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Assessment of Teachers' Instructional Practices: Towards Proposing an Innovative Instructional Model for Teaching-Learning Material in Chemistry

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Abstract

Twenty-first-century teaching focuses on the standards of teaching practice to improve instruction and learning outcomes. Teachers as the key figures in school are called upon to reflect on their instructional practices and exemplify the highest standard for teaching grounded in global best practices. This study aimed to assess the teachers' instructional practices and identify challenges before and during the COVID-19 pandemic to effectively implement instructional strategies in the teaching of chemistry. The respondents were composed of 107 public Junior High School chemistry teachers in the 8th district of Cavite. The mixed-method sequential explanatory research design was used. Quantitative data were collected using the Science Instructional Practices Survey and the questionnaire on the teachers' perceptions of emergency remote teaching, while qualitative data were gathered utilizing focus group discussions, classroom observations, and virtual interviews. The findings of the study showed that chemistry teachers' instructional practices include prior knowledge and traditional instruction. Before the COVID-19 pandemic, four major themes emerged as challenges to teachers in effectively implementing various instructional strategies: learner characteristics, teacher competency, the language of instruction, and classroom management practices. Five themes were identified as challenges to teachers during the pandemic, namely, appropriate assessment strategy, feedback mechanism, technology usage and availability, parental involvement, and appropriate teaching-learning materials. The findings in this study provided valuable inputs in the development of an innovative instructional model for designing a chemistry lesson.

Keywords: Assessment, Instructional Practices, COVID-19 Pandemic, Instructional Model, Teaching-Learning Material

1. Introduction

The understanding of what constitutes effective teaching and learning has increased significantly over time. Several attempts have been made to describe effective teaching and identify the factors that influence teaching effectiveness. The Organization for Economic Cooperation and Development (OECD, 2013) stated that effective teaching occurs when the student is placed at the center of instructional decisions. This suggests that the instructional focus should be tailored to the students' diverse learning needs. Kloser (2014) believed that effective teaching is guided by specific instructional practices. These instructional practices are a set of teaching strategies and methods of instruction employed by the teacher in the classroom to achieve the desired teaching and learning objectives (Kalu-Uche, 2015). Saleh and Jing (2020) defined instructional practices as the action made by teachers in producing the lesson in the classroom. How the teachers plan their instructions into a sequence of events - presenting the lesson, asking questions, demonstrating skills, and evaluating performance are all parts of their instructional practices.

Windschitl et al. (2012) found that of all the factors associated with student achievement in schools, teachers' instructional practices have the most powerful influence on learning. The quality of instruction, and more specifically the quality of the teacher who plans and implements instruction, has a direct impact on student achievement (Heck, 2009). Studies showed that although students seem to learn from a variety of materials and methods, the key to learning is the teacher. The emphasis on teachers' instructional practice has the potential to increase student engagement and improve their performance in science.

Creating conditions for students' meaningful learning is a challenging task for teachers in a science classroom. Every day, science teachers face the challenge of providing rich and meaningful learning experiences for their students (Luft & Dubois, 2017). They employ a wide variety of instructional practices aiming to positively influence students' opportunities to learn.

Science teachers in the country ensure that students are prepared to adapt to new technologies as a result of Industry 4.0. The government has taken steps to maintain science education programs. However, in the most recent Programme for International Student Assessment (PISA) in 2018 the Philippines ranked last among participating countries with science being one of the subjects tested (Dela Cruz, 2022). As a result, the Department of Education (DepEd) was compelled to propose new programs to address the country's poor academic performance and improve educational quality. Serafica et al. (2018) emphasized that science teaching entails learning how to teach science effectively. This means investigating some effective pedagogical theories and models that can assist teachers in teaching scientific concepts and processes. Furthermore, learning science involves both pedagogy and the teachers' instructional skills in assisting students to understand and love science, and to apply science-process skills in understanding the natural world and activities in daily life.

The announcement of Coronavirus Disease 2019 (COVID-19) as a pandemic in March 2020 marked a turning point in the education system globally (Toquero, 2020). This pandemic crisis has affected about 1.6 billion pupils in more than 190 nations, causing the largest disruption of educational institutions in history (*UNSDG Policy Brief: Education during COVID-19 and Beyond*, 2020).

During this pandemic, several innovative instructional practices for supporting the continuity of teaching and improving learning quality were identified (Salayo et al., 2020). The pandemic has compelled education institutions to embrace virtual teaching, emergency remote teaching, and other learning modalities.

The issues on what teaching strategies and methods to use to help the students perform better, develop a positive attitude towards chemistry, and become independent and strategic learners equipped with the knowledge, skills, work habits, and character traits who are ready to face the challenges of the 21st-century science education can be possibly resolved by looking at the teachers' instructional practices.

This study aimed to improve science education by introducing an instructional model for teaching-learning material (TLM) in chemistry. The findings that were obtained in this study may prove valuable to science education teachers**,** students, researchers, and school administrators. The researcher hopes that science teachers will use the proposed instructional model in the design of their instructions and the development of their teaching-learning materials. To the students who are the direct recipients of the teacher's instructional practices. The outcome of this study may help them to become highly motivated in learning chemistry with the aim that they will perform better. To the researchers who might wish to conduct more intensive and broader studies on the instructional practices of chemistry teachers and to the school administrators in determining and evaluating the effectiveness of the school's present program of instruction. This study may provide them with baseline data for planning and revision of instructional processes.

It is on this premise that this study was undertaken: to assess the chemistry teachers' instructional practices before and during the COVID-19 pandemic, identify their challenges in effectively implementing instructional strategies, and propose an innovative instructional model for teaching-learning material in chemistry.

