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Development and Validation of a Test Instrument in Assessing the Content Knowledge of Grade 3 Teachers in Science

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Abstract. One of the important aspects, apart from the learning environment and teaching and learning resources, is the quality of our teachers. The teachers are the drivers of the curriculum in the classroom. This study aimed at developing and validating a test instrument for assessing the content knowledge of 27 elementary science teachers in Grade 3 Science. Findings revealed that all indicators relative to the characteristics of the assessment tool are highly evident with a weighted mean of 3.87 based on the results of the validation. The assessment tool can be used to effectively assess the science teachers' content knowledge in Grade 3 science. Moreover, Cronbach's alpha values of 0.73 for the test items based on the results of the evaluation of the content experts imply that the assessment tool is acceptable in terms of internal consistency. The mean of the content knowledge test scores of 44.07 out of a possible 58 and the item and scale analyses as well as validity checks indicate that the final version of the content knowledge test questionnaire is a good instrument to measure the content knowledge of Grade 3 science teachers. A consistent level of test difficulty and discrimination indices were evident, and the results provided varied points in terms of the interpretation of the test items. The number of retained items and modified or revised items supports the validity and reliability of the test instrument in general.

Keywords: Assessment; Content Knowledge; Grade 3 Teachers; Science; Test Instrument

1. Introduction

The drive for the achievement of the 21st-century learning outcomes and the motivation of the Department of Education in the Philippines to be at par with other countries not only in the Southeast Asian Region but also in the global region is now the trend in the reforms in the country's educational system. Since the start of the implementation of the K to 12 Basic Education Curriculum in the country, there have been various actions and several educational reforms have been implemented to ensure the mastery of knowledge and skills among Filipino learners after each level. There are also several initiatives conducted to ensure

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the success of such strategic actions, plans, and reforms. To further test the effectiveness of such reform, DepEd has formulated assessment policies that define the needs for basic education students to take classroom and national examinations and participate in international large-scale assessments. This is because assessments of the learning of the learners serve as the reflection of the status of the level of their achievement in the different learning areas. The results of the assessment also serve as a basis for policy guidelines and decisions to address the gaps and issues in the delivery of quality, accessible, inclusive, equitable, and liberating basic education services to all Filipino learners.

Teachers should know about the content they teach to translate it into instruction for the learners to appreciate it. A strong content knowledge that a teacher has can have a significant impact on teaching practice and student achievement. Science teachers play a pivotal role in establishing students' interest in learning science (Cadiz & Orleans, 2022). Teachers are the direct implementers of the science curriculum in the classroom. They also engage students in different learning experiences to develop students' understanding of the nature and concept of science. Science teachers adapt to changes in the approach of making students learn better in terms of content in science. Through this, science teachers become more resourceful in planning, designing, and finding appropriate learning resources suitable for the needs and interests of the students. In other words, motivating students to learn is the reflection of the presence of teachers inside a science classroom. It has something to do with the level of how students achieve the learning outcomes. These teachers inspire the students to think critically and creatively.

Science teachers' knowledge of content and how they deliver the teaching process are their weapons to become effective in educating the students. As time goes by, these professional qualities may be developed or reduced depending on the affecting factors. There should be constant self-assessment on what area teachers have difficulties in so that they can find ways to address these difficulties. Education authorities can provide various programs for science teachers at the elementary level in conformity with the demands of maintaining and or somehow improving the quality of the teaching-learning process in the science area. Science teachers should be updated on the latest updates and innovations in teaching science concepts. It is the need of every science teacher to have professional development to ensure that they can deliver effective and quality science education to their students.

One of the pressing problems in the science education field right now is identifying the critical areas of knowledge that support science teachers in being effective practitioners (Mikeska, Phelps, & Croft, 2017). Science content and science processes are intertwined in the K to 12 Curriculum. Without the content, learners will have difficulty utilizing science process skills because these processes are best learned in context. Organizing the curriculum around situations and problems that challenge and arouse learners' curiosity motivates them to learn and appreciate science as relevant and useful. The DepEd emphasizes that the quality of learning is greatly influenced by the quality of teaching. At present, the Department is responding to the challenge of improving students' learning performance. To ensure the effectiveness of the delivery of instruction, it is right that the teachers should be empowered in terms of the mastery of the science content since the teachers are content knowledge is very important as they, the teachers, translate content knowledge into instructional delivery that is suitable and appropriate for the learners. To support the call to further improve the K to 12 Basic Education Curriculum in the country and to make Filipino learners globally competitive, this study attempts to develop and validate a test instrument as a measure to assess the content knowledge of Teachers in Grade 3 Science.

Nature of Content Knowledge of Science Teachers

Teachers' knowledge of a subject is referred to as content knowledge. Shulman's (1986) definition of content knowledge as relating to science is knowledge about everyday life situations relating to states of matter phenomena and focuses on core concepts and principles that describe how chemical processes occur. Teachers' content knowledge (CK) is a significant predictor of students' learning (Großschedl, Mahler & Harms, 2018). The teachers' content knowledge affects their lesson planning and simulated teaching. A prevalent approach to understanding and assessing teaching quality is to measure teachers' professional competency (Greensfeld & Gross, 2020).

