that majority of the respondents strongly agree on factors affecting the effectiveness of Science teaching in which expertise in the subject matter is the primary factor followed by teaching performance, administrative support, student's level of understanding, teacher communication, digital proficiency, instructional materials and professional development. Based on the descriptions of an effective science teaching given by the science teachers, it is said that teaching science concepts can be apply in real life situations. The strategies use to be effective in teaching Science during pandemic must be engage flexible learning. In other factors that may affect the effectiveness of Science teaching is teaching resources. There was no significant difference on the teacher's perspective of the eight factors affecting the effectiveness of science teaching when grouped according to profile variables. Furthermore, positive significant moderate to high correlations were observed among factors affecting the effectiveness of science teaching in the current pandemic. The study suggests that training and seminars that focuses on enhancing content knowledge and pedagogy in teaching science during pandemic should be given among Science teachers that highlights on techniques and strategies on science teaching during COVID-19 pandemic. Correspondingly, future studies that focus on determining other factors that can affect the effectiveness of science teaching in the current pandemic must be conducted.

**Keywords:** educational disruption, factors, pandemic, online survey, science teaching

## INTRODUCTION

The goal of science education is to develop students' cognitive and scientific literacy, promote scientific understanding, and prepare them to be responsible citizens (Timonen, 2020).

The complex activity of teaching science lies at the heart of the scientific education vision articulated in the standards. Science teachers must live up to the expectations established by their pupils in order to be the greatest teachers they can be. They are responsible for stimulating advanced learners, understanding the diversity and sensitivity of students, and committing to continued professional development. Teachers must be educated in both their subject areas and effective teaching strategies in order to ensure that students are equipped for careers, colleges, and the workforce once they graduate from high school. Crawford (2007) asserts that a successful science teacher enables students to acquire the scientific knowledge and empirical reasoning skills required to be active citizens and internationally competitive science learners. It is highlighted the necessity of interacting with and understanding the scientific approach. According to Pangilinan (2018), in order to determine the optimal teaching tactics for scientific instruction, teachers must react to their students' learning preferences.

A scientific instructor can engage students in a variety of effective learning strategies. Because these experiences influence students' self-perceptions, engagement, and achievement, it was noticed that teaching methods in higher

education are regarded as a major issue. However, important changes in teaching tactics occur throughout the year as a result of social, cultural, and technical improvements. The use of educational models can help students learn more about science. Constructivism is a cognitive philosophy that focuses on the learner's construction of knowledge and concepts. (Hardy, 1997). The learning theory, according to Jodi and Julia (2002), contains an interpretation of the important results from research on how people learn. A 2016 study by Qarareh at Tafila Technical University in Jordan found that using the constructivist learning approach can assist students enhance their science skills. The constructivist learning model's learning approaches let learners examine the breadth and depth of their prior experience.

This year's coronavirus pandemic is reported to have had an impact on the global education system. The efficacy of teaching science has been called into doubt, from in-person education to online learning. However, Covid-19 sparked an educational revolution that will see the use of blended learning in the future (United Nations Education, Science and Cultural Organization [UNESCO], 2020). The difficulties in discovering and developing effective teaching strategies and procedures persist. According to Garcia (2020), during the Covid -19 Pandemic, numerous teachers from over the world discussed their main teaching concerns. Professors encounter challenges such as technology and connectivity issues, providing social and emotional support while complying to safety requirements, managing timelines, and maintaining a "family" feel in each science session. The closing of the Covid-19 crisis school had a negative impact on science teaching at the primary and secondary levels in Ireland (Chadwick and McLoughin, 2020).

Infections with Covid-19 are still on the rise in the Philippines, and students are still adjusting to the new teaching and learning methods. Because of the pandemic's impact, science teachers were compelled to switch to a new educational system that compels them to include their technological expertise into their teaching methods. Regardless of background or circumstance, teachers have a big impact on educational systems and help students reach their learning objectives. Teachers are responsible for ensuring that all pupils continue to learn during the Covid-19 issue.

Before Pandemic, a number of factors that affect how well science is taught have been identified. However, the effectiveness of teaching had been questioned as a result of the COVID-19 Pandemic. There haven't been many studies done on the variables influencing how well science is taught during the COVID-19 pandemic. In light of the COVID-19 pandemic, the researchers identified the factors influence the efficacy of science education by aspiring science teachers.

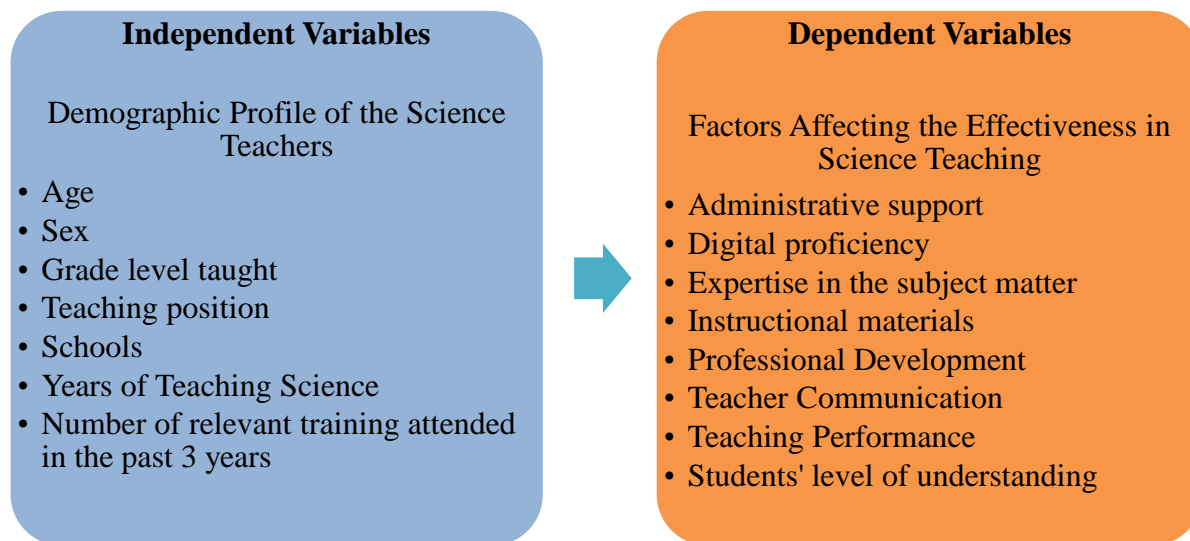
### Conceptual Framework

COVID-19 impacts people worldwide. The health department planned to close schools around the world; 55 million K-12 students and 4 million teachers had already left (Garcia, 2020). Learning Never Stops instructors demonstrate leadership and inventiveness in order to ensure that no student falls behind (UNICEF, 2020). Teachers all throughout the world worked tirelessly to adapt to the new learning arrangement so that all of their students may continue their education despite the outbreak.

