Library Progress International
Vol.44 No.3, Jul-Dec 2024: P.2861-2874

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

Manipulative Skills And Science Performance Among Grade 9 Learners

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How to cite this article: Nathaniel B. Magallanes, Maredil R. Ambos, Mark N. Abadiano, Reymark S. Pabilando, Maed-Ie (2024) The Relationship Between Corporate Governance Transparency, Corporate Social Responsibility Transparency and Financial Transparency on The Performance of Public Listed Companies in Malaysia. *Library Progress International*, 44(3), 2861-2874.

Abstract
This one group pretest posttest with themes study examined the effect of teacher-made manipulative (physical) on Grade 9 learners' science performance and manipulative skills in an integrated school in Iloilo City for School Year 2021- 2022. This study also improvised competency-based learning materials as an intervention to the respondents. Statistical tools used were mean, standard deviation, and Wilcoxson signed rank test. The overall result showed that learners' performance in Science 9 provided an effective intervention after the instruction with the manipulatives. Manipulative skills resulted with significant change after the exposure to the treatment, the teacher-made manipulatives, thus, it was found effective. Data show that manipulative skills set adds up and skills set reveal improved results in posttest over those in the pretest. Science performance increases as a result of alignment of competencies with content-based lesson. Further, it was observed that learners are viable to accomplish task easily and receptive to the learning materials with the help of the teacher-made manipulatives and with the presence and guidance of the teacher himself. It is suggested that teacher-made manipulative (physical) is an innovative strategy to put positive change not only in science subjects but also at some other domains in science or in some other subject areas and these manipulative shall undergo thorough lesson study for it to be incorporated in science lessons in the classroom.

Keywords: Manipulative Skills, Science Performance, Science Education, Grade 9 Students

Introduction

Background of the Study

The physical manipulative will be able to address the gap. In the classroom, teachers may utilize the use of raw school materials like folders made of paper, plastic envelop, paper clips and the like to create a simple physical manipulative aligned to the learning competency in which teachers expect learners to gain. Modi (2021) stated that the more we give importance to skill development, the more competent will be our youth. On this regard, quality learning affects quality education in which learners' experiences count the most. According to Elliot and Corrie (2015), one of the global challenges are the following: insufficient availability, low quality, and ineffective usage of Learning Teaching Materials (UNESCO Learning Portal).

The pandemic started in the Philippines in 2020 and caused so many problems in education. Majority of the schools around the Philippines carried out modular mode of learning which posted a weak interaction between the learner and the teacher. Expectations of contact lessen learning, for example, conducting online classes to learners which is very difficult to do due to connectivity problems, presenting the lesson to the class interactively by which old teachers are not ready for it, gadget availability, financial challenges to buy gadgets compatible to online learning and load for communication devices by both the family of the learners and the teacher themselves.

In this study, manipulative is a flexible learning material used either online or paired with a module. The manipulative skills enable the learners to be proactive in their hands-on experience during the lesson proper. Manipulative skills used to provide an actual process of the science concept scenario in which it is a competency-based lesson and congruent to the objectives of the lesson with the materials being used.

Research has shown that learning for understanding (chemistry) needs an active, self-reflecting and self-responsible learner whereby students construct their own knowledge (Treagust, Duit & Nieswandt, 2000). Manipulative can activate the thinking process since the learner personally carries out hands-on the manipulative and has the understanding of the science concepts with the help of the physical manipulative as a support for learning and to comprehend deeper to the abstract concept in Matter Domain Science nine (9) examples like Quantum Mechanical Model and carbon compounds, to name a few.

For almost six years of teaching Science in the public school, the researcher observed and collected challenging problems which he was personally exposed on the ground among learners. These problems are (1) guessing answers from test or quizzes, (2) no appetite to think deeper, (3) lack of opportunity to experience learning by hand and learning at hand, (4) lack of ownership in their learning, (5) the need to develop responsibility over gained information, and (6) less skillful to manipulate the physical manipulative.