To achieve scientific literacy among learners, they should have the ability to explain phenomena scientifically, evaluate and design scientific inquiry, and

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interpret data and evidence scientifically. This can be achieved when the learners are influenced by scientific knowledge and the teachers play a big role in it. The teachers' content knowledge should understand the major facts, concepts, and explanatory theories that form the basis of scientific knowledge, such knowledge includes knowledge of both the natural world and technological artifacts (DepEd, 2019). Moreover, the learners are expected to demonstrate an understanding of basic science concepts and the application of science inquiry skills. Hence, they should exhibit scientific attitudes and values to solve problems critically, innovate beneficial products, protect the environment, conserve resources, enhance the integrity and wellness of people, make informed decisions, and engage in discussions of relevant issues that involve science, technology, and environment (Kelly et al., 2020).

Table 1 shows the key stage and grade level standards in science based on the K to 12 Science Education Curriculum framework wherein spiral progression is observed. The expected learning outcomes in Grade 3 up to 6 science vis-à-vis the competencies tested in Grade 4 TIMSS are also presented.

Table 1 Key Stage and Grade Level Standards in Science

Key Stage Standards **K1 to 3**	**Key Stage Standards** **Grades 4 to 6**
At the end of Grade 3, students should have acquired healthy habits and have developed curiosity about themselves and their environment using basic process skills of observing, communicating, comparing, classifying, measuring, inferring, and predicting. This curiosity will help learners to value science as an important tool in helping them continue to explore their natural and physical environment. This stage	At the end of Grade 6, students should have developed the essential skills of scientific inquiry—designing simple investigations, using appropriate procedure, materials and tools to gather evidence, observing patterns, determining relationships, drawing conclusions based on evidence, and communicating ideas in varied ways to make meaning of observations and/or changes that occur in the environment. The content and skills learned will be applied to maintain good

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should also include developing scientific knowledge or concepts.	health, ensure the protection and improvement of the environment, and practice safety measures.
Grade Level Standards **Grade 3 (K to 12)**	**Grade 4 (Tested in TIMSS 2019)**
Describe the functions of the different parts of the body and things that make up their surroundings—rocks and soil; plants and animals; the Sun, Moon, and stars; classify these things as solid, liquid, or gas; describe how objects move and what makes them move; identify sources and describe uses of light, heat, sound, and electricity; describe changes in the conditions of their surroundings. Content leads learners to become more curious about their surroundings, appreciate nature, and practice health and safety measures.	Investigate changes in some observable properties of materials when mixed with other materials or when force is applied to them; identify materials that do not decay and use this knowledge to help minimize waste at home, school, and in the community; describe the functions of the different internal parts of the body to practice ways to maintain good health; classify plants and animals according to their habitat and observe interactions among living things and their environment; infer that plants and animals have traits that help them survive in their environment; investigate the effects of pushing or pulling on the size, shape, and movement of an object; investigate which type of soil is best for certain plants and infer the importance of water in daily activities; learn about what makes up the weather and apply knowledge of weather conditions to make decisions for the day; infer the importance of the Sun to life on Earth.

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The framework of the science curriculum in the Philippines requires learning outcomes that are expected in each student in the 21st century. Science teachers should be equipped with the fundamental characteristics involving content knowledge to have full potential traits in their performance and being professionals (Cadiz, 2021). The qualities that can ensure a teacher's effectiveness are not the sum of his knowledge, but rather the link between the different types of knowledge he possesses (Liakopoulou, 2011).

The learning interactions provided by science teachers and the quality of their teaching are directly linked to the interest of students in science (SEI-DOST & UP NISMED, 2011). Therefore, it takes up a prominent role because it connects subject matter knowledge to teachers' understanding of how to teach content to students (Keller, Neumann, & Fischer, 2017).

Issues and Gaps in Science Teachers' Content Knowledge

The content knowledge of teachers has been a common issue in an educational institution. It evolves from many different perspectives of teachers who are teaching different subject areas. Though academic institutions have been trying to contextualize or generalize the idea of assessing teachers' pedagogical content knowledge, it seems that there are new indicators that emerge from the changes in society wherein they are affected and their students too. Assessing teachers' content knowledge (CK) is one of the very few international studies that directly measure science teachers' CK (Greensfeld & Gross, 2020). Moreover, they also mentioned that one of the challenges in measuring teachers' content knowledge is identifying the context in which teachers would be willing to participate in such a test. In the study of Greensfeld & Gross (2020), their findings revealed that teachers have low content knowledge on the basic topic of states of matter. There are grounds for concern that teachers may also lack the required levels of CK in other vital subjects in the curriculum.