Science is a high-order cognitive talent whose practical application entails the study, observation, and laboratory inquiry of the physical and structural features and behavior of the environment. According to Cho and Baek (2019), basic scientific education, such as lab activities, improves fundamental understanding and prepares students for critical courses. Montoya (2015) believes that all students should be scientifically informed. It improved the scientific ability of both pupils and professionals.

According to Teeranusoun (2013), four variables contribute to good scientific education. Course content, teacher communication, teaching performance, and teacher effectiveness are all factors to consider. Learning objectives, evaluation, and instructional methods are all part of the course content. Teachers who can communicate are required. Teachers must be open-minded and effective communicators. Oral, written, and media-based communication are all forms of communication. Teachers and students will communicate more effectively if communication skills are valued.

Figure 1. Paradigm of the Study



The figure illustrates attributes as the independent variables (Demographic Profile of the Science Teachers) that affect the dependent variables (Factors Affecting the Effectiveness in Science Teaching). The output of the study is about an action plan on the different factors affecting the effectiveness of science teaching during this COVID-19 pandemic.

### Methodology

The study have utilized descriptive research design and survey questionnaires as main tools to gather the required data. There are 44 science teachers that served as participants. These science teachers are from three public high schools in the Division of Zambales, Philippines, namely Subic National High School, Castillejos National High School, and San Guillermo National High School. Purposive Sampling was employed. The survey questionnaires are composed of three (3) parts. The first part is the profile of the respondents. The second part is the survey checklists consisting of five (5) statements each to different factors affecting the effectiveness of science teaching. And the third part consists of three (3) open-ended questions that includes describing effective teaching science, strategies to be effective in teaching science amidst the current pandemic, and the other factors that may affect the effectiveness in science teaching in order to answer the respondent’s perception about the study. The study used survey questionnaires created by the researchers which is administered using Google form and face to face survey (see Appendix A). The survey questionnaire was content validated by experts using a 4-point Likert among the criteria format, readability, clarity, organization, accuracy of the content, adequateness of the content, suitability of items, suitability to target respondents, congruence to the research objective, and objectivity of the items, resulting to means of 3.67 to 4.0. The study checked if there are significant difference in the factors affecting effectiveness in science teaching when grouped according to profile. Also, the steps in thematic analysis of Braun and Clark (2019) were employed in identifying, analyzing, and reporting patterns (themes) within data.

### Results and Discussion

#### Demographic Profile of the Respondents

The Table 4 emphasizes the frequency count and percentage distribution of the demographic profile of the respondents.

**Age.** As shown in table, science teachers with aged 25-30 dominated the distribution with a total of 12 (27.27%). This was followed by teachers aged 36-40 with a total of 8 (18.18%), aged 31-35 with a total of 5 (11.36%), aged 46-50 with a total of 5 (11.36%) and aged 51 above with a total only of 4 (9.09%).

**Sex.** Out of 44 science teachers, 33 or 75% are female and 11 or 25% are male. The result shows that there is a greater number of female respondents.

**Grade Level Taught.** Majority of the teacher respondents taught Grade 8 with number of 18(27.27%). Meanwhile, 17 (25.78%) teachers taught Grade 10,16 (24.24%) teachers taught Grade 9 and 15 (22.73%) teachers taught Grade 7. The result shows that most of the grade levels taught by science teachers are Grade 8.

**Table 4 Respondents' Demographics**

Profile	Category	Frequency (N=44)	Percentage (100%)
<b>Age</b>	25-30	12	27.27
	31-35	5	11.36
	36-40	10	22.72
	41-45	8	18.18
	46-50	5	11.36
	51- above	4	9.09
<b>Sex</b>	Female	33	75.00
	Male	11	25.00
<b>Grade Level Taught</b>	Grade 7	15	22.73
	Grade 8	18	27.27
	Grade 9	16	24.24
	Grade 10	17	25.78
<b>Teaching Position</b>	Teacher I	24	54.54
	Teacher II	9	20.45
	Teacher III	6	13.63
	Master Teacher I	2	4.54
	Master Teacher II	3	6.81
<b>School</b>	Subic National High School	24	54.54
	Castillejos National High School	12	27.27
	San Guillermo National High School	8	18.18
<b>Years of Teaching Science</b>	1-5	16	36.36
	6-10	12	27.27
	11-15	16	36.36
<b>Number of relevant trainings</b>	1-3 times	14	31.81
	4-6 times	21	47.72
	7-9 times	3	6.81
	10 and above	6	13.63

**Teaching Position.** Among the science teacher respondents, 24 (54.54%) are Teacher I, 9 (20.45%) are Teacher II, 6 (13.63%) are Teacher III, 3 (6.81%) are Master Teacher II and 2 (4.54%) are Master Teacher 1. The result revealed that there are more Teacher I position than Masters Teachers.

**School.** The table shows that 24 (54.54%) or half of the Science teachers are from Subic, 12 (27.27%) are teachers from Castillejos and 8 (18.18%) are Science teachers from San Marcelino. It described that most of science teachers are from the District of Subic.

**Years of Teaching Science.** The respondents' years of teaching, as illustrated in the table, it revealed that 16 (36.36) have 1-5 years of teaching, 16 (36.36) have 11-15 years of teaching and 12 (27.27) have 6-10 years of teaching.