The researcher chose this study because of the following main reasons that help learners better understand the Matter Domain in Science 9: (1) To help learners to be able to comprehend thoroughly with the aid of manipulative; (2) To contribute to the science functional literacy of the society in making physical manipulative in as much as possible environment friendly and be able to recycle materials and to produce new set of resources that will enable learners from lower order thinking skills to progress and proceed to the next higher order thinking skills; (3) To provide a sense of creativity on the part of the learners to be competent in handling physical manipulative, and (4) To bring about reflective thinking and making sense of their learning.

According to Evangelista (2014), a lack or insufficient supply of manipulative materials can negatively impact students' academic performance in science subjects, particularly within the new K-12 curriculum. This situation has prompted the development of physical manipulatives to better meet students' needs. Marley (2014) notes that numerous studies have found that performance on learning objectives improves when tasks involve recognition, recall, and are contextually similar to the initial learning experience.

Based on the above discussion referred to the literature review of instructional manipulative, hence this study continues to confirm the science performance with the usage of physical manipulative.

Manipulative brings about interest, engagement and some affective action-reaction in which it facilitates learning from Reimer (2005). Science teacher will enable to encourage and motivate learner to go on in their learning as they continue the usage of physical manipulatives.

Hence, the conduct of this study.

Theoretical Framework of the Study

Ataizi (2012) argued that learning occurs most effectively when it is directly tied to the specific context in which it is experienced. Bruce (2012) further explained that "learning by doing" involves individuals making sense of their experiences through active participation, including creating and exploring. In contrast, Kolb (2012) described the experiential learning cycle as a learning spiral: when a concrete experience is enhanced by reflection, given meaning through thought, and transformed through action, the resulting new experience becomes more comprehensive and profound. Subsequent iterations of this cycle facilitate further exploration and the application of learning to new contexts. These micro theories provide the foundation for this research study on manipulatives.

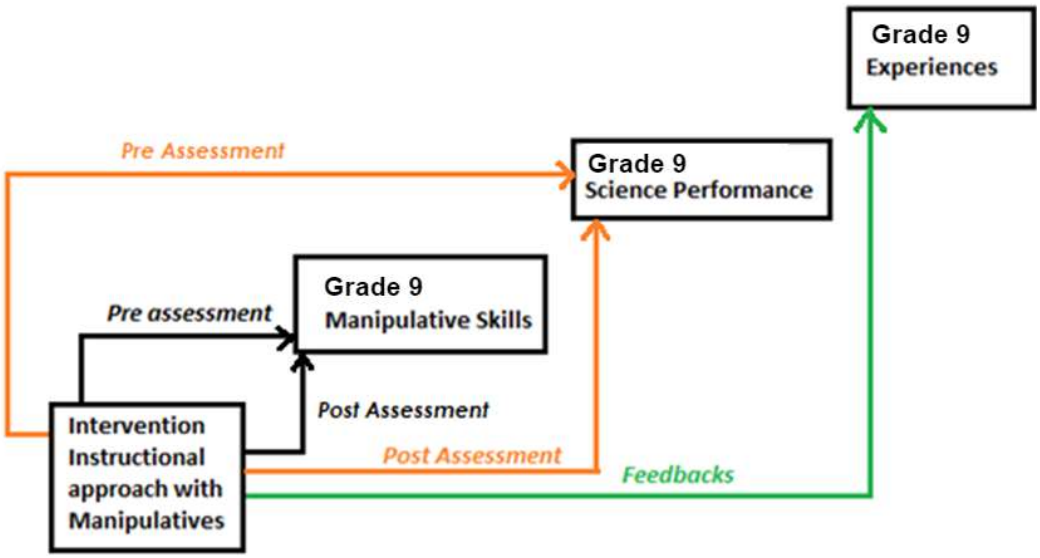

Figure 1.Paradigm showing the diagrammatic presentation of the relationship between the study variables.

Instructional approach with teacher-made manipulative is the intervention of the study. Before the intervention, science performance test and manipulative skill test were conducted as the input of the study while the after the intervention, science performance test and manipulative skill test were also given as the output of the study.