Specifically, this study sought to answer the following questions:

1. What is the level of chemistry teachers' perceptions of emergency remote teaching (ERT) during the COVID-19 pandemic as assessed by themselves in terms of:
   - 1.1 Attitude
   - 1.2 Competence
   - 1.3 Engagement
   - 1.4 Readiness
   - 1.5 Satisfaction

2. What are the instructional practices of chemistry teachers before the COVID-19 pandemic?
3. What are the challenges encountered by chemistry teachers before and during the COVID-19 pandemic to effectively implement instructional strategies in the teaching of chemistry?
4. What are the salient features of the proposed innovative instructional model gathered from the instructional practices of teachers in the field before and during the COVID-19 pandemic?
5. What teaching-learning material can be developed from the proposed innovative instructional model

2. Conceptual Framework

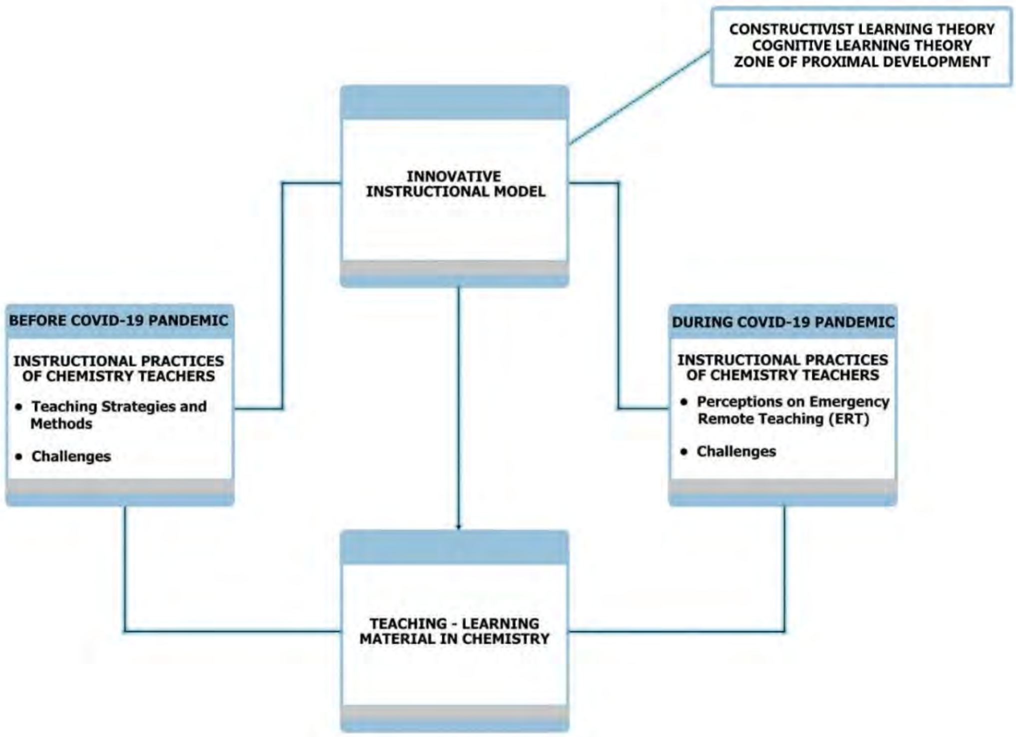

Figure 1. Study Framework

Figure 1 presents the conceptual framework of the study. The left rectangular box shows chemistry teachers' instructional practices, particularly their teaching strategies and methods before the COVID-19 pandemic, as well as the challenges in effectively implementing these instructional strategies. The right rectangular box describes chemistry teachers' instructional practices during the COVID-19 pandemic highlighting their perceptions of emergency remote teaching (ERT) along with the challenges in this global educational crisis.

The major output of this study is the proposed innovative instructional model shown at the center of the left and the right rectangular boxes. This indicates that the instructional model is based on the findings from the variables coming from the two boxes.

Meanwhile, the dotted line shows the connection of the proposed instructional model to the different learning theories. These underlying learning theories supporting the variables in the study include constructivist learning theory, cognitive learning theory, and the zone of proximal development. These learning theories provide the foundation for the design of the innovative instructional model. Khalil and Elkhider (2016) mentioned the importance of linking instructional strategies and methodologies to human learning theories They stated that learning theories are used as a source of verification for instructional strategies as well as a foundation for strategy selection. Learning theories provide information about the relationships between methods, context, and learner characteristics for better integration, and they also allow for reliable prediction of the success of selected instructional strategies.

Finally, the box at the bottom of the paradigm shows how teaching-learning material (TLM) in chemistry can be developed by incorporating the salient features of the proposed innovative instructional model.

3. Methods

3.1. Research Design

This research employed the mixed-methods sequential explanatory research design. Piccioli (2019) sees the mixed method as particularly effective in providing a better justification for the chosen method of investigation, successful in confirming results, and helpful in identifying inconsistencies in the research-questions formulation and expanding the research breadth.

3.2. Respondent

The respondents of this study were composed of 107 chemistry teachers from the 32 public Junior High Schools in the 8th district of Cavite, Philippines.

3.3. Instrument

This study utilized 7 research instruments for the collection of data. Quantitative data were collected using the Science Instructional Practices Survey (SIPS) tool by Hayes et al. (2016), the questionnaire on the teachers' perceptions of emergency remote teaching, the validation instrument on the acceptability of the proposed instructional model, and the evaluation questionnaire on the salient features of the developed lesson exemplar. Qualitative data were gathered through focus group discussions, classroom observations, and virtual interviews.

3.4. Research Procedure

Five successive study phases were carried out to facilitate data collection from teacher respondents.

3.4.1. Phase 1 – Examination of Relevant Literature and Theory and Identification of the Gap

This phase involves a comprehensive examination of relevant literature and theory regarding teachers' instructional practices. The development and validation of research instruments are also part of this phase. Careful attention was observed to ensure that research instruments and data collection tools were free of bias. Similarly, authorization and approval from the author for the survey tool adoption were obtained during this stage as well as obtaining permission to conduct the study from the Institutional Ethics Review Committee (IERC) and the approval of the Schools Division Superintendent, Division Office of Cavite was also sought. The respondents' participation was entirely voluntary, and they were asked to sign a consent form. Confidentiality of the respondent's data was ensured and safeguarded.

3.4.2. Phase 2 – Administration and Collection of Quantitative Data

This phase is the collection and gathering of quantitative data before and during the COVID-19 pandemic. The first part of this phase was the distribution of the SIPS questionnaire to the respondents through personal face-to-face mode. Before distributing the survey tool, the respondents were orientated briefly on the purpose and significance of the study. The second part of this phase was the collection of data during the pandemic. The online survey on the teachers' perceptions of emergency remote teaching was distributed to the respondents on different platforms such as Facebook Messenger, and e-mail. The link to this online survey was in the Google Form.