**Number of Relevant Training.** The table revealed the Science teachers' trainings, 21 (47.72%) of the respondents attended 4-6 times training during the pandemic, 14 (31.81%) attended 1-3 times, 6 (13.63%) attended 10 and above times and 3 (6.81%) attended 7-9 times. This implies that only few had the chance to have 10 and above trainings.

**Effect of Different Factors on the Effectiveness of Science Teaching**

**Administrative Support.** Table 5 shows the respondents' effectiveness of science teaching on administrative support.

As shown in the Table 5, the teachers agree that administrative support affects the effectiveness of Science teaching based on the weighted mean of 3.65 (SD=0.47). This indicates that administrative support is an effective factor in terms of science teaching.

**Table 5 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Administrative Support**

Statements	Mean	SD	VD
1. An effective administration establishes effective forms of online education to redirect the focus on delivering alternative learning methods for those students who do not have similar opportunities.	3.79	0.41	SA
2. With administrative roles, the educational sector can function effectively or efficiently.	3.55	0.50	SA
3. Effective administration and operations support an education that goes well beyond imparting knowledge.	3.70	0.46	SA
4. An effective administration extracts and analyzes key data to inform a school's strategic decisions around education provision.	3.70	0.46	SA
5. The administration provides a well-rounded education that encompasses the whole child.	3.50	0.51	SA
<b>Total</b>	<b>3.65</b>	<b>0.47</b>	<b>SA</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

It revealed that respondents strongly agree that effective administration establishes effective forms of online education to redirect the focus on delivering alternative learning methods for those students who do not have similar opportunities (M=3.79). Effective administration and operations support an education that goes well beyond imparting knowledge (M=3.70) and extracts and analyzes key data to inform a school's strategic decisions around education (M=3.70).

In addition, they strongly agree that with administrative roles, the educational sector can function effectively or efficiently (M=3.55). Moreover, they agree that administration provides a well-rounded education that encompasses the whole child (M=3.50).

Based from the findings of Olokooba (2021), school administrators could boost teacher morale by giving and supporting various teaching methods and strategies needed to meet objectives and motivate students to study.

**Digital Proficiency.** Table 6 indicates the respondents’ effectiveness of science teaching on digital proficiency.

As shown in Table, the teachers agree that Digital proficiency affects the effectiveness of science teaching based on the weighted mean of 3.36 (SD=0.56). This indicates that digitally proficiency is an effective factor in terms of science teaching.

**Table 6 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Digital Proficiency**

Statements	Mean	SD	VD
1. The teacher uses appropriate instructional computer applications or online platforms in teaching.	3.57	0.50	SA
2. The teacher has sufficient technical know-how on the utilization of office application and online platforms in teaching.	3.36	0.53	A
3. The teacher knows numerous appropriate instructional aids (schoology, google classroom, canvas, Edmodo, etc.) depending on the teaching strategy.	3.41	0.54	A
4. The teacher knows on troubleshooting the computer or the teaching application when needed.	3.09	0.71	A
5. The teacher has adequate knowledge in preparing online instructional materials.	3.36	0.53	A
<b>Total</b>	<b>3.36</b>	<b>0.56</b>	<b>A</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

The COVID-19 epidemic has presented unprecedented challenges, requiring teachers to adjust to online education and, as a result, to use a variety of digital tools and resources to address difficulties and implement novel approaches to teaching and learning (König et al., 2020).

**Expertise in the Subject Matter.** Table 7 indicates the respondents’ effectiveness of science teaching on expertise in the subject matter.

**Table 7 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Expertise in the Subject Matter**

Statements	Mean	SD	VD
1. The teacher has a mastery of the subject matter.	3.84	0.37	SA
2. The teacher has vast knowledge on the topics.	3.77	0.42	SA
3. The teacher develops understanding of the science concepts among the students.	3.82	0.39	SA

4. The teacher has chronological or sequential organization of content knowledge.	3.80	0.41	SA
5. The teacher establishes fundamental knowledge on the basic concepts of the topics.	3.82	0.39	SA
<b>Total</b>	<b>3.81</b>	<b>0.40</b>	<b>SA</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

Table 7 shows that the teachers agree that expertise in the subject matter affects the effectiveness of teaching Science based on the weighted mean of 3.81 (SD=0.40). This indicates that being professionally developed is an effective factor in terms of science teaching.

It revealed that respondents strongly agree that teacher must have a mastery of the subject matter (M=3.84), must develop understanding of the science concepts among the students (M=3.82), establishes fundamental knowledge on the basic concepts of the topics (M=3.82), has chronological or sequential organization of content knowledge (M=3.80) and has vast knowledge on the topics (M=3.77).

**The findings back with Cicek and Taspinar's (2021) study, which indicated that gender, university type, academic title, discipline, and teaching experience had no effect on teacher educators' total subject matter expertise.**

**Instructional Materials.** Table 8 indicates the respondents' effectiveness of science teaching on instructional materials.

Table 8 shows that the teachers agree that instructional materials affect the effectiveness of teaching Science based on the weighted mean of 3.49 (SD=0.54). This indicates that being professionally developed is an effective factor in terms of science teaching.

**Table 8 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Instructional Materials**

Statements	Mean	SD	VD
1. The teacher has rich knowledge of the application of concept maps, diagrams, pictographs, photos, videos etc. for the lesson.	3.55	0.55	SA
2. The teacher uses online media sites such as YouTube, Wikipedia and other websites that serves as instructional resources for the teacher and students.	3.43	0.59	A
3. The teacher has a positive attitude toward the use of instructional material during teaching.	3.61	0.49	SA
4. The teacher has available, accessible and good digital instructional aids (laptop, tablet, phones, camera etc.)	3.32	0.56	A
5. The teacher utilizes trusted online sources to supplement science topics.	3.55	0.50	SA
<b>Total</b>	<b>3.49</b>	<b>0.54</b>	<b>A</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

It revealed that respondents strongly agree the teacher must have a positive attitude toward the use of instructional material during teaching (M=3.61), must have a rich knowledge of the application of concept maps, diagrams, pictographs, photos, videos etc. for the lesson (M=3.55) and must utilize trusted online sources to supplement science topics (M=3.55). Moreover, they agree that teacher must use online media sites such as YouTube, Wikipedia and other websites that serves as instructional resources for the teacher and students (M=3.43) and must has available, accessible and good digital instructional aids (laptop, tablet, phones, camera etc.) (M=3.32).