This study is grounded in Piaget's (1980) theory of cognitive constructivism. External representations play a crucial role in daily instruction, such as teachers using chalkboards to draw graphs and choosing textbooks with illustrations to convey key information. One specific type of external representation, instructional manipulatives, is frequently recommended for enhancing classroom learning (Marley & Charbonneau, 2014).

One group composed of ten (10) learners underwent the usual conventional approach of teaching and learning with instructional manipulatives to assimilate information that will enable them to carry and accommodate knowledge in Science concepts from the theory of Cognitive constructivism. Manipulative skills described the learners' explorative action-reaction towards the stimulus in the form of manipulative and as to how they construct abstract concepts in science to solidify well their understanding leading to mastery of the learning competencies. That is how cognitive constructivism works. Science performance and manipulative skills outcome described learners gained scores from lessons they learned with manipulatives to help their in-depth understanding of science ideas and the skills that they have acquired after the intervention.

Statement of the Problem

This study sought for answers on the effect of physical manipulative on Grade 9 learners' science performance and manipulative skills.

Specifically, it sought answers to the following questions:

1. What is the level of science performance of Grade 9 learners before and after exposure to instructional approach with teacher-made manipulatives?
2. What is the level of manipulative skills of Grade 9 learners before and after exposure to instructional approach with teacher-made manipulatives?
3. Is there a significant difference in the level of science performance of Grade 9 learners before and after exposure to instructional approach with teacher-made manipulatives?
4. Is there a significant difference in the level of manipulative skills of Grade 9 learners before and after exposure to instructional approach with teacher made manipulative?
5. What are the Grade 9 learners' experiences after exposure to the intervention?

Hypotheses

Based on the inferential statement of the problem, the following hypotheses were tested:

1. There is no significant difference in the science performance of Grade 9 learners before and after exposure to instructional approach with teacher- made manipulatives.

2. There is no significant difference in the manipulative skills of Grade 9 learners before and after exposure to instructional approach with teacher- made manipulatives.

Definition of Terms

The following terms are conceptually and operationally defined to give clearer understanding and in-depth meaning to the readers:

Conventional Instructional Approach (7Es learning cycle) with manipulatives - in this study, it follows the 7E-Learning Cycle model of lesson planning with the aid of prepared teacher-made manipulatives as a form of instructional intervention.

In this study, teacher-manipulative is a learning material used inside the classroom or during online class or even used outside the school premises or used at home. It can build an atomic model or to show a scientific concept example carbon atom with the compound attach to it and many more. It can be a simplified template of a concept and with the use of white board markers; acetate white plastic folder and visual aids organize together and became a manipulative.

Manipulatives - teaching material as any object from the real world that children can move around, play with or even build an idea in a form of a model to show a scientific concept (Evangelista 2014).

Teacher-made Manipulatives (Physical) - in this study, there are four (4) manipulatives made according to the content such as electronic structure of matter, chemical bonding, the variety of carbon compounds, and mole concept. The first manipulatives have three parts blank template for quantum number section, orbital filling sequence, and electronic configuration. Second manipulatives have two parts the blank atoms and insert correct compound. Third manipulatives have two parts uses of a certain carbon group and carbon bonding. Fourth manipulative have three-parts unit conversion template, atomic mass and number of moles blank template and lastly blank formula for solving grams and its percentage composition.

Manipulative skills in science involve the use and handling of scientific apparatus and chemical substances during laboratory investigations. This includes techniques for safely using, cleaning, and storing scientific equipment (Fodzil, 2017). In this study, the focus is on observable skills related to handling learning materials. These skills are assessed using a teacher-created test designed to evaluate students' proficiency with instructional manipulatives.

Science performance (academic) refers to the educational outcomes achieved by a student, teacher, or institution, specifically in terms of grades (Majo, 2016). In this study, science performance is measured by comparing students' scores on pretest and posttest assessments.Significance of the Study

The results of this research study will be beneficial to the following:

Science teachers. Improvised instructional materials examples are the instructional manipulative (physical) directly recreated and invented by classroom teachers that will assist learners on their understanding of science concepts.