3.4.3. Phase 3 – Gathering and Collection of Qualitative Data

This phase includes the collection and gathering of qualitative data accomplished using focus group discussions, actual classroom observations, and online interview methods. Focus group discussions aimed at eliciting information and probing deeper into the respondents' instructional practices. To avoid biases, the researcher invited her co-teacher to facilitate and function as the moderator of the FGD. FGD took an average of 45-60 minutes. Classroom observations were also part of the third phase to confirm if the respondent was implementing the instructional practices mentioned in the FGD. Another important activity in the third phase was the conduct of a virtual interview to capture the challenges of the chemistry teacher in delivering emergency remote teaching.

3.4.4. Phase 4 – Analyzing and Interpreting Data

This phase involves analyzing and interpreting the collected quantitative and qualitative data. The quantitative data were analyzed and interpreted using descriptive analysis whereas, the qualitative data were analyzed and interpreted using the inductive approach to thematic analysis. Data collected from the focus group discussions, classroom observations, and virtual interviews were transcribed and coded to identify dominant and emerging themes.

3.4.5. Phase 5 – Development and Validation of the Proposed Instructional Model for Teaching and Learning and Its Salient Features

This phase includes the development of the proposed instructional model as input in the design of the TLM in chemistry. The related body of knowledge was reviewed and analyzed using internet searches of existing instructional models related to teachers' instructional practices. The proposed instructional model was developed by combining information on the teachers' instructional practices from the existing bodies of knowledge with the actual instructional practices of teachers in the field. The initial draft of the proposed instructional model was presented to experts for validation. This is to ensure the accuracy and appropriateness of the identified elements in the instructional model. The proposed instructional model and its salient features were revised and finalized by incorporating all the comments and suggestions from the experts and using the salient features of the proposed instructional model, an illustrative example of the teaching-learning material in chemistry was developed conforming to the learning competencies in chemistry set in the K to 12 curriculum.

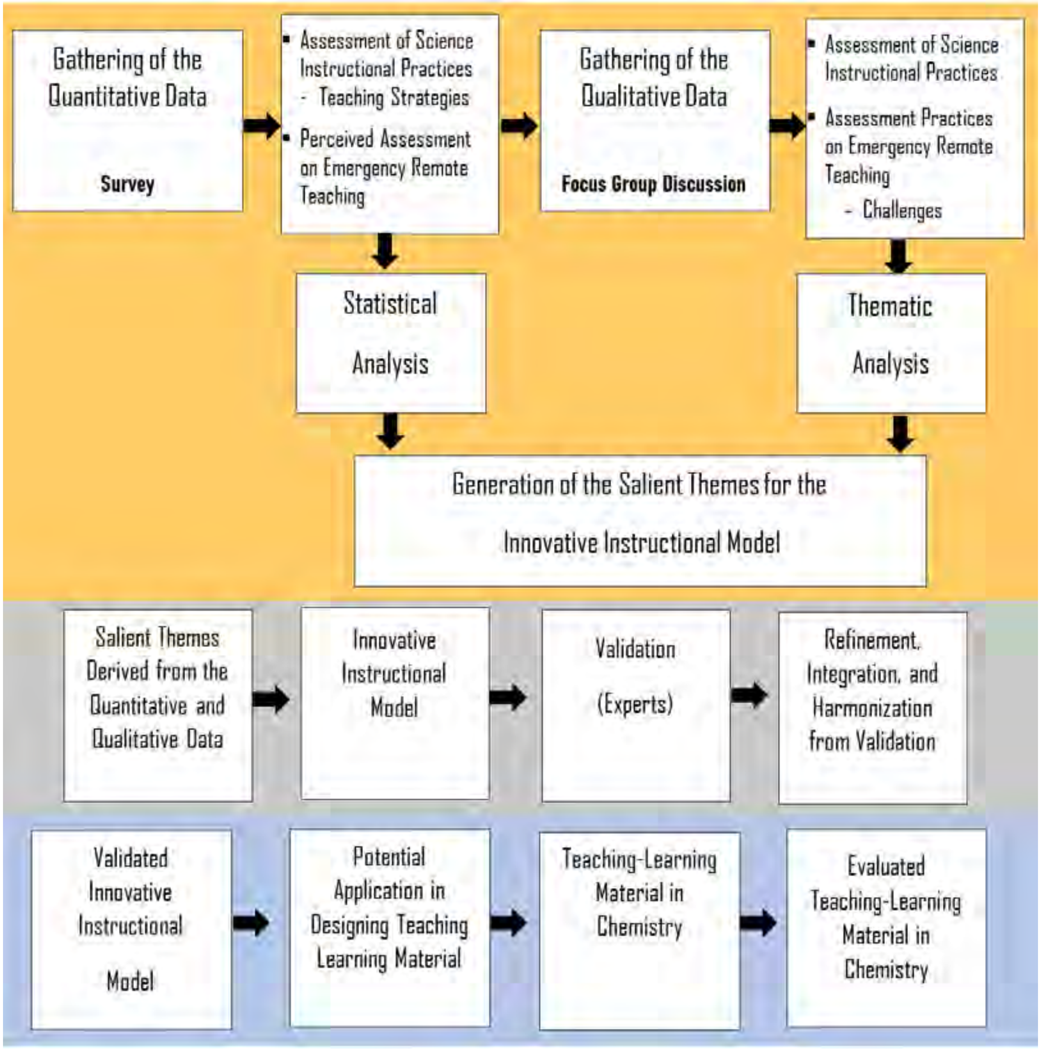

Figure 2. The Flow Diagram of the Research Procedure

4. Results and Discussions

Table 1. Demographics of the Teacher Respondents (n =107)

Demographic		**F**	**%**
Sex			
	Male	11	10.30
	Female	96	89.70
Age (years old)			
	21 - 30	36	33.60
	31 - 40	37	34.60
	41 - 50	22	20.60
	Over 50	12	11.20
Position/Academic Rank			
	Teacher I	61	57.00
	Teacher II	7	6.50
	Teacher III	35	32.70

	Master Teacher	4	3.70
Career Stage (Years Teaching Chemistry)	1 - 5	44	41.10
	6 - 10	36	33.60
	11 - 15	11	10.30
	16 - 20	1	0.90
	21 - 25	8	7.50
	26 - 30	2	1.90
	31 - 35	5	4.70
Highest Educational Attainment	Bachelor's Degree Graduate	41	38.30
	Bachelor's Degree with MA units	55	51.40
	MA Graduate	8	7.50
	With PhD/EdD units	2	1.90
	PhD/EdD Graduate	1	0.90
Field of Specialization			
	Biology	36	33.60
	Chemistry	12	11.21
	General Science	37	34.60
	Physics	20	18.69
	Others	2	1.90

4.1. Chemistry Teachers' Perceptions of Emergency Remote Teaching

Table 2 presents the respondents' perceptions of emergency remote teaching during the COVID-19 pandemic The level of their perceptions is determined in terms of attitude, competence, engagement, readiness, and satisfaction dimensions.