This is consistent with the findings of Chingos and Whitehurst (2012), who discovered that deploying instructional materials has a significant impact on students' learning and performance.

**Professional Development.** Table 9 indicates the respondents' effectiveness of science teaching on professional development.

As displayed on the table, the teachers agree that professional development affects the effectiveness of science teaching based on the weighted mean of 3.50 (SD=0.57). This indicates that being professionally developed is an effective factor in terms of science teaching.

**Table 9 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Professional Development**

Statements	Mean	SD	VD
1. The teacher attends webinars and conferences to further enhance their professional skills and knowledge.	3.75	0.44	SA
2. The teacher is updated in the scientific community discoveries, studies and researches.	3.55	0.50	SA
3. The teacher attends quality enhancement education like graduate/post graduate studies or skills and competency trainings.	3.36	0.61	A
4. The teacher is involved with research and development of the institution or the community.	3.32	0.69	A
5. The teacher reflects on their teaching and training experiences as part of the professional development.	3.50	0.59	A
Total	<b>3.50</b>	<b>0.57</b>	<b>A</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

It revealed that respondents strongly agree that teacher must attends webinars and conferences to further enhance their professional skills and knowledge (M=3.75).

They must be updated in the scientific community discoveries, studies and researches (M=3.55) and must reflect on their teaching and training experiences as part of the professional development. Moreover, they also agree that teacher needs to attend quality enhancement education like graduate/post graduate studies or skills and competency trainings (M=3.36) and must be involved with research and development of the institution or the community (M=3.32).

This supports the conclusions of Emery et al. (2019), which emphasize that professional development in teaching improves student performance and learning outcomes.

**Teacher Communication.** Table 10 shows the respondents' effectiveness of science teaching on teacher communication.



Table 10 shows that the teachers strongly agree that Teacher Communication affects the effectiveness of teaching Science based on the weighted mean of 3.64 (SD=0.49). This indicates that being able to communicate well with the students is an effective factor in science teaching.

It revealed that respondents strongly agree that Science teachers must have the ability to explain science concepts in an approachable manner where students find it easy to comprehend (M=3.75). This was followed by having the ability to correct the science misconceptions of the audiences (M=3.66) and ability to engage science concepts in localize and realistic manner (M=3.68). The teacher also strongly agrees that it's important to have the ability to influence the students with the importance and relevance of science in everyone's lives (M=3.57) and to convey proper instruction during online sessions to the students' respective lab activities (M=3.55).

The finding confirms the study of Khan et. al (2017) that teacher communication skills have effects in the academic achievement of the students.

**Table 10 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Teacher Communication**

Statements	Mean	SD	VD
1. The teacher can explain science concepts in the most appropriate manner.	3.75	0.44	SA
2. The teacher can engage science concepts in a localized and realistic manner.	3.68	0.47	SA
3. The teacher can convey proper instruction during online sessions to the students' respective lab activities.	3.55	0.55	SA
4. The teacher can influence the students with the importance and relevance of science in everyone's lives.	3.57	0.50	SA
5. The teacher can correct the science misconceptions of the audience.	3.66	0.48	SA
<b>Total</b>	<b>3.64</b>	<b>0.49</b>	<b>SA</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

**Teacher Performance.** Table 11 shows the respondents' effectiveness of science teaching on teacher performance.

Table 11 shows that the teachers strongly agree that Teacher Performance affects the effectiveness of teaching Science based on the weighted mean of 3.69 (SD=0.46). This indicates that being able to perform excellently in teaching is an effective factor in teaching Science.

It revealed that respondents strongly agree that Science teachers needs to understand the science concepts, principles, and strategies (M=3.84). The teacher must be enthusiastic in teaching (M=3.77) as well as could discover new alternative approaches in monitoring student's learning outcomes (M=3.73).

It revealed that respondents strongly agree that Science teachers needs to understand the science concepts, principles, and strategies (M=3.84). The teacher must be enthusiastic in teaching (M=3.77) as well as could discover new alternative approaches in monitoring student's learning outcomes (M=3.73).

**Table 11 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Teacher Performance**

Statements	Mean	SD	VD
1. The science teacher is enthusiastic in teaching.	3.75	0.44	SA
2. The teacher can understand the science concepts, principles, and strategies.	3.84	0.37	SA
3. The teacher discovers new alternative approaches in monitoring student's learning outcomes.	3.73	0.45	SA
4. The teacher has adequate time to complete job responsibilities.	3.55	0.55	SA
5. The teacher can provide back up plans for some potential issues.	3.57	0.50	SA
<b>Total</b>	<b>3.69</b>	<b>0.46</b>	<b>SA</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

In addition, the respondents also strongly agree that teacher must be able to provide back up plans for some potential issues (M=3.57) and has an adequate time to complete job responsibilities (M=3.55).

The results confirm (Barron et al., 2021) conclusion that educators must adapt and be creative. The pandemic has caused teachers to reevaluate how much time they spend on administration, teaching, and student interaction.

**Students' Level of Understanding.** Table 12 shows the respondents' effectiveness of science teaching on students' level of understanding

Table 12 shows that the teachers strongly agree that Student's level of understanding affects the effectiveness of teaching Science based on the weighted mean of 3.64 (SD=0.48). This indicates that Student's level of understanding is an effective factor in science teaching.

It revealed that respondents strongly agree that Science teacher must give the students opportunities to explain their ideas (M=3.73) as well as considers individual differences of the students (M=3.73).

In addition, they also strongly agreed to consider the different abilities of the students in the subject (M=3.66), utilizes social media platforms such as messenger, Facebook and google meet, etc. to maintain online communication in the students (M=3.59) and assesses the students' level of performance before planning a lesson (M=3.50).