Learners. The students may benefit directly from the teacher-made manipulatives (physical). This may increase their interest and accelerate their performance as reflected in their raw scores in assessment from summative test, performance task and written works in science basic education.

Instructional materials writers. They may translate research findings and best practices into books or into supporting materials. Moreover, teachers can access it following proper steps on how to do it.

Curriculum makers. They may release up-to-date national curriculum guide for basic education. It is the basis of teacher-made manipulative in science as part of improvisation of learning materials.

School administration. Leaders similar to a school principal need to implement the DepEd Order or Memorandum at the school level. Innovations like teacher-made manipulative (physical) in the classroom by the teacher be implemented with the approval of the school head.

Department of Education (DepEd). This study is of great importance to the Department of Education for it may give them an idea to create an order or memorandum regarding the guidelines for the teacher- made manipulative in the science curriculum that is aligned with the national curriculum responsive to the needs of learners.

Other Researchers. They may be provided with data information on gaps and the current trends in which instructional manipulative is included in the research.

They can also replicate the study to validate the efficacy of the study. They can continue to extend the research by putting new combinations to future research studies.

Delimitation of the Study

The respondents of the study were the ten Grade 9 learners enrolled in Tiu Cho Teg Ana-Ros Foundation Integrated Farm School, located at Lanit, Jaro, Iloilo City under the Philippine K- 12 Science Curriculum Matter Domain for the Grade 9 Second quarter only. The use of Microsoft Powerpoint by the teacher to visually convey science concepts and the use of seven ‘Es’ in lesson planning in science were introduced.

The intervention in the study was physical manipulatives in the possession of the learners while having their competency-based Science 9 lessons online via Google meet. The study was conducted on March 21-25, 28-31, 2022 and April 1 and 4, 2022.

Teacher-made pre-test and posttest scores were gathered to determine the Science performance and manipulative skills (observable) on the topics listed on the table of specification except the two lessons:

Thirty learners were not expected to attend online class because of connectivity problems despite the obtained sim cards with loads. Also, the teacher prepared temporary Google accounts with password ready for access online and Science 9 handouts were distributed ahead of time as well. Throughout the course, the learners were able to submit requirements like handouts and feedbacks, yet during the posttest, only ten responded and submitted. There are reasons that are beyond the control of the teacher like pandemic restrictions, device inaccessibility, and transportation safety.

Mean, Standard deviation and Wilcoxson-Signed Rank were the statistical tools used to analyze data. For the qualitative data, thematic analysis was utilized.

Review of Related Literature

Instructional Manipulatives

Practitioners in education say that instructional manipulative is a successful strategy in formal education (NAEYC, 2009). The proper planning of classroom activities will be of great degree to affect the educational objectives and ideas to be presented to the learners. It should have set a scope and limitation of the manipulatives and its lesson related to it. Prior to the lesson proper, it is a must to be mindful in three areas to ponder upon such as Learning Conditions, Learner Characteristics and Attention. In terms of science and mathematics, instructional guidance should be appropriate to learners.

Petersen and McNeil (2013) argue that preconceptions can influence the effectiveness of manipulative-based instruction. Reimer and Moyer (2005) highlight that manipulatives stimulate interest, engagement, and emotional responses, thereby facilitating learning. Marley (2014) notes that many studies show improved performance on learning objectives related to recognition, recall, and tasks that are contextually similar to the initial learning. This suggests that manipulatives should be contextualized.

Pouw, van Gog, and Paas (2014) discuss common findings in manipulative research, which may explain inconsistent results in learning transfer. They suggest that further research is needed to understand these implications for classroom instruction, particularly in aligning learning experiences with outcomes.

Additionally, Pouw, van Gog, and Paas (2014) identify two key considerations: first, manipulatives should be designed to support knowledge construction by aligning their functions with the intended learning outcomes, and second, they should effectively represent spatial concepts.

Tan (2015) emphasizes that science concepts should be addressed through a two-step process: planning a research lesson in a workshop and then presenting and critiquing it in a seminar and workshop. His study demonstrated the effectiveness of lesson study in developing manipulative models for classroom instruction. This approach helps manage misunderstandings of science concepts and addresses issues with physical manipulatives used as analogical tools for elementary learners. To ensure competency-based science lessons, materials such as Microsoft PowerPoint presentations, lesson plans, and supplementary resources must be aligned with competency standards. Teachers can collaborate and provide feedback through lesson study.