Table 2. Teachers' Perceptions of Emergency Remote Teaching

Dimension	Mean	SD	Adjectival Rating	Interpretation
Attitude	3.17	.345	Agree	Moderately High
Competence	3.32	.340	Agree	Moderately High
Engagement	3.26	.371	Agree	Moderately High
Readiness	3.29	.388	Agree	Moderately High
Satisfaction	3.33	.430	Agree	Moderately High

Mean Range and Description

3.51 – 4.00	Strongly Agree	High
2.51 – 3.50	Agree	Moderately High
1.51 – 2.50	Disagree	Moderately Low
1.00 – 1.50	Strongly Disagree	Low

The 'attitude' dimension describes the respondents' feelings and personal viewpoints toward remote teaching, particularly on the integration of technology. With an overall mean score of 3.17 (Agree) and standard deviation (SD) of .345, the teacher demonstrates a moderately high level of positive attitude towards remote teaching. Despite the current global crisis, the respondents viewed the transition to emergency remote teaching as a positive response measure of the education system to continue learning.

The 'competence' dimension refers to the respondents' knowledge, skill, or ability to use online tools and web resources in the delivery of lessons. As presented in Table 2, the teacher respondents show that they are competent in conducting online instruction under emergency remote teaching. This finding depicted an overall mean score of 3.32 (Agree) and a standard deviation (SD) of .340 and was interpreted as Moderately High.

The 'engagement' dimension pertains to the respondents' approaches to encouraging student participation, attention, interest, optimism, and motivation while students are taught in a remote learning environment. The overall mean value obtained was

3.26 (Agree) with a standard deviation (SD) of .371 and interpreted as a Moderately High level. This means that the respondents are engaged in using various methods to encourage students' participation, motivation, and interest.

The 'readiness' dimension describes the respondents' preparedness for the integration of technology in remote learning. The data shown in Table 2 depicted that teacher respondents displayed a moderately high level of readiness and preparedness for using technology in their remote teaching. This is illustrated in the overall mean score of 3.29 (Agree) and a standard deviation (SD) of .388.

This 'satisfaction' dimension refers to the degree of the respondents' contentment with emergency remote teaching and their belief that this modality of instructional delivery is a success. The calculated overall mean value is 3.33 (Agree) and the standard deviation (SD) is .430 which is interpreted as Moderately High. This result suggests that the respondents are happy, satisfied, and contented with remote teaching as the new mode of instructional delivery.

4. 2. Instructional Practice of Teachers

Tables 3 and 4 present the dominant and the least frequently used instructional practices of chemistry teachers respectively.

Table 3. Mean Scores of Chemistry Teacher Instructional Practices based on Science Instructional Practices Survey (Dominant Practices)

Area	Mean	SD	Verbal Interpretation
How frequently do you incorporate each of the following into your science instruction?			
Prior Knowledge	3.63	.466	Daily or almost daily
Traditional Instruction	3.52	.429	Daily or almost daily

Mean Range and Description
3.51 – 4.00 Daily or almost daily
2.51 – 3.50 Often (once or twice a week)
1.51 – 2.50 Rarely (a few times a year)
1.00 – 1.50 Never

As shown in Table 3, the 'Prior Knowledge' and 'Traditional Instruction' areas obtained the two highest overall mean scores of 3.63 and 3.52, respectively, and were interpreted as daily or almost daily. These results suggest that these two areas are the dominant instructional practices of teacher respondents.

The area of '*Prior Knowledge'* is the most common instructional practice of the teacher respondents. This means that the teacher practices instruction that blends the pre-existing knowledge and experience of students in the classroom. The National Research Council (2012) regarded this area of teachers' instructional practice as an ideal and best technique for science teaching and is strongly associated with student achievement. This instructional practice employs a constructivist approach wherein the learners actively construct or make their knowledge and meanings based on their previous experiences. Anchored on the constructivist and cognitivist learning theories this instructional practice stresses that knowledge is constructed in the learners' minds, and to organize their newly learned knowledge, students create schemas. The prior knowledge of the students, experiences, and insights all serve as the basis for their continued learning. The students learn new information by connecting it to things they already know, allowing them to modify their prior knowledge to accommodate new information.

The area of **'***Traditional Instruction*,**'** on the other hand, ranked second in the teachers' frequently used instructional practice. This type of instruction according to is highly teacher-designed and teacher-directed rather than learner-centered (*Education News – College of Education. University of Saskatchewan*, 2019). Content, rote learning, and memorization are the main focuses of this instructional strategy. Traditional instruction is one of the most widely used instructional strategies, especially among traditional teachers who are the controller of the learning environment. The teacher is regarded as the main source of information providing the students with clear, specific, and direct instruction in explaining science concepts or ideas. Teaching ideas and concepts in science using this area of instruction strategy means making the lesson highly structured, carefully sequenced and planned, and well-directed by the teachers. This suggests that the teacher stands in front of the class and provides the knowledge in a logical, sequential, or step-by-step manner actively involving the students in making meanings and constructing knowledge.