**Table 12 Effect of Different Factors on the Effectiveness of Science Teaching in terms of Students' Level of Understanding**

Statements	Mean	SD	VD
1. The teacher uses differentiated instructions to matches to the students' level of understanding.	3.59	0.50	SA
2. The teacher gives the students opportunities to explain their ideas.	3.73	0.45	SA
3. Teacher considers the complexity of learning activities based on the gain knowledge of students.	3.66	0.48	SA
4. The teacher considers individual differences of the students.	3.73	0.45	SA

5. The teacher identifies students' strengths and weaknesses by using assessment before planning a lesson.	3.50	0.51	A
Total	<b>3.64</b>	<b>0.48</b>	<b>SA</b>

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

**Summary of the Effect of Different Factors on the Effectiveness of Science Teaching**

Table 13 shows the summary of the effect of different factors on the effectiveness of science teaching.

**Table 13 Summary of the Effect of Different Factors on the Effectiveness of Science Teaching**

Factors	M	SD	VD
Expertise in the subject matter	3.81	0.40	SA
Teaching performance	3.69	0.46	SA
Administrative Support	3.65	0.47	SA
Student’s level of understanding	3.64	0.48	SA
Teacher communication	3.64	0.49	SA
Digital proficiency	3.36	0.56	A
Professional development	3.50	0.57	SA

Legend: Strongly Agree (SA) 3.50-4.00; Agree (A) 2.50-3.49; Disagree (D) 1.50-2.49; Strongly Disagree (SD) 1.0 – 1.49

All in all, the science teacher strongly agrees on the different factors for affecting the effectiveness of Science teaching with a mean score of  $M=3.59 \pm 0.47$ . Results revealed that the respondents strongly agree that the presented factors ensure effective science teaching in which expertise in the subject matter ( $M=3.81$ ) is the primary factor followed by teaching performance ( $M=3.69$ ), administrative support ( $M=3.65$ ), student’s level of understanding ( $M=3.64$ ), teacher communication ( $M=3.64$ ) and digital proficiency ( $M=3.36$ ). Respondents also agree that professional development ( $M=3.50$ ) and instructional materials ( $M=3.49$ ) also affects the effectiveness of Science teaching.

**Description of an Effective Teaching in Science**

The Table 14 shows the ten (10) main themes emerged from the respondents when asked how they describe an effective teaching in Science.

**Theme One: Applies Science learnings in real life situations.** The ability to apply scientific knowledge to real-world situations is frequently cited as an essential component of high-quality science education. Heinz (2021) argues that students will have an easier time grasping scientific concepts if professors use a variety of teaching methods and incorporate real-world examples into their lessons. Mnemonic devices, offering real-world examples and activities, and fostering peer conversation are all examples of these methods. An effective science education, a respondent suggests, “to have an effective teaching in science, we must not focus on remembering concepts but how you apply them in real life situations”. Teachers should give students real-world examples of how to use the knowledge and abilities they are learning in class. The teacher's focus should be on making sure students understand the concepts and material at hand, but shouldn't discount the value of memorization techniques (DiCarlo, 2009).

**Theme Two: Uses relevant strategies and techniques.** Using different techniques will help teachers to improve their teaching and they are able to motivate and encourage student's participation in class (MacDonald, 2022). The respondents describe effective teaching in Science by means of using relevant strategies and techniques. This includes that science teachers should help students develop exploratory questions and high-order thinking skills. Implementing different teaching strategies and techniques will help students to achieve and meet the learning outcomes of the lesson.

According to Auld (2019), teaching different techniques and strategies can inhibit learning and making students feel that they are part of learning community. Also, it improves students' motivation and learning skills and able to determine the strengths and weakness.

**Table 14 Description of an Effective Teaching in Science.**

Main Themes	Significant Statement	F (N=44)	%
Applies Science learnings in real life situations	To have an effective teaching in science, we must not focus on remembering concepts but how you apply them in real life situations. ST43	13	29.55
Uses of relevant strategies and techniques	We should help students develop exploratory questions and high-order thinking skills. ST34	11	25
Denotes concrete understanding in principle of teaching	Science teachers' effective science teaching should denote concrete understanding and application of science concepts among students. ST41	5	11.36
Understands students learning style	I should know and have understanding on students' learning style. ST15	2	4.55
Conducts experimentation	We should engage students to perform actual experimentation. ST11	2	4.55
Engages hands-on experiences	I should allocate time of students to engage in hands-on experiences. ST18	2	4.55
Creates meaningful connection	We must uplift a sense of fairness and meaningful connection. ST20	2	4.55
Improves student's academic success	Science teachers should be able to improve performance and knowledge for student's academic success. ST7	1	2.27
Commits to continual professional development	Teachers must commit to continuing professional development. ST17	1	2.27
Discusses course content	Science teacher should discuss and process content. ST19	1	2.27

**Theme Four: Understands students learning style.** Understands students learning style is also described being effective in science teaching. Effective teacher must recognize and respect individual differences among his/her students and be able determine what learning activities or instructions that best suit to all the learners (Barberos, et al., n.d.). This includes that science teachers should know and have understanding on students' learning style. Understanding students' learning styles and differences will create an inclusive environment and able to make, develop efficient curriculum or strategies that will encourage students' active participation and to easily learn the concepts. Teachers must understand students' learning styles and differences so that they can implement appropriate method of teaching and assessment for all learners (Barberos, et al., n.d.).

**Theme Five: Conducts experimentation.** According to Science Education Resource Center (2018), that conducting an experiment will help students build their ownership of the new idea and able to use it to scaffold learning. The respondent stated that "we should engage students to perform actual experimentation". Engaging and motivating students to perform or conduct laboratory activities, helps students to develop their scientific and problem-solving skills. In addition, experiments promote active learning and improve students' understanding and skills (Science Education Resource Center, 2018).

**Theme Six: Engages hands-on experiences.** Hands-on experiences allow students to become comfortable and familiar with hands-on processes and skills of what will hopefully become their careers (A, 2022). One respondent also describes as being engage in hands-on experiences as effective science teaching. The respondent stated "I should allocate time of students to engage in hands-on experiences". Engaging students' hands-on experiences will improve their learning process and performance. Also, teachers will correct students' misconception about the lesson. Hands-on experiences help students to gain better understanding of the lesson. It allows students to learn from their mistakes and enrich their minds in new and engaging learning styles (Masten, 2015).