Jessica Bayliss (2003) argues that manipulatives reduce misconceptions and promote a comprehensive understanding of science concepts due to their multi-sensory nature. Maricic (2022) examined whether physical manipulation of materials enhances conceptual understanding and retention in magnetism. The results showed that the group with physical manipulatives achieved a deeper understanding and better retention of magnetism-related content compared to other groups.

In the science education blog "Ms. Karla from Sunrise Science" (2014), it is noted that manipulatives cater to both visual and kinesthetic learning styles. Saitta's (2011) research on dimensional analysis in chemistry involved first-semester

students working collaboratively to compute and convert units. The study showed that manipulative activities in dimensional analysis helped students master essential skills and solve word problems.

Zacharia (2014) found that students using virtual manipulatives in electric circuits comprehension had better outcomes compared to those using physical manipulatives. The virtual group had a clearer understanding of current flow, whereas the physical group faced process-related issues due to a lack of understanding of current flow. The study used pre- and post-assessments with 194 randomly selected students.

Zacharia's (2014) study on the effects of introducing virtual manipulatives within a physical manipulative-oriented curriculum found that despite the benefits of physical manipulatives, preconceptions and abstract ideas related to moles and chemical mass posed challenges. The study compared student performance in areas like gas laws and stoichiometry between control and treatment groups, utilizing surveys, interviews, and observations.

Banks (2014) reported that manipulative activities had a statistically significant positive effect on three out of four activities for the experimental group, compared to only two for the control group. The study found that while the control group excelled in dimensional analysis and compound formulas, the experimental group struggled with transferring information and conceptualizing 3D models. It highlighted the need for guided instruction and effective use of manipulatives.

Guzman (2012) suggests using simple manipulatives to enhance understanding of genetic concepts, such as codons and protein synthesis. The study showed that simple manipulatives led to higher scores in assessments of translation exercises, reinforcing laboratory experiments, textbooks, and 3D models.

It also helps the identification of the strengths of the students' usage of learning resources used in the classroom, examples are textbooks, laboratory experiments, and 3D models; it is useful to also observe the misconceptions of each student with varying learning styles. In this approach, learning science is in active modal by doing manipulative, laboratory experiments and exercises and 3D models.

Different resources including the physical manipulative can be maximized through the lesson study and organizing them according to the process of the "topic lesson" leading to the mastery of the science concept.

Gire's (2010) study comparing virtual and physical manipulatives found no significant difference in overall student scores. However, physical manipulatives were more effective for understanding effort force, distance pulled, and mechanical advantage, while virtual manipulatives were better for understanding the concept of work. The order in which manipulatives were used impacted student learning gains for effort force, distance pulled, and mechanical advantage.

The identical pre-, mid-, and post-tests included 13 multiple-choice questions to assess conceptual understanding, with each question having equal weight. Cronbach's Alpha was used to measure reliability. Mauchly's test, Greenhouse-Geisser estimates of sphericity, and repeated measures ANOVA were used to analyze overall scores.

According to Kahneman's capacity theories of attention (1973), people have limited attentional resources. Danton and Kruschke suggest that attention is influenced by the salience of cues; more salient cues attract more attention.

The interpretation of data in terms of friction effects and experimental uncertainties was too limited. There is inconsistency of data interpretation from the real pulley data since it was not instructed to them how to interpret the data.

The theory from Bruner (1961) is that students construct knowledge in different systems of mental representations labeled enactive, iconic and symbolic. The theory explains abstract concept to concrete or in its reverse. Based on the theory according to Atkinson's, instructional manipulatives are relevant as stimuli focused to the learner in their environment. Manipulative flexibility is on multimodal representations encoding and subsequent retrieval encoding.