We cannot deny the reality that our learners today have been experiencing hardships, difficulties, and challenges in their path particularly in the demands of the changing society and disruptions in education. The changing society directed modification in the implementation of curriculum and desired learning outcomes that should be advantageous to the part of the learners. According to the PISA 2018 National Report of the Philippines by DepEd (2019), Filipino

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students attained an average score of 357 points in Scientific Literacy, which was significantly lower than the OECD average of 489 points. The mean score of Filipino students is within Proficiency Level 1a. Hence, an average Filipino student can use basic science knowledge to recognize or identify explanations of scientific phenomena. When students can engage in content and socio-related issues by applying the ideas of science and being reflective as citizens, it is an indicator that teachers are promoting the direction toward scientific literacy. A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically.

The Philippines scored 249 in science which placed the country last among 58 participating countries based on the reports of the 2019 Trends in International Mathematics and Science Study (TIMSS) conducted by the International Association for the Evaluation of Educational Achievement (IEA). The Department of Education as part of their aggressive reforms in the K to 12 Education in terms of intensive up-skilling and re-skilling of the teachers should be part of doing strategic ways to address the gaps in the curriculum they are implementing considering the global standards for scientific literacy emphasized in PISA. This is because the performance of Filipino learners is associated with teachers' quality in terms of their content knowledge in science. Belmi and Mangali (2020) conducted a study to examine the degree of alignment and identify possible gaps in the content knowledge domains in the scientific literacy competencies and levels of cognitive demand. The results of their mapping showed that there is a clear gap to take note of in terms of the concepts covered in the K to 12 science curriculum which are not aligned with the concepts which are specified in the PISA Science Framework in the content knowledge, particularly in physical systems, living systems, and earth and space systems.

Balagtas, Garcia, & Ngo (2019) revealed in their study that the competencies in Grades 4 and 8 Science are not aligned with the TIMSS 2015 Assessment Framework. They also revealed based on their findings on the alignment of TIMSS 2015 Assessment Framework Grade 4 Science vis-à-vis Philippine 2016 K to 12 Science Curriculum that out of the 66 competencies (31 competencies under Life Science, 21 competencies under Physical Science, and 14 competencies under Earth Science) covered by the TIMSS assessment, only 37

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or about 56% of the competencies in the K-12 curriculum are reflected in Grade 4 Science Curriculum, 19 or 29% is covered in Grade 3, nine (9) or 14 % is covered in higher grades, and one (1) or 1% is not explicitly reflected in the curriculum. This means that only 56 or about 85% of the TIMSS 2015 Assessment in Science Grade 4 was covered explicitly by the Philippine curriculum in Grades 3 to 4 Science. In terms of the cognitive domains, 19% of the competencies are classified under knowing, 54% are under applying and 27% are under reasoning. This implies that there are identified gaps in the Grade 4 curriculum in terms of content but not necessarily in the cognitive requirements of the TIMSS Science Grade 4. The authors suggested that there is a need to design and implement continuing professional development programs that will allow teachers and education leaders to update and deepen their content knowledge and pedagogical skills, particularly in the delivery of instruction in science curricula which are emphasized in international large-scale assessments.

Development and Validation of Test Instrument in Content Knowledge

Assessment plays an important role in determining the quality of basic education. As per DepEd Order No. 29, s. 2017, otherwise known as the 'Policy Guidelines on System Assessment in the K to 12 Basic Education Program', this policy aims to: (a) establish baselines for the basic education system and the implementation of the K to 12 curriculum in schools in terms of teaching and learning; (b) monitor the implementation of the K to 12 curriculum in schools in terms of teaching and learning; and (c) measure effectiveness of instructional reforms that are part of the K to 12 basic education program. Hence, a suitable method to develop reliable, objective, and valid instruments measuring teachers' content knowledge is needed to measure teachers' competence in an area (Jüttner et al., 2013). Various strategies have been used to directly measure teachers' science content knowledge. Researchers have conducted tests utilizing true/false questions, multiple choice items, open-ended items; check-marking items that required explanations of the chosen answer (Greensfeld & Gross, 2020).

There is a need to develop tests that will be responsive to the teaching competencies and skills of the teachers in respective subject areas, assessment tests that are situated in the framework of the K-12 Philippine Basic Education Science Curriculum. These tests or exams would require teachers, at different

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stages of their professional careers, to refresh their knowledge and engage in transferring this knowledge to varied contexts (Greensfeld & Gross, 2020). However, one obstacle to conducting rigorous studies is the lack of adequate measures, particularly regarding teacher learning and change, though more recent research has begun to explore measuring teachers' science content knowledge (Rivera et al., 2015). Test development is proven to be a tedious and rigorous process. It requires a lot of time starting from specifying the content areas and objectives, preparing the table of specifications, and formulating test questions (Ebagat et al., 2016). It is a probable venture and opportunity for a study as the K-12 Program is a recent development in the country that has made tremendous changes in the teaching of Grade 3 Science.