Table 4. ***Mean Scores of Chemistry Teacher Instructional Practices based on Science Instructional Practices Survey*** **(Least Frequently Used Practices)**

Area	Mean	SD	Verbal Interpretation
How frequently do your students do each of the following in your science class?			
Critique, Explanation, and Argumentation	3.34	.470	Often
Data Collection and Analysis	3.21	.438	Often

Instigating an Investigation	3.13	.471	Often
Modeling	2.85	..650	Often

Mean Range and Description
3.51 – 4.00 Daily or almost daily
2.51 – 3.50 Often (once or twice a week)
1.51 – 2.50 Rarely (a few times a year)
1.00 – 1.50 Never

As shown in Table 4, the *'Critique, Explanation and Argumentation'* area obtained an overall mean score of 3.34 which is interpreted as often. This suggests that this area of instructional practice is used by the teacher respondents once or twice a week. The teacher uses instruction that engages students in explanation and argumentation based on evidence. Also, the teacher encourages students to create an argument in support of or in opposition to a claim. Argumentation was described by Erduran et al. (2015} as an important discourse process in science education that emphasizes evidence-based support of knowledge assertions and underpinning reasoning. Explaining the reasoning behind an idea is important in science instruction, especially for the development of a student's cognitive abilities. Argumentation and critiquing each other's reasoning in science teaching offer many benefits. These include developing critical thinking skills, encouraging a spirit of inquiry, enhancing conceptual understanding, and improving the academic performance of students.

The *'Data Collection and Analysis'* area received an overall mean score of 3.21 and was interpreted as often. This means that teacher respondent uses instructional practice encouraging students to collect, record, analyze, and interpret data once or twice a week. Data collection and analysis are important components of scientific processes. In these processes, the students organize scientific data into charts or graphs and make meanings by analyzing relationships and patterns to discover trends and information which can be used in making a conclusion and informed decisions.

The *'Instigating an Investigation'* area obtained an overall mean score of 3.13 which is interpreted as often. Once or twice a week, as part of the teacher's instructional practice, the student is involved in formulating questions, planning, and implementing an investigation. It is evident from the data that teachers are less likely to practice enabling students to "choose variables to investigate, and design or implement their investigations*"*. Instigating an investigation describes the teacher's practice to employ inquiry-based instructional strategies using inquiry teaching and learning. Learners are more likely to remember concepts and newly acquired knowledge if they explore and manipulate settings, struggle with problems and conflicts, or conduct experiments.

Out of all the categories, the area of '*Modeling*' received the lowest mean score of 2.85. This suggests that this area of teacher instructional practice is the least frequently utilized by the teacher respondents in their science class. Scientific modeling, according to Rogers (2012) is the generation of a physical, conceptual, or representation of a real phenomenon that is difficult to observe directly. Models can help one visualize, or picture in his mind, something that is difficult to see or understand. Modeling is a reasoning tool that helps scientists in visualizing, abstracting, and conducting thought experiments. Students' ability to generate ideas is typically aided by instruction that employs models as a thinking tool.

All these four areas of teachers' instructional practices critique, explanation, and argumentation; data collection and analysis; instigating an investigation; and modeling are considered inquiry-related activities. Abd-El-Khalick et al. (2004) stated that science teachers are encouraged to demonstrate classroom practices related to inquiry. Making predictions, observations, and inferences; developing, carrying out, and criticizing investigations; gathering evidence; proposing explanations and conclusions based on evidence, and communicating findings to others are all part of scientific inquiry. According to the Next Generation Science Standards (NGSS) Lead States (2013), these inquiry processes, as well as core concepts of engineering design and technology applications, should be strengthened in science classrooms.

4.3. Chemistry Teachers' Challenges Before the COVID-19 Pandemic

Table 5 presents the themes that emerged as the challenges to teachers in effectively implementing instructional strategies for teaching chemistry before the COVID-19 pandemic.

Table 5. Thematic Analysis of Chemistry Teachers' Challenges in the Implementation of Instructional Strategies before the COVID-19 Pandemic

Selected Codes	Theme
▪ Students lack interest and have low motivation in learning ▪ Students are inattentive and have a short attention span ▪ Students' poor information retention and. short-term memory ▪ Students have difficulty expressing their thoughts, ideas, and feelings.	Learner characteristics

▪ I am not confident in teaching chemistry, because it is not my area of specialization ▪ I find it difficult to incorporate real-world connections into the lesson ▪ I should study the lesson well to ensure that I am prepared and ready for my chemistry class. ▪ I must plan my instructions in advance because most chemistry topics are difficult	Teacher competency
▪ Students prefer Filipino as the medium of chemistry teaching ▪ The teacher's effort in preparing the lesson becomes meaningless because of the English language ▪ When the lesson is taught in Filipino, students are more engaged ▪ Filipino instruction encourages student performance and confidence	Language of instruction
▪ Managing student's untoward classroom behavior is a challenge ▪ I need to set classroom routines and protocol ▪ I use disciplinary measures in the classroom ▪ When the classroom is structured, students have fun while learning	Classroom management

4.3.1. Learner Characteristics

Drachsler and Kirschner (2012) described learner characteristics as the personal, academic, social/emotional, and cognitive characteristics of the learners. Teachers, as instructional designers, must understand learner characteristics to create instructions tailored to a specific group of students. More efficient, effective, and/or compelling educational materials, as well as appropriate teacher instructional strategies, can be planned and developed by taking learner characteristics into account. Results show that some students are not driven by interest, engagement, and questions about the things around them. They do not strive to learn more and do not show initiative in their interest. Moreover, some students usually tend to get bored when they feel obligated to learn rather than excited to learn. These students get trouble focusing on tasks, they easily get distracted resulting in the inability to complete the tasks. It is necessary to maintain their engagement for them to learn. Responses also indicate that students' poor reading skills and comprehension hinder their participation in classroom discussions, along with their poor communication skills and lack of confidence to answer questions or even ask questions to get meaningful answers.