According to Dual Coding theory, the presence of two coding is more effective than one. Embedded cognitive theory by Pouw (2014) is not a standalone on internal process but instead an interactive process from the surroundings of the learners and the learner only. Authentic environments support instructional cognitive processing for learning using instructional manipulatives.

Marley (2015) considered learning gains manipulative a form or reasoning where one learns from spatial positioning of the objects. In the dual coding theory, imparting information with images resulted in good memory storage and retrieval, based on the sufficiency of the image or text.

A motivation drives the instructional activities upon students affected by positive reinforcement to situational engagement experience that will affect cognitive consequence in the future engagement in the understanding of science concept per se through manipulative, one of which is enjoyment attributed toward facilitation of learning.

In the perspectives of embodiment theory of Barsalou (2008), physical action using manipulative is effective in learning gains to increase sounds and other aspects like emotion and visuals essential in the learning surroundings. According to Bjork (2011), the learning enhancements can be challenging yet examples assembling manipulative which push through an in- depth cognitive processing. Perceptual richness may support, on the other hand, bland manipulative work in hand to assist retention of learning it out from the usage of manipulative.

According to McCrudden (2014), instructional manipulative effectiveness can be assembled in many ways to relationships (spatial relationship) that represent abstract ideas. Manipulative must be found in the grassroots of intended learning outcomes.

Science Manipulative Skills

Researcher Fadzil (2014) describes that student in the elementary school have lack of practical work in science classroom laboratory experimentation which boils down to being less equipped in terms of manipulatives skills in the middle school or in high school. The result was that their intellect in science does not necessarily have the same manipulative skills. It gives the researcher ideas that elementary teachers and secondary
school teachers can collaborate and bridge the gap in terms of manipulatives skills and their transition period.

he study, grounded in Anderson's acquisition theory and Bandura's observational learning theory, focused on students' manipulative skills, which are the ability to handle laboratory equipment and apply proper techniques. The MSTT (Manipulative Skills in Transition Task) was used to assess these skills in students transitioning from primary to middle school.

Data from observations, audio interviews, and drawings were analyzed. Two main themes emerged: functional and technical aspects of classroom activities. Under the functional aspect, four subthemes were identified: (1) task operation during practical work, (2) time and workplace management, (3) safety precautions, and (4) numeracy and drawing techniques.

Students faced challenges in following instructions and checking the functionality of laboratory tools. While they performed satisfactorily with the thermometer, they often neglected to inspect the microscope before use. Glass slides and coverslips were frequently mishandled. Most students demonstrated good performance with the Bunsen burner but were unaware of the dangers of hot water, often leaving it unattended.

In terms of time and workplace management, students lacked practice with the Bunsen burner, leading to repetition. The working area was sometimes disorganized, with items placed too close or far away. Most students were able to clean and store equipment properly. However, they struggled with numeracy tasks and had limited time for drawing specimens.

Regarding initial temperature assumptions, students often guessed zero, indicating a primary-level understanding. The study deals with the assessment of students' manipulative skills during a practical work approach in terms of activities. The practical work done in the experiments inside the science classroom settings in which students are given diagnostic tests, rubrics with criterion in every category. The study was materialized in eight (8) schools in Malaysia. Each student conducts an individual experiment. It can determine skills that need improvements. The additional suggestive feedback is to include safety measures, manipulative skills in science, and finally, certify students output and fix properly their tasks.

Manipulative skills by Fadzil (2014) tells us that skills development never stops in idleness yet not to hang things in an empty air but consistent practice of the science skills towards mastering it will enable them to carry-out science task properly inside the classroom. Safety is part of it, for survival and life skills since in science it deals with electricity and chemical compound.

The proposed domain in psychomotor taxonomy here is that there is a need to provide a clear articulation of abilities, knowledge and aptitude to develop in terms of technical capabilities. The psychomotor domain extension came about to help educators to hit the target goal that includes the learning outcomes like the engineers from Australia. Laboratory work in science and engineering heavily emphasizes the practical skill of handling laboratory equipment. Bloom's taxonomy of psychomotor objectives, however, is too general to directly address this specific concern in the context of science and engineering education.