The content standards and mapping of competencies are the basis of the construction of the test items (Rivera et al., 2015). The development of the content knowledge items per knowledge dimension will be described in more detail so that the ideas can be used for the development of items (Jüttner et al., 2013). These are supported by the national and international assessment reports. A pilot test is necessary to determine the reliability of the test items. According to Ebagat, Dacanay, & Simeon (2016), try-out is important to ensure that the test is a good instrument. A panel of experts reviewed the test items to assess which of the items apply to the standards. Choosing a panel of experts who evaluated the content and consistency of test items to the content, competencies, and cognitive process dimension is proven to be an extremely vital stage in test development. It is better to choose credible experts who will devote time and effort to check the alignment of the test questions to the content and competencies. An item analysis will be made after the researcher has scored the individual test items wherein the index of difficulty and index of discrimination will be determined. Through this, the researcher can easily determine which of the items should be retained, revised, and rejected (Ebagat, Dacanay, & Simeon, 2016). The most used measure to test the reliability of items is Cronbach's alpha estimate of reliability which is frequently misused without testing the strict assumptions that are required to be a good estimate of reliability and without providing evidence of validity.

2. Methodology

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The primary goal of this study is to develop a test instrument aiming to measure the content knowledge of Grade 3 science teachers. This portion of the study contains the stages that were undertaken in deciding what should make up a test instrument to measure science teachers' content knowledge in Grade 3 science. It was divided into two (2) major phases – the instrument development stage and the validation phase.

The first stage is the instrument development phase in which the researcher used the K to 12 Most Essential Learning Competencies in Grade 3 science as a basis for the development of test items classified into four types and focused on the four (4) science content areas: (a) Matter; (b) Living Things and their Environment; (c) Force, Motion, & Energy; and (d) Earth & Space. Likewise, during this stage, the researcher has finalized the test format and prepared the test blueprint or the draft of the test questionnaire.

The second stage involved the phase in which the test items were developed along with the scoring guide, answer sheet, and the tool to evaluate the test instrument. The materials were scrutinized and validated by Education Program Supervisors in Science, Master Teachers, and Science Education Experts from the Higher Education Institutions. The evaluators returned the documents with an accomplished evaluation tool after 2 to 3 weeks. Test try-outs of the test items were also conducted for the select Grade 3 science teachers who participated in the online assessment in 4 batches. Moreover, in this stage, the responses of the 27 Grade 3 science teachers were checked and evaluated by 12 junior and senior high school master teachers. The analysis phase to determine the reliability and validity of the test items was conducted based on the responses of the 27 proficient and highly proficient Grade 3 science teachers from four schools divisions in DepEd Region III (Central Luzon).

The researcher collected the data following the following activities:

2.1 Preliminary Activities. The first part is the planning stage and test construction stage. In the planning stage, the researcher examined the most essential learning competencies as to the topics that were included as part of the items. This study considers the findings in the scientific literacy of Filipino students in terms of the alignment of competencies in science based on the TIMSS 2019 report. These gaps were the basis for constructing the test instrument in the content knowledge of Grade 3 teachers in science. During the test construction stage, the researcher sought the assistance of an expert in

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classifying and categorizing the most essential learning competencies of Grade 3 science. The teachers' content knowledge in science was assessed using various types of tests which involved true or false response questions, construct response questions, open-ended response questions, and data response questions. In the construction stage, the researcher developed the draft of the test items based on the categorization of the most essential learning competencies of Grade 3 science. The researcher reviewed the test items along with the information provided about each item. Once the first draft of the test blueprint had been completed, the researcher formulated the test items for the various types of tests. The test questions were arranged according to the cognitive process dimensions of Krathwohl (2002). The said cognitive dimension has been adopted by the DepEd to be used in lesson development and formulation of assessment tasks and activities in the classroom. After writing the test items, the researcher sought the assistance of the 5 division science program supervisors who will serve as content experts. The content experts scrutinized the test items to ensure the content validity. A 4-point Likert (1.0 - Not Evident; 2.0 - Somewhat Evident; 3.0 - Evident; 4.0 - Highly Evident) scale was used to evaluate the assessment tool. Likewise, the internal consistency of the items was calculated. Moreover, the structure of the test items and language was scrutinized by a language expert. This stage was very crucial for the experts to assess and evaluate if the test questions were coherent and congruent to the learning competencies and cognitive process dimensions in Grade 3 science. The researcher incorporated the comments and suggestions of the experts in the revised and finalized version of the items. The content knowledge of the teachers handling Grade 3 Science was assessed using the twenty-nine (29) test items focusing on the teachers' content knowledge of observable characteristics of materials, changes in materials based on the effect of temperature, groups of animals according to their parts, parts of plants, living and non-living things, basic needs of living things from their environment, protect and conserve the environment, position of an object in relation to a reference point, uses of different types of energy, and changes in the weather.