4.3.2. Teacher Competency

Fauth et al. (2019) defined teacher competency as the teacher's pedagogical content knowledge and skills, self-efficacy, and teaching enthusiasm. A good teacher is well-versed in the tasks and instructional strategies that will help students develop conceptual understanding. Results showed that teachers had no choice but to teach the subject. They put the extra mile knowing too well that chemistry is not their line of specialization. Du Plessis (2020) identified that 'out-of-field teaching' contributes negatively to teachers' competency. "Out-of-field teacher as described by him refers to qualified teachers, (often highly qualified), assigned to teach subject fields or year levels for which they do not have appropriate or suitable qualifications; these qualifications include content knowledge and pedagogical content knowledge, or teaching expertise. Being non-chemistry majors had an impact on how they planned instructions although their commitment to the given task is very evident from their practices. Moreover, findings revealed that teachers are not confident to implement the lab work (lab method); thus, it hinders the active participation of students in the class. This finding on teacher apprehension is consistent with the findings of Mizzi (2013) stating that teachers' lack of confidence is manifested in various ways, such as when preparing lesson plans, selecting appropriate classroom activities, conducting laboratory experiments, linking and applying various concepts and principles to everyday life situations, and generating students' interest and passion for the subject. Teacher responses also show that they acknowledge that they are not content specialists who are needed to steer students toward higher-order or critical thinking. Because of their limited knowledge of the out-of-field subject, they avoid in-depth content knowledge discussions compromising the quality of learning.

4.3.3. Language of Instruction

The language of instruction appeared as another challenge that respondents had in successfully implementing the instructional strategies in teaching. Language of instruction refers to the student's preferred medium of instruction in chemistry. As provided for in the DepEd Order No. 36, s. 2006, English shall be used as the language of instruction for science subjects in all public and private schools at the elementary and secondary levels in the Philippines. However, based on the teacher respondents, students learn better if the medium used in chemistry teaching is Filipino. The preparedness of the chemistry teacher to give their best effort in imparting the lessons in English become meaningless because of a lack of active participation in the class. Student engagement will be more evident using lingua franca mother tongue-based instruction. Students tend to become more articulate and confident in expressing their ideas or in explaining content when using their native language. Moreover, teachers' use of mother tongue-based instruction patiently meets the needs of their students to help them understand the lessons and improve their academic performance. Using the mother tongue in teaching science enables students to communicate with teachers and other fellow students and allows them to discuss ideas, experiences, and problems faced during the learning process (Khushnuma et al., (2020).

4.3.4. Classroom Management

Classroom management describes how a teacher organizes the physical, educational, and social arrangements in the classroom to create an environment that is conducive to learning (Arnold & Nunnery, 2012). A structured classroom is frequently associated with a safe classroom, one in which students can have fun while learning. Finding ways to address the untoward behavior of the students is a challenge to teacher respondents, and dealing with some students' disruptive behavior includes instilling discipline and disciplinary actions. Addressing inappropriate or off-task behavior is necessary for managing the class especially when a student violated a classroom policy. Managing the classroom properly has a direct impact on effective teaching and learning. A properly managed classroom allows the teacher to engage more in students' learning. O'Scanaill (2021) stated that science classrooms are among the most challenging to manage. Things can go wrong in science classrooms due to the chemicals, laboratory tools, and equipment used in the experiments. Teachers must keep a close eye on all experiments while also allowing students to make mistakes and learn from them.

4.4. Chemistry Teachers' Challenges During the COVID-19 Pandemic

As shown in Table 6, 5 themes emerged as challenges for teachers in effectively implementing instructional strategies in the teaching of chemistry during the COVID-19 pandemic.

Table 6. Thematic Analysis of Chemistry Teachers' Challenges in the Implementation of Instructional Strategies during the COVID-19 Pandemic

Selected Codes	Theme
▪ There is lacking academic integrity and honesty ▪ No strict set of rules in giving the test ▪ Student independent learning is absent ▪ Checking student's output is challenging	Appropriate assessment strategy
▪ No responses from the students during inquiry and monitoring ▪ Unable to contact the students ▪ Some students are not submitting their work even after some follow-up ▪ Difficulty in tracking the student's progress	Feedback mechanism
▪ Cannot join a synchronous session due to poor internet connection ▪ Occasional power interruptions ▪ Unsupported software applications ▪ Outdated gadgets and connectivity cost	Technology usage and availability
▪ Some parents are working and they do not have time to assist the students in answering the module ▪ Parents cannot give what they do not have, they cannot extend help because of their educational level ▪ Unsupportive parents in the modular leaning	Parental involvement
▪ Contents of the modules are untrustworthy, poorly referenced, and not gender sensitive ▪ Learning competencies in the module are difficult to understand and not achievable ▪ Some of the tasks in the module are inappropriate for the level of the students ▪ Congested activities in the module	Appropriate Teaching-Learning Material

4.4.1. Appropriate Assessment Strategy

Dayagbil et al. (2021) believed that an appropriate assessment strategy is necessary to ensure that students have acquired a variety of skills and knowledge. In the assessment of learning, the teacher has to think of innovative ways of assessing students in the context of their situation and home environment so the outcomes expected of the course will be manifested by the students. Findings showed that during emergency remote teaching, assessment becomes a challenge for teachers, particularly on the issue of academic honesty and integrity. Honesty is not inculcated amongst students, and value formation as part of lesson planning may be ineffective. As reflected in responses, there is a need to address the teachers' concerns on how to conduct off-classroom performance assessments and the bulk of submissions that they have to evaluate which are submitted online or offline.

4.4.2. Feedback Mechanism

A feedback mechanism is a system or structure through which the teacher communicates the students' performance outcomes in the form of feedback. As indicated by the responses, constant communication with the students about what they will learn, what level of mastery they have, and how to keep making progress is critical for their success. Giving regular and continuous feedback is an effective way to improve learning outcomes (Mamoon, 2016; Selvaraj & Azman, 2020). Providing meaningful feedback to the students means giving them what they accomplished. Feedback acknowledges what the learner has done well while also pointing out what has been misunderstood or misconstrued. Once feedback was provided, students' areas of strengths and areas of challenges were identified. This will provide an opportunity for the teacher to reflect on his/her instructional practices, and make changes to their instructions to improve their effectiveness as a teacher.