**Theme Seven: Creates meaningful connection.** Promoting diversity and equality in the classroom, help students recognize and respect people's differences and create an inclusive environment (Deer, 2022). The respondents agree that a meaningful relationship between scientific concepts is essential for effective instruction. It is stated that "we must uplift a sense of fairness and meaningful connection". Promoting fairness inside the classroom, students will be able to feel that they are safe and comfortable within the classroom. Also, treating the students equally will be able to create a positive teacher-student relationship. Ferlazzo (2021), "equality and fairness" in student care involves providing the same conditions for all students, regardless of their socioeconomic background.

**Theme Eight: Improves student's academic success.** Teachers should provide evidence or activities that help students enhance their thinking skills and process. Motivate students to discover new things and complete their work on time (Robertson, 2018). The respondents describe an effective Science teaching as able to improve student's academic success. The respondent stated that "science teachers should be able to improve performance and knowledge for student's academic success". Teachers should monitor student's performance and learning by encouraging them to discover new things or concepts and applying explicit instruction to improve student's academic outcome. Teachers able to improve student's performance by applying appropriate teaching strategies and assessing their weaknesses and strengths (H, 2020).

**Theme Nine: Commits to continual professional development.** Continuing education assists career-minded individuals in improving their skills and jobs. School administrators must encourage teachers to pursue professional development in order to ensure the best learning outcomes for their students and to be more effective and satisfied in their work (Queens University of Charlotte, n.d.) Becoming an effective science teacher is a continuous process and ongoing opportunities to build their understanding, abilities and professional development (National Committee on Science Education Standards and Assessment; National Research Council, 1996). The respondents also describe effective science teaching as being committed to continual professional development. Science teachers must responsible for their own professional development and maintain their teaching profession. But there are many challenges to continue professional development. Based from the study of Bernadine (2019), it revealed that school typically do not provide adequate help or supervision for their students. Furthermore, educators are discouraged because continuous professional teacher development programs do not offer financial incentives.

**Theme Ten: Discusses course content.** Teacher should address students' misconceptions/incomplete conceptions about the lesson and able to designs lesson that help students to improve their learning and knowledge (Kentucky Department of Education, 2020). Furthermore, one respondent describes course content as effective

science teaching. This includes discussing and processing content and making meaningful connection. Teacher should provide support and implement activities for students who are struggling with understanding the concepts. Teacher should implement a strategy that helps students easily understand the concepts. Engaging students that science should be fun to learn or understand the concepts and ideas (Walden University, 2022).

**Strategies used to be Effective in Teaching Science amidst the current Pandemic**

The Table 15 shows the ten (10) main themes emerged from the respondents when asked what are the strategies they used to be effective in teaching Science amidst current pandemic.

Main Themes	Significant Statement	F (N = 44)	%
Engage Flexible learning	I utilize blended learning. ST16	15	34.09
Applies real-life activities	I engage my students with real life activities. ST17	4	9.09
Utilize hands-on Learning activities	I utilize learner-based activities. ST9	4	9.09
Practice good teacher’s attitude	Having an enthusiastic attitude towards student. ST6	4	9.09
Employ inquiry-based instruction	We using examples or materials that they can see in their surroundings. ST3	3	6.82
Use Interactive simulations	We use interactive simulation platforms. ST10	3	6.82
Employ various teaching Resources	I use various tools in teaching students. ST5	3	6.82
Employ cooperative learning	I employ cooperative learning. ST18	2	4.55
Caters student’s differences	We try to understanding and cater the individual differences of our learners. ST11	1	2.27
Use differentiated instruction	We use differentiated instructions. ST7	1	2.27

**Theme One: Engage flexible learning.**

According to Joan (2013) that flexible Learning is a set of educational philosophies and systems, concerned with providing learners with increased choice, convenience, and personalization to suit the learner. In particular, flexible learning provides learners with choices about where, when, and how learning occurs. Most of the respondents stated that flexible learning is one of the strategies that affects effective Science teaching. This includes utilizing Online teaching platform and combination of online and modular learning. And based on Rojas (2021), the combination of different methods of teaching, including the use of online platforms and digital or printed modules.

**Theme Two: Applies real-life activities.** Boss (2017) suggests using project-based learning to get your students working together with people from all around the world and putting what they've learned into practice. Some respondents of the study expressed that application of real-life activities is one of the strategies used in Science teaching. This includes engaging students with real life activities. This means that we need to provide a concrete example of a real-world application for each and every learner. Multiple pedagogical approaches exist, as stated by SERC (2021), for using real-world examples in the classroom. Case study and investigative case methods, field labs and student research, and the incorporation of local data and examples into the classroom are all examples.

**Theme Three: Utilize hands-on Learning activities.** According to Timmons (2018), that hands-on (also called experiential learning) can be activities like making an analog clock from a paper plate, brass fastener, and two strips of paper in the shape of arrows. Giving hands-on learning activities is also one of the strategies used by the Science teachers. And based on Martin (2020), hands-on learning is a form of education in which children learn by doing. Instead of simply listening to a teacher or instructor lecture about a given subject, the student engages with the subject matter to solve a problem or create something.

**Theme Four: Practice good teacher's attitude.** According to Nagase (2020), that the teachers' emotional distress was significantly and negatively correlated with attitudes toward integrated classroom management and perceived ability to teach students with disabilities. Teacher's attitude is also described as an effective Science teaching. This includes showing a positive, enthusiastic attitude towards students, understanding and catering their individual differences. And based on the study of GCU (2016), attitude is very important when you are a teacher. It affects your students in many ways and can shape their learning experience.

**Theme Five: Employ Inquiry based instruction.** Inquiry-based instruction, as defined by Alper (2018), is a student-centered approach in which the teacher facilitates student-generated questions, methodologies, and interpretations of data. Students take an active role in gathering data for their projects by asking questions and systematically searching for answers. Using inquiry-based instruction is another method that the respondent utilize to improve their Science teaching. According to Bauld (2022), this is a teaching approach wherein students develop knowledge using methods and procedures that are analogous to those of practicing scientists.