2.2 Actual Data Gathering**.** The main activity in this part included the try-out stage and the evaluation of the answers/responses. Try-out is important to ensure that the assessment tool is a good instrument. The researcher secured a letter of approval from the regional director through the Policy, Planning, and

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Research Division (PPRD). The researcher sent an email to the participants relative to their participation. Prior instructions were given to the participants before the scheduled online assessment. The participants were informed of the schedule of the administration of the online test. An online administration of the test questionnaire was done due to the strict community restrictions implemented by the LGUs. Likewise, an online assessment was done to ensure the safety and health of the participants. The try-out in the form of an online assessment was administered in four batches to properly ensure the smooth proctoring of the test. The researcher gave an orientation to the participants about the entire administration of the test. Before the actual conduct of the online assessment, the participants were given informed consent. All 27 participants gave their consent to be the participants. They were asked to open their camera for the entire duration of the online test. The entire online assessment is 2 hours and 27 minutes. The participants wrote their corresponding serial numbers on the answer sheets instead of their names. The participants were given access to the test questionnaires and answer sheets uploaded to Google Drive. The last part of the data gathering is the evaluation of the answers/responses of the Grade 3 science teachers. The researcher organized a limited face-to-face evaluation activity. The participants were the science junior high school and senior high school master teachers recommended by the division science education program supervisors. The researcher gave an orientation to the evaluators. There were two parts of the evaluation. The first part was the individual evaluation where each evaluator used the provided template. The second part was the group evaluation where the 3 members per group convened with their final scores, and analysis/interpretations. Moreover, the evaluators were given a scoring guide.

2.3 Post Activities. When the allotted time given to the participants ended, the proctor asked the participants to scan/picture their answer sheets and upload them to their corresponding folders in Google Drive. The proctor gave a brief post-orientation to the participants of the online assessment and answered some additional queries from them such as the results of their scores with the interpretation if they intend to have a copy of the results. For the evaluators of the answers of the Grade 3 participants of the online assessment, the evaluators were given a post-orientation as to the plans as ways forward of the results and findings of the evaluation of the content knowledge of Grade 3 science teachers.

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This study ensured that the responses of the Grade 3 science teachers during the online assessment were strictly kept confidential. Likewise, the researcher sought informed consent from each of the participants during the conduct of the online assessment. All grade 3 science teachers have agreed to the informed consent. They were also fully informed that the results of the online assessment relative to their scores will not reflect as part of their performance nor be used as a document against them. Moreover, during the evaluation of their responses, each answer sheet has a unique participant code instead of their names.

The mean result of the assessment tool evaluated by the division science education program supervisors was calculated. Likewise, Cronbach's Alpha value was computed for the internal consistency of the items. An item analysis was done to determine the index of difficulty and index of discrimination of the test items. Item reliability is an estimate of the ability to confirm the item difficulty hierarchy of the measure and is dependent on item difficulty variance (i.e., a wide range of difficulty). Low item reliability is indicative that the sample is not large enough to precisely locate the items on the latent variable. The interpretation of the difficulty index (table 3) and level of discrimination of an item (table 4) are given below.

Table 3 Interpretation of Difficulty Index

Range	Difficulty Level
20 & below	Very difficult
21 – 40	Difficult
41 – 60	Average
61 – 80	Easy
81 & above	Very Easy

Table 4 Level of Discrimination of an Item

Discrimination Index	Item Evaluation
0.41 – 1.00	Very good item
0.31 – 0.40	Reasonably good item but possibly subject to improvement
0.21 – 0.30	Marginal, usually needing and being subject to improvement
−1.00 – 0.20	Poor item, to be rejected or improved by version

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The statistical analysis of the data was performed using Microsoft Excel. These data analysis techniques were conducted to finalize the test items which are included in the final test instrument to assess the content knowledge of teachers in Grade 3 Science.

3. Results and Discussion

3.1 Developed Test items in Measuring the Content Knowledge of Teachers in Grade 3 Science

Table 5 presents the types of test questions developed by the researcher intended for the purpose of measuring the content knowledge of Grade 3 science teachers. The description of each part of the test is given along with the number of items.

Table 5 Type and description of each part of the developed test

Type of Test	Description of the Test
True or False Response Questions	This part consists of eight (8) items to elicit the factual content knowledge, significant science ideas and conceptual understanding of the teachers. This is not just a typical true or false type of test, but it also asks the teachers to give their explanation as a response to support their answer without just guessing.
Constructed Response Questions	This part consists of twelve (12) items that will ask the teachers to apply their knowledge, skills, and critical thinking abilities. The items also aim to measure their ability to apply, analyze, evaluate, and synthesize the content knowledge that they have in science. The teacher can give the definition of terms, making of visual models or diagrams, developing graphic organizers, designing and illustrating science investigation, and analysis of reading selections or passages.
Open-Ended Response Questions	This part consists of six (6) items that will ask the teachers to expound their ideas and thoughts on their content knowledge in science concepts in Grade 3 learning competencies in the form of sentences.

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Data Response Questions	This part consists of three (3) items that will ask the teachers to observe, analyze, and give significant inferences to the given data. In here, the teachers can be able to evaluate the data by comparing and contrasting the information.

The developed test items measure the teachers' science content knowledge in Grade 3 science and aspire to align the questions based on the expected learning competencies in TIMSS as an assessment to measure the content knowledge. Although the TIMSS assessment is designed to assess the content knowledge of Grade 4 students, it should be taken into consideration that science teachers play a big role in facilitating the learning outcomes among the learners. Thus, strengthening the content knowledge of Grade 3 science teachers would provide them with the opportunity to improve their practice. These assessment items address the various content challenges elementary science teachers face in their work and were designed to be used as a foundation for building practice-based assessments of elementary science teachers' content knowledge in teaching science (Mikeska et al., 2017).