4.4.3. Technology Usage and Availability

The COVID-19 pandemic emphasized the important role of technology in delivering education. This pandemic has drawn our attention to some online educational and technological resources needed by teachers to support the continuity of teaching and learning. Online technology such as the Internet was used by teachers to provide synchronous classes and some interactive teaching methods. Results showed that slow or unreliable internet can restrict a teacher from delivering a lesson using his/her prepared online instructional strategy, and can even stifle innovation in online teaching and learning. It also limits teachers' access to online educational resources and their ability to communicate with students to provide clear instructions on student work, affecting teachers' practice of delivering timely and meaningful feedback to students (Di Pietro, 2020). Moreover, lessons are disrupted by an unstable internet connection minimizing the amount of time teachers have to teach, and potentially reducing students' learning opportunities. Furthermore, outdated technology and differing online device capabilities may lessen teachers' productivity. The high cost of a broadband connection, as well as the necessary equipment for online classes, such as a router, has added to the financial strain on teachers, who are finding it difficult to pay their monthly internet bills on their meager salaries.

4.4.4. Parental Involvement

Parental involvement refers to how involved a parent is in his or her children's education. Parents are known to be the children's first teachers from the moment they are born. Their traditional role is to educate, guide, and raise children to be responsible members of the community. During the pandemic, however, parental involvement in education has become critical. Most parents have had no choice but to become more involved than ever in their child's learning. Parents' role as home facilitators was emphasized amid the pandemic, guiding their children's learning, supervising their children as they studied, and helping their children develop self-regulated learning techniques (Garbe, 2020). The pandemic saw many parents juggling careers with simultaneously monitoring their child's learning from home. Teachers are challenged to provide activities that will encourage parents to get involved in children's education. As described in the responses, lack of or limited parent education hampered parental involvement in their children's learning. Children's learning is most likely associated with their parent's educational background. This result is in line with the review findings of Karre and Perkins (2022) which confirms that the educational and economic opportunities of the children are strongly influenced by their parents' educational degrees.

4.4.5. Appropriate Teaching-Learning Material

"Teaching-Learning Material" (TLM) refers to a variety of instructional resources that teachers use in the classroom to help students achieve specific learning goals**.** During the COVID-19 pandemic, printed Self-learning Modules (SLMs) became the most widely used teaching-learning material in the Philippines (Pe Dangle, 2021). Self-learning modules are self-contained, self-instructional, self-paced, and interactive learning materials designed for a specific topic or lesson, in which the learner actively engages with the instructional content rather than passively reading it. These learning modules are utilized in public schools in the country as part of the modular learning modality under DepEd's alternative teaching and learning methods. Finding ways to address issues and concerns in the self-learning modules prepared by DepEd is a challenge to teachers. Teachers are confronted with the challenging task of providing clear instructions for the different learning tasks in the learners' module. Moreover, teachers are also challenged to thoroughly explain the modules and provide further examples for students' better understanding of the lesson. Furthermore, teachers face difficulty in explaining to students that a certain item or example in the said module contains an error that must be corrected. Addressing these concerns becomes a problem for teachers since they were unable to contact and communicate with their students easily due to a lack of or poor internet access (Lai & Widmar, 2021).

4.5 The Proposed Innovative ASPIRE (I-ASPIRE) Instructional Model

ASPIRE is an acronym for Activate, Strategize, Present, Investigate, Reflect, and Evaluate describing the six precursors of instruction. The letter 'I' in I-ASPIRE means 'innovative,' as the teaching-learning precursors of this instructional model were culled from quantitative and qualitative data obtained from teachers' instructional practices in the field before and during the COVID-19 pandemic. In the I-ASPIRE instructional model (Figure 2), the teachers aspire to embrace challenges and opportunities in the teaching-learning process to bring the best to the students and provide them with meaningful learning experiences to become successful and independent learners.

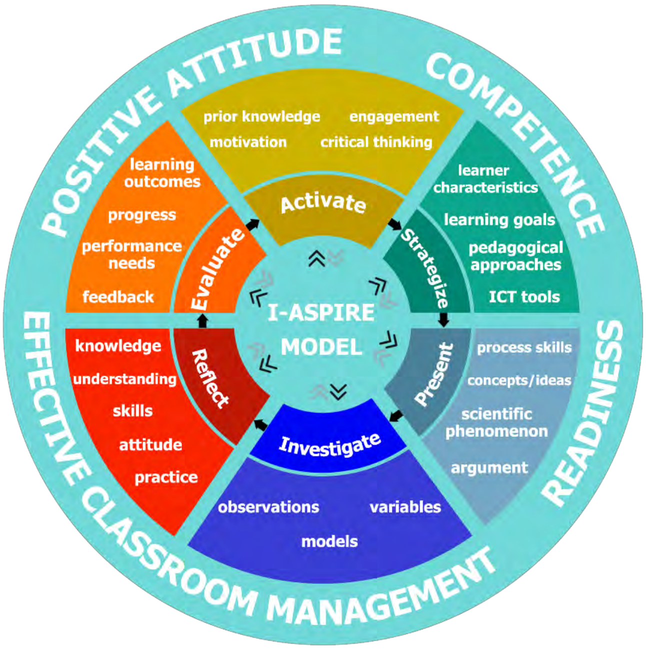

Figure 2. The Proposed I-ASPIRE Instructional Model

The I-ASPIRE instructional model is composed of four concentric layers. The first layer (the inner circle in the Figure) corresponds to the name of the innovative instructional model. The I-ASPIRE model encourages teachers as instructional designers to make good and effective instructions - to make learning easier, quicker, and more enjoyable despite challenges. Anchored on the cognitivism and constructivism learning theories, the I-ASPIRE instructional model supports the learner-centered philosophy and places the learner as the focus of the teaching-learning process. It aimed to develop active, goal-oriented, self-regulating learners who take personal responsibility for their own learning.