**Theme Six: Use interactive simulations.** According to Makri (2017), games and simulations are already heavily incorporated into the conventional educational process as quickly expanding technological applications. Some respondents of the study also expressed those interactive simulations is one of the strategies used in Science teaching. In addition, according to Ouahi (2021), the proliferation of data and the growth in the breadth and depth of human understanding need the use of a variety of approaches to educating future scientists. It has also seemed necessary to establish a mode of instruction that will streamline and facilitate the learning process for the students. And based on the findings of Dantic's (2021), that simulations improved both students' quantitative scores and their qualitative responses to questions.

**Theme Seven: Employ various teaching Resources.** According to JISC (2012), that teaching resources have numerous advantages for new users such as enhanced quality and flexibility of resources, freedom of access and enhanced opportunities for learning and support for learner-centered, self-directed, peer-to-peer and social or informal learning. Some respondents of the study also expressed that teaching Resources is one of the strategies used in Science teaching. And teaching resource can take many different forms and will mean slightly different things to every teacher, parent, and child. But the basic definition is simple: A teaching resource is a material that is designed to help facilitate learning and knowledge acquisition.

**Theme Eight: Employ cooperative learning.** Zook (2018) claims that cooperative learning is built on group work, but it is much more than that. In addition, some study participants adopted cooperative learning as one of the tactics in effective Science education. According to Staff (2019), cooperative learning, often known as small-group learning, is an instructional technique in which small groups of students collaborate on a common task. Cooperative learning helps students learn more, remember more, and build superior critical thinking abilities. Because they prefer cooperative learning to lectures, they are more likely to attend and complete the course. It helps students grasp complex, time-consuming jobs (Teed et al., n.d.).

**Theme Nine: Caters student's differences.** According to Harris (2022), the goal of education is to assist each student to achieve all-round growth based on his or her individual characteristics. To accomplish this, students should be given appropriate aid and guidance based on their abilities and learning needs, so that they can maximize their potential. According to one Science Teacher, "Catering to student differences is also one of the tactics utilized by Science teachers". According to Lo (2008), rather than viewing the learner as a set of stimulus-response reactions, a bundle of nerves, or a number on a test or inventory score sheet, some educators believe that we should approach the issue from a more humanistic perspective that allows us to explain learning from the possible "experiences" that the student has gone through during the learning process.

**Theme Ten: Use differentiated instruction.** According to Weselby (2021), differentiating instruction may mean teaching the same material to all students using a variety of instructional strategies, or it may require the teacher to deliver lessons at varying levels of difficulty based on the ability of each student. Another strategy used by the respondents that affects the effectiveness of Science teaching is employing differentiated instruction. According to Sparks (2015), differentiated instruction” is the process of identifying students’ individual learning strengths, needs, and interests and adapting lessons to match them has become a popular approach to helping diverse students learn together.

**Other Factors that may affect the Effectiveness in Science Teaching**

The Table 16 shows the six (6) main themes emerged from the respondents when asked what are the other factors that may affect the effectiveness in Science teaching.

**Table 16 Other factors that may affect the Effectiveness in Science Teaching.**

Main Themes	Significant Statement	F (N=44)	%
Teaching resources	Having enough resources or tools in teaching. ST6	15	34.09
Parental support	The support of parents/guardians play a vital role in making teaching effective during the pandemic. ST19	8	18.18
Teaching methods	Employing different teaching methods like experiment-based activities. ST11	7	15.90
Internet support	The availability/accessibility to the internet. ST14	6	13.64
Learning environment	The Child-home learning environment. ST41	2	4.55
Student’s behavior	The interest of the student to learn.ST12	1	2.27

**Theme One: Teaching resources.** According to JISC (2012), there are numerous advantages for new users such as: enhanced quality and flexibility of resources, freedom of access and enhanced opportunities for learning and support for learner-centered, self-directed, peer-to-peer and social/informal learning. Most of the respondents stated that Teaching resources is another factor that affects effective science teaching. And teaching resource can take many different forms and will mean slightly different things to every teacher, parent, and child. But teaching resource is a material that is designed to help facilitate learning and knowledge acquisition.

**Theme Two: Parental support.** Mills (2021) found that parental support was an even more powerful protective factor against substance use among middle schoolers than it had been among younger adolescents. Parental involvement and interest also play a role in determining how successful a Science education ultimately is. "Support of parents and guardians play a critical role in making education effective during pandemic" was cited as evidence. Essau (2008) argues that parental support, which includes concepts like nurturing, attachment, acceptance, coherence, and love, is an important component of effective parenting. Involved parents also aid their children's education by teaching their children the language and other skills necessary for learning, such as how to set goals, assess progress, and be conscious of the learning process. Furthermore, teachers may give more attention to pupils whose parents are actively interested in their education (UNESCO, 2021).

**Theme Three: Internet Support.** More than half of respondents indicated every student had enough access to the devices they require for online learning, and another third said that's true for more than three-quarters of their pupils, according to Lieberman (2021). Effective Science education is influenced in part by teachers' access to the internet, according to surveys of educators in the field. Teachers can continue to educate in a more adaptable fashion in today's environment if they have access to a reliable, low-cost, easily available, and powerful internet



connection. Also, the pandemic has brought to light, according to NCES (2021), the importance of providing students with the tools they need to participate fairly in educational opportunities, particularly when they are delivered remotely. Even if word processing, research, and communication outside of school hours were vital to education before the epidemic, they are now all but impossible without access to computers and the internet. During the 2020–2021 school year, students relied heavily on these resources to stay actively involved in their education.

**Theme Four: Teaching methods.** MacDonald (2022) claims that educators can better engage, motivate, and reach their students in both traditional and online settings by drawing on a variety of teaching strategies grounded in the theory of many teaching styles. Methods of instruction also have a role in determining the success of a science class. When a teacher has a deeper understanding of their students' backgrounds, they are more equipped to create engaging and relevant lessons that meet their needs. Additionally, Dantic (2021) highlighted that, Innovative teaching pedagogies assist students better understand challenging scientific subjects by enhancing their thinking and understanding of complex ideas.

**Theme Five: Learning environment.** A learning environment, according to WGU (2021), is more than just a classroom; it is a place where students feel comfortable and supported in their quest of knowledge, as well as inspired by their surroundings. The learning environment of the students is another aspect that influences good science teaching. According to two of the respondents, "Child-home environment" is a factor that influences teaching efficacy. A good learning environment improves a student's ability to learn. According to those polled from their study, the most serious concern with the learning environment is noise (Dantic & Aragon, 2021).