The instrument has 4 parts. The first part is the true or false response questions which allow the teachers to not just provide a true or false answer in every item but instead, each item allows them to justify their answer through an explanation. The second part of the test is the constructed response wherein the various types of items require teachers to observe, infer, synthesize, and evaluate information in various ways in the form of definitions, visual models and diagrams, graphic organizers, developing a science investigation, and reading comprehension. Likewise, the test items are properly arranged according to Bloom's Hierarchy of Knowledge. The third part of the test is an open-ended response wherein the items allow the teachers to elaborate their understanding of the open-ended questions by giving meaningful statements or sentences. Likewise, the open-ended questions allow the Grade 3 science teachers to answer in an open-text format so that they can answer based on their complete knowledge and understanding of the content. The last part of the test is the data response questions wherein the items allow the respondents to analyze and evaluate the information in the form of data.

The test instrument can assess the Grade 3 science teachers' content knowledge in science wherein the items included in the test questionnaire, which

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are also in various types, can also be able to provide an opportunity for the teachers to demonstrate their critical and creative thinking. Furthermore, the test items can show areas/topics of weakness, which can lead to a shift in potential professional development focus for the Grade 3 teachers. As mentioned by Bucher (2009), professional development is based on teacher content knowledge needs, and if students are struggling with a particular topic, professional development programs can be developed and funded to aid in alleviating these roadblocks.

3.2 Validity and Reliability of the Test Items

Table 4 presents the weighted mean of the evaluation of the assessment tool to measure the content knowledge of Grade 3 science teachers. The results show that all indicators relative to the characteristics of the assessment tool are highly evident with a weighted mean of 3.87.

Table 6 Weighted Mean of the Evaluation of the Assessment Tool

Indicators	Mean	Verbal Interpretation
The items include various approaches in scientific inquiry and procedures.	4.00	HE
The items are based on the learning competencies in Grade 3 Science.	4.00	HE
The items assess higher order thinking skills of teachers.	4.00	HE
The items allow the teachers to demonstrate their content knowledge in various test types.	4.00	HE
The items provide opportunities to teachers to express varied and multiple ways of answers (e.g. graphic organizers, sentences, visual illustrations, data analysis)	3.80	HE
The test items are developed considering the local context or setting (e.g. local landmarks)	3.80	HE

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The items are developed leading to a high degree of cognitive level.	3.80	HE
The allotted time for each type of test is enough to answer the given questions.	3.40	HE
The test items allow expression of science process skills such as observing, inferring, synthesizing, and evaluating.	4.00	HE
The test items promote the revised Bloom's taxonomy of cognitive learning such as analyzing, evaluating, and creating.	4.00	HE
The test items allow the demonstration and understanding of relationships among topics and concepts along with the learning competencies.	4.00	HE
The test items address the misconceptions of teachers.	3.80	HE
The scoring guide is aligned to the test type used.	3.60	HE
The scoring guide allows flexible answers to demonstrate the conceptual understanding of teachers.	4.00	HE
Weighted Mean	3.87	HE

Legend: *Range of Rating Description and Verbal Interpretation (VI): 1.00 -1.74 Not Evident (NE); 1.75 -2.49 Somewhat Evident (SE); 2.50 -3.24 Evident (E); 3.25 -4.00 Highly Evident (HE)*

It can be gleaned from the table that the evaluators labeled the assessment tool as highly evident which implies that the indicators referring to the characteristics of a good assessment tool in grade 3 science are met and stipulated in the test items. The remarks of the evaluators are enumerated below:

- The test items are well-designed. It expresses ideas that are coherent and precise.
- The indicators stated in this instrument articulately measure the effectiveness of the tool in assessing the content knowledge of teachers in science 3.
- The assessment tool uses different types of approaches and forms of questions in eliciting the content knowledge of elementary teachers about grade 3 Science Content.

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- The assessment tool can assess the Science teachers' content knowledge with the MELCS of Grade 3 Science. The test items are arranged from simple to complex concepts.

To sum up the evaluation, the test, which provides a very in-depth way, is indeed appropriate and applicable to measure and assess the cognitive knowledge of Grade 3 teachers. Likewise, it covers the entire learning competencies in Grade 3 Science.

Internal consistency, a measure of the inter-relatedness of items in the scale with Cronbach's coefficient alpha, is used to measure the degree of the scale's item homogeneity. This is important to check the reliability of the instrument made. Cronbach's alpha values of 0.73 based on the results of the evaluation of the content experts imply that the assessment tool is acceptable in terms of internal consistency. Moreover, the mean of the content knowledge test scores of 44.07 out of a possible 58 total points and the item and scale analyses as well as validity checks indicate that the final version of the content knowledge test questionnaire is a good instrument to measure the content knowledge of Grade 3 science teachers.