The second and the third layer of the I-ASPIRE model identifies the six precursors of instructions and describes the different elements of each of the identified precursors respectively. These instructional precursors - activate, strategize, present, investigate, reflect, and evaluate, are the step processes of instructions or the learning experiences provided by the teacher for effective teaching. Notably, the six instructional precursors are sequenced cyclically. This cyclical pattern indicates that these precursors occur at regular intervals, one after the other, from the first to the last. The first precursor of instruction in the I-ASPIRE model is ***Activate.*** Activating students' prior knowledge means combining pre-existing knowledge and previous experience. Activating prior knowledge elicits what students already know and builds on it with new information. By stimulating previous knowledge, learners' comprehension of new information can be improved, allowing students to develop critical thinking skills (Kikas et al., 2021). This precursor is supported by cognitivism learning theory, which focuses on how the learner's brain internally processes, retains, and recalls information based on how information is organized into existing knowledge schemas. The second precursor of instruction in the I-ASPIRE model is ***Strategize.*** In this precursor, the teachers plan a strategy for achieving the learning goal. They begin strategizing their instructions by analyzing the learners' characteristics and context. The result of the analysis may reveal important variables that may affect the learner and must be addressed during the instructional design and delivery processes, especially in promoting active learning (Phala & Chamrat, 2019). Choosing the appropriate pedagogical approach and integrating the selected instructional media, and information and communication technology (ICT) tools in instruction also form part of this precursor. The third precursor of instruction in the I-ASPIRE model is ***Present.*** This refers to the teacher's presentation of the lesson by implementing the instructional plan made in the strategize component. An important part of this precursor is explicitly teaching the concepts and skills. This may include the teachers' effective use of varied pedagogical instructional approaches - strategies, methods, and techniques of teaching focusing on student-centered learning. Effective use of this teaching and learning approach guides the student to be an active participant in the learning process. Creating effective and engaging presentations is important to keep the discussion interesting, help the teacher communicate with confidence, and motivate the students to listen (Daniel et al., 2017). The fourth precursor of instruction in the I-ASPIRE model is Investigate. This precursor describes teachers' practice of employing inquiry-based instructional strategies. Teachers are expected to practice enabling students to 'instigate an investigation', 'critique and make argumentation', and 'build a physical and conceptual scientific phenomenon model. Utilizing these inquiry-based instructional strategies allows students to become more active, motivated, and accountable for their own learning (Gholam, 2019). This precursor is anchored on the cognitive constructivism learning theory focusing on how the learners construct their knowledge through individual personal experiences. Facilitating knowledge acquisition through instigating an investigation, critiquing, and modeling helps learners identify where they are having difficulty and is part of an inquiry method to alleviate misconceptions (Oyarzun & Conklin, 2020). The fifth precursor of instruction in the I-ASPIRE model is Reflect. This precursor enables the students to reflect upon their knowledge learned, skills, and values developed. This may involve checking for student understanding by providing more practice and additional enrichment activities for those who have already mastered a skill with additional learning opportunities and challenges, as well as encouraging students to ask questions, which allows him/her to clarify any unclear or confusing concepts. The sixth and last precursor of instruction in the I-ASPIRE model is Evaluate. This precursor describes making use of different assessment tools to determine student learning. Assessing learning outcomes allows teachers to determine whether students gained knowledge and skills from the lesson. It also lets the teacher see if their teaching has been successful in meeting learning objectives and, if not, where they can improve (Fisher & Bandy, 2019).

The fourth and the last (outer circle) layer of the I-ASPIRE model corresponds to the professional and personal qualities of the teacher describing the other salient feature of this instructional model. Effectively implementing the identified six precursors of instruction requires teachers' instructional skills. And this is where the teacher's professional and personal qualities come into play. These teachers' qualities include a positive attitude, competence, readiness, and effective classroom management. Ulug et al. (2011) found that teachers' positive attitudes, influence students' motivation, self-confidence school attitudes and schoolwork, and overall personality development. Meanwhile, Fauth et al. (2019) showed that teacher competence (pedagogical content knowledge, self-efficacy, and teaching enthusiasm) was positively related to students' interest; self-efficacy, and student achievement. Similarly, teacher readiness has a positive relationship and significant effect on student achievement (Tumanduk et al., 2020). Lastly, teachers' effective classroom management creates an environment that is conducive to teaching and learning (Tyagi, 2022). In a well-managed classroom with an established set of procedures and routines, the students are motivated and the climate of the classroom is work-oriented but relaxed and pleasant (Wong et al., 2012).

The big constructs located in the last layer of the concentric circles showed that these professional and personal qualities of the teacher are all-encompassing of the identified six precursors of instruction in the I-ASPIRE instructional model. Also, noticeable in the I-ASPIRE instructional model is the aqua color of the outermost layer that encompasses the entire model up to the center. This indicates that teachers' professional and personal qualities contribute to the successful implementation of the I-ASPIRE instructional model in the classroom.

The I-ASPIRE model can be used with large and small numbers of students in the class. It works best with topics that require students to create a model. It is particularly effective in instruction that uses inquiry-based instructional strategies. The I-ASPIRE model does not provide guidance or procedures on deciding what instructional media, ICT tools, and assessment strategies to use. Teachers have to go beyond the I-ASPIRE model to make these decisions. Also, the flexibility of the model to handle VUCA (volatile, uncertain, complex, ambiguous) learning contexts such as the COVID-19 pandemic is not predetermined, but it is suggested that the I-ASPIRE model be used during in-person classes. The I-ASPIRE instructional model hopefully helps the teachers in the design of their teaching-learning materials in science for effective instruction and improved learning outcomes.

Validation results of the I-ASPIRE instructional model showed positive evaluations in terms of purpose, front-end analysis, content, technical aspect, and overall design components. The I-ASPIRE model has the potential to improve teachers' existing teaching strategies and methods and tailor them to their students' needs. Consequently, teachers may be able to cultivate an innovative mindset and go above and beyond to support the students.

4.6. Teaching-Learning Material (TLM) in Chemistry

A Lesson Exemplar (LE) in chemistry was developed as an illustrative example of the TLM in chemistry incorporating the salient features of the I-ASPIRE instructional model. The CHED K to 12 Transition Program describes a lesson plan exemplar as a "roadmap for a lesson containing a detailed description of the steps a teacher will take to teach a particular topic. It contains the following parts: Objectives, Content, Learning Resources, Procedures, Remarks, and Reflection (Call for Submission of Inquiry-based Lesson Plan Exemplars in Science and Mathematics (Grades 7 to 12), 2017).

The Procedures part of the prepared LE in chemistry incorporates the six identified precursors of instructions - Activate, Strategize, Present, Investigate, Reflect, and Evaluate. This part provides the different learning tasks that distinctly describe each instructional precursor.

Evaluation of the developed LE showed positive comments from the evaluators, particularly in providing the students with meaningful learning experiences. Each part of the LE meets the Department of Education (DepEd) standard practices in increasing the students' engagement and improving their skills, and understanding of the subject matter.

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