**Theme Six: Student's behavior.** According to Kirkpatrick (2019), teachers who lack confidence in their capacity to execute classroom activities are more likely to have illogical beliefs and have heightened or harmful negative emotions. Teachers demonstrate these ideas, emotions, and behaviors on a daily basis. The student's behavior is another component that influences the success of science teaching. According to Masrom (2021), another successful strategy for teachers to manage student behavior is to promote positive behaviors such as homework completion, careful listening, and respect for others.

**Difference in the Factors Affecting the Teaching Effectiveness of Science by Profile Variables**

Based on the results of the study, there is no significant difference on the factors affecting the effectiveness of science teaching when grouped according to profile variables as indicated by the results of the one-way Analysis of Variance (ANOVA) (see Appendix L).

It means, regardless of their age, sex, grade level taught, teaching position, schools, years of teaching science, and number of relevant trainings, they taught synonymously that all these factors cannot effectively affect the science teaching.

**Relationship Among the Factors Affecting the Effectiveness of Science Teaching**

The table 17 below shows the correlation among the factors affecting the effectiveness of science teaching during the COVID-19 pandemic.

**Table 17 Correlation Coefficients among the Factors Affecting the Effectiveness of Science Teaching**

Variables	1	2	3	4	5	6	7	8
Administrative Support	1	0.162	.457**	0.070	0.083	.375*	0.221	.607**
Digital Proficiency	0.162	1	.378*	.437**	0.092	0.216	0.118	.302*
Expertise in the Subject Matter	.457**	.378*	1	0.185	.402**	.758**	.615**	.693**
Instructional Materials	0.070	.437**	0.185	1	.350*	0.124	.366*	0.201

Professional Development	0.083	0.092	.402**	.350*	1	.343*	.593**	.343*
Teacher Communication	.375*	0.216	.758**	0.124	.343*	1	.648**	.675**
Teacher Performance	0.221	0.118	.615**	.366*	.593**	.648**	1	.486**
Students' Level of Understanding	.607**	.302*	.693**	0.201	.343*	.675**	.486**	1

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

As presented on the table, statistically positive significant relationships ranging from moderate to high correlations are observed between the factors affecting the effectiveness of science teaching. Positive moderate correlations are noted between expertise in the subject matter and administrative support ( $r=0.457$ ;  $p<0.01$ ), instructional materials and digital proficiency ( $r=0.437$ ;  $p<0.01$ ), professional development and expertise in the subject matter ( $r=0.402$ ;  $p<0.01$ ), teacher performance and expertise in the subject matter ( $r=0.615$ ;  $p<0.01$ ), teacher performance and professional development ( $r=0.593$ ;  $p<0.01$ ), teacher performance and teacher communication ( $r=0.648$ ;  $p<0.01$ ). In addition, moderate and positive moderate correlations are noted between students' level of understanding and administrative support ( $r=0.607$ ;  $p<0.01$ ), students' level of understanding and expertise in the subject matter ( $r=0.693$ ;  $p<0.01$ ), students' level of understanding and teacher communication ( $r=0.675$ ;  $p<0.01$ ), and students' level of understanding and teacher performance ( $r=0.486$ ;  $p<0.01$ ). Furthermore, positive high correlation where observed between teacher communication and expertise in the subject matter ( $r=0.758$ ;  $p<0.01$ ).

Result of the study implies that when the respondent's evaluation on a specific factor affecting the effectiveness of science teaching during COVID-19 pandemic increases, other factors will also likely to increase. The finding supports the study of Lai Lai (2015) which found out a significant positive relationship between the factors towards effective teaching among secondary school teachers.

### Conclusions

The significant conclusions based on the findings of the study are as follows:

1. A typical Science teachers-respondents is from Subic National High, ages 25-30, female, teaching Grade 8 and are Teacher-I, having 1-5 years and 11-15 years of teaching experience, and attended relevant trainings and seminars, 1-3 times.
2. The respondents strongly agree that the presented factors ensure effective science teaching in which expertise in the subject matter is the main factor.
3. The primary description of an effective Science teaching is applying science learnings in real life situations.
4. The primary strategy used to be effective in teaching Science during COVID-19 pandemic is engage flexible learning.
5. In the other factors that may affect the effectiveness of Science teaching, the most underlying factor is teaching resources.
6. Using the one-way Analysis of Variance (ANOVA), it shows that there is no significant difference on the teacher's perspective of the eight factors affecting the effectiveness of science teaching when grouped according to profile variables.
7. There is a statistically positive significant relationships ranging from moderate to high correlations observed between the factors affecting the effectiveness of science teaching.

### Recommendations

The recommendations of the researchers are as follows:

1. Educational institutions must reassess the needs of teachers so that they can succeed in the current Covid-19 pandemic where the period of education is disrupted.
2. Teachers should be equipped with technological skills necessary to cope with unexpected change due to crises/disasters such as COVID-19. Similarly, online teaching pedagogies should be incorporated into regular mandatory teacher professional development programs to provide teachers with ongoing skills in online teaching.

3. The study recommends that training and seminars that focuses on enhancing content knowledge and pedagogy in teaching science during pandemic should be offered towards Science teachers. This may include trainings and seminars that highlights on techniques and strategies on science teaching during pandemic.
4. Science teachers should adopt variety of instructional strategies or techniques to instruct diverse students in the current pandemic.
5. Administrations may also offer programs and policy instructions that cater and address inquiries and concerns of teachers especially the teaching resources required for online teaching. Creation of these helps to avoid teaching ineffectiveness among teachers.
6. Although the results provided information about the factors affecting the effectiveness of Science teaching in the current pandemic, there are limitations in this study. Researchers limited the number of respondents to 44 Science teachers and this affect to the generalizability of the results. The limitations of this study only include science teachers within the three largest schools in the municipality of San Marcelino, Castillejos and Subic, further study may be conducted to include all schools within the Division of Zambales for better results and generalizability.
7. In addition, future studies should focus on determining other factors that can affects the effectiveness of science teaching in the current pandemic.

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