3.3 Level of Difficulty and Discrimination Indices of the Test Items

Table 7 shows the difficulty and discrimination indices of the test items. Out of the 29 items, 10 of the items need modification/revision while 19 of the items were retained.

Table 7 Difficulty and Discrimination Indices of the Test Items

Item No.	Diff. Ind.	Interpretation	Disc. Ind.	Interpretation	Decision
1	0.8125	Very easy	0.375	Reasonably good item	Modified/Revised
2	0.5625	Average	0.625	Very good item	Retained
3	0.5	Average	0.500	Very good item	Retained
4	0.75	Easy	0.500	Very good item	Modified/Revised
5	0.5625	Average	0.375	Reasonably good item	Retained
6	0.5625	Average	0.625	Very good item	Retained
7	0.5625	Average	0.625	Very good item	Retained
8	0.4375	Average	0.375	Reasonably good item	Retained

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9	0.5625	Average	0.625	Very good item	Retained
10	0.5	Average	0.500	Very good item	Retained
11	0.625	Easy	0.750	Very good item	Modified/Revised
12	0.4375	Average	0.625	Very good item	Retained
13	0.6875	Easy	0.375	Reasonably good item	Modified/Revised
14	0.375	Difficult	0.500	Very good item	Retained
15	0.6875	Easy	0.375	Reasonably good item	Modified/Revised
16	0.5	Average	0.500	Very good item	Retained
17	0.625	Easy	0.500	Very good item	Modified/Revised
18	0.5	Average	0.500	Very good item	Retained
19	0.875	Very easy	0.250	Marginal	Modified/Revised
20	0.25	Difficult	0.500	Very good item	Retained
21	0.5625	Average	0.875	Very good item	Retained
22	0.5	Average	0.75	Very good item	Retained
23	0.5625	Average	0.625	Very good item	Retained
24	0.8125	Very easy	0.375	Reasonably good item	Retained
25	0.6875	Easy	0.375	Reasonably good item	Modified/Revised
26	0.375	Difficult	0.75	Very good item	Retained
27	0.625	Easy	0.5	Very good item	Modified/Revised
28	0.8125	Very easy	0.375	Reasonably good item	Modified/Revised
29	0.5	Average	0.5	Very good item	Retained

Legend: *Diff. Ind. – Difficulty Index; Disc. Ind. – Discrimination Index*

It can be gleaned from the table that the developed test items vary in terms of the level of difficulty and discrimination indices. In terms of the difficulty index, 15 out of the 29 items are labeled as average, 7 items are easy, 4 items are very easy, and 3 items are difficult. In terms of the discrimination index, 20 out of the 29 items are labeled as very good items, 8 items are reasonably good, and 1 item is marginal. Items 1, 4, 11, 13, 15, 17, 19, 25, 27, and 28 which were labeled as modified/revised were finalized and included as part of the final version of the test questionnaire.

Items 1 and 4 are part of true or false questions wherein the respondents were asked to give their explanations to support their answers without guessing. These items elicited factual content knowledge, significant science ideas, and conceptual understanding from the teachers. Some of the respondents provided

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inaccurate information and failed to justify their answers. It seems that there was confusion and inconsistency in the answers of the teacher-respondents.

Items 11, 13, 15, 17, & 19 are part of constructed response questions wherein the respondents were asked to apply their knowledge, skills, and critical thinking abilities. The items measure their ability to apply, analyze, evaluate, and synthesize the content knowledge that they have in science. The respondents can define terms, make visual models or diagrams, develop graphic organizers, design, and illustrate science investigation, and analyze reading selections or passages.

4. Conclusions

Based on the findings of this study, the following conclusions were drawn: (1) this study has developed a test instrument to measure the content knowledge of Grade Teachers in Grade 3 Science. The test instrument which includes true or false response questions, constructed response questions, open-ended response questions, and data response questions can be able to measure the content knowledge of Grade 3 science teachers in various ways and opportunities. Likewise, the test instrument can able to synthesize and determine how the Grade 3 science teachers can relate what they know and believe about teaching with the subject matter, or content that they are teaching as part of their teaching practice; (2) the developed test instrument provides a very in-depth way of measuring the content knowledge of Grade 3 science teachers and indeed an appropriate and applicable tool that is aligned to the most essential learning competencies of science 3; (3) a consistent level of test difficulty and discrimination indices was evident since the results provided varied points in terms of the interpretation of the test items. The number of retained items and modified/revised support the validity and reliability of the test instrument in general.

With teachers being the key component for change, particularly in the aspect of curriculum implementation, it is important to recognize that upskilling and reskilling of Grade 3 science teachers as part of their professional development is a source of information to keep the Grade 3 science teachers strengthened in terms of content and updated on new teaching strategies and skills when they deliver their content knowledge into practice. Moreover, these professional development strategies should be ongoing and should relate directly to their field of practice to get the most benefit from what they should learn. The developed test questionnaire aspires to measure the content knowledge of Grade 3 science teachers wherein the findings can serve as baseline data for the target professional development programs and capacity-building for Grade 3 science teachers in strengthening their content knowledge.

The test questionnaire is a good tool and sufficient in assessing the science teachers' content knowledge in the context of the most essential learning competencies in Grade 3 Science. The test questionnaire can be administered to Grade 3 science teachers in the other schools divisions wherein the results and findings may be gathered and analyzed.

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References

Bucher, A.M. (2009). A Survey of Instruments to Assess Teacher Content Knowledge in Science. Unpublished Thesis, Bowling Green State University.

Balagtas, M.U., Garcia, D.C.B., & Ngo, D.C. (2019). Looking through Philippine's K to 12 Curriculum in Mathematics and Science vis-a-vis TIMSS 2015 Assessment Framework. *EURASIA Journal of Mathematics, Science and Technology Education, 2019, 15(12),* https://doi.org/10.29333/ejmste/108494

Cadiz, A.P., Orleans, A.V., (2022). Gender Sensitiveness of Secondary Science Teachers' Pedagogical Content Knowledge. *IOER International Multidisciplinary Research Journal, 4*(1), pp. 178 – 186.

Cadiz, A. P. (2021). Pre-service teachers' reflective practice and their teaching practicum beliefs. *Jurnal Inovatif Ilmu Pendidikan, 3(*2), 105-119.

Department of Education (2017). Policy Guidelines on System Assessment in the K to 12 Basic Education Program, DepEd Order No. 29, s. 2017

THE QUEST ISSN 1908-3211 (Online) | ISSN 1908-322X (Print)
Journal of Multidisciplinary Research and Development

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Vol.3 No.1 (2024)
Received: 04-20/ Revised: 06-20/ Accepted:06-30-2024
https://neust.journalintellect.com/quest

Department of Education. (2016). K to 12 curriculum guide science (Grade 3 to Grade 10). Retrieved from

https://www.deped.gov.ph/wp-content/uploads/2019/01/Science-CG_with-tagged-sci-equipment_revised.pdf

Ebagat, W. E., Dacanay, A. G., Simeon, F. B. (2016). Development and Validation of an Achievement Test in Araling Asyano with Questions Addressing the K to 12 Araling Panlipunan Skills. The Normal Lights, 10(2), 30 – 64.

Greensfeld, H. & Gross, T. (2020). What Do We Know about Teachers' Knowledge? Assessing Primary Science Teachers' Content Knowledge in the Jewish and Arab Sectors. EURASIA Journal of Mathematics, Science and Technology Education, 16(10).

Großschedl, J., Mahler, D., & Harms, U. (2018). Construction and Evaluation of an Instrument to Measure Content Knowledge in Biology: The CK-IBI. Educ. Sci., 8, 145; doi:10.3390/educsci8030145

Jüttner, M., Boone, W., Park, S. & Neuhaus, B.J. (2013). Development and use of a test instrument to measure biology teachers' content knowledge (CK) and pedagogical content knowledge (PCK). Educational Assessment Evaluation Acc, 25:45-67 DOI 10.1007/s11092-013-9157-y

Keller, M. M., Neumann, K., & Fischer, H. E. (2017). The Impact of Physics Teachers' Pedagogical Content Knowledge and Motivation on Students' Achievement and Interest. *JOURNAL OF RESEARCH IN SCIENCE TEACHING, 54*(5), 586-614.

Kelly, D.L., Centurino, Victoria, Martin, M.O., & Mullis, I.V.S. (Eds.) (2020). *TIMSS 2019 Encyclopedia: Education Policy and Curriculum in Mathematics and Science*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/timss2019/encyclopedia/

Krathwohl, D. R. (2002). *A Revision of Bloom's Taxonomy: An Overview. Theory Into Practice, 41(4), 212-218.* doi:10.1207/s15430421tip4104_2

Liakopoulou, M. (2011, December). The Professional Competence of Teachers: Which qualities, attitudes, skills, and knowledge contribute to teacher's effectiveness. *International Journal of Humanities and Social Science, 1*(21).

Mikeska, J.N., Phelps, G. & Croft, A.J. (2017). Practice-Based Measures of Elementary Science Teachers' Content Knowledge for Teaching: Initial Item

P-ISSN: 1908-322X and E-ISSN: 1908-3211
Vol.3 No.1 (2024)
Received: 04-20/ Revised: 06-20/ Accepted:06-30-2024
https://neust.journalintellect.com/quest

Development and Validity Evidence. ETS Research Report Series ISSN 2330-8516

Rivera, J.L.M., Manley, A.C.H., & Adamson, K. (2015). Development and Validation of a Measure of Elementary Teachers' Science Content Knowledge in Two Multiyear-Teacher Professional Development Intervention Projects. Journal of Research in Science Teaching, Vol. 52, No. 3, pp. 371-396.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14.

SEI-DOST & UP NISMED, (2011). Framework for Philippine Science Teacher Education. Manila: SEI-DOST & UP NISMED.

TIMSS & PIRLS (2019). Philippines TIMSS 2019 Encyclopedia. International Education Assessment