The hierarchy in Bloom's taxonomy starts with the primary classifications in the first column, followed by seven levels. These levels include: 1) recognition of tools and materials, 2) handling tools and materials, 3) basic operation of tools, 4) competent operation of tools, 5) expert operation of tools, 6) planning work operations, and 7) evaluating outputs and planning for improvement. The second column specifies subclassifications, and the third column maps knowledge to knowledge type. The knowledge type has three categories “Know how”, “Know that”, and “Knowing”. The “know that” emphasizes the recognition and understanding of the tools and materials in its corresponding safety precautions information. The “know how” is more on doing the task. The “knowing” is attributed to the fluency of the performed actions. Research shows from the introduction of the study that multiple representations can improve student learning.

This article will enable to assess educators’ and students’ capacity not only limited to the use of science equipment or apparatus in the laboratory but also to measure how the teaching manipulatives which include also the physical manipulative are used by learners.

Instructional Manipulative Assessment

The Department of Education in the Philippines created a resource book entitled, Guidelines and Process for LRMDS (means Learning Resources Material Development) Assessment and Evaluation. The evaluation has factor A, Content, factor B, Other Findings, and Factor C, Additional Requirements for Manipulative. It has four columns such as very satisfactory, satisfactory and not satisfactory. In terms of content, it assesses the mastery level of the learner after the usage of the manipulatives. It is interesting on the part of the learners to use it. The manipulators carry accurate factual information, the information is up to date, visuals are relevant to the text, age - appropriate visuals, typographic or layout design facilitate understanding concepts, materials in appropriate size in school use, and lastly, easy to use and is durable. The Factor C manipulatives, other findings, will include factual, grammatical and conceptual error. Factor C manipulatives additional requirements that include presence of support material, summarized activities, suggested activities supporting innovative pedagogy, safe to use, size and composition is appropriate for intended audience, manual task compatible with the motor skills of the intended users. Specific material like Manipulative should set a child- friendly atmosphere in which students can enjoy while they are learning science concepts.

The Philippines Science High School is an institution specializing learners in science, engineering, technology and mathematics in secondary school settings. The Curriculum and Instruction manual version 2 dated February 1, 2020 provides a rubric checklist of the instructional materials used by the teachers and learners in imparting science concepts. There are four aspects in which the instructional material is being evaluated such as content, instructional value, language mechanics and production quality. There is a scale which describes the quality of the material. 5=excellent, 4=very satisfactory, 3= satisfactory, 2=needs improvement, and 1=unsatisfactory and NA=item not applicable to material being used.

The content describes the coverage of learning competencies prescribed by the subject. Accurate information is sufficient and relevant with local context. Gender and cultural equity are present with the integration of values, experience lifelong and life wide activities and establish original creation out of established ideas.

The second aspect is the instructional value. Visual graphics and other graphics organizers are placed for example flowchart, pictures and diagrams. Materials have safety precautions to awaken learners’ consciousness. The material is flexible and versatile to the pacing of the learners, higher order thinking skills development that includes creative thinking, critical thinking and problem solving as it uses the material. Learning objectives can be seen by the learners. The content is in sequence from simple to complex, from concrete to abstract. The third part of the language mechanics is the embedded words bearing correct grammar, spelling, and word usage. Language suited to the learners’ understanding and grade level takes into consideration. Variations of sentences and paragraphs sustain an interesting spark towards the material and ideas acquisition. The instructions, questions, exercises and problems are straight forward. The sources are properly cited.

The fourth part and the last is the production quality. Attractive suited visuals, and layout design can be seen that include illustrations, graphs and the like. It also follows the appropriate font size and type, overall can catch and sustain attention.

It will give us the standards to consider in making instructional materials inside the science classroom whether it is a ready-made or a teacher - made to further improve the quality of the materials. In making teacher- made assessment tool, one of the greatest considerations is to refer to other research studies as to the placement of scores and columns, the observable skills enumerated, the guidelines is clear enough as to how you will answer the manipulative skill test and also as to the points counted.

In creating teacher-made manipulative, it will entail various safety measures, visual considerations, content of the lesson must be precise and accurate to deliver the quality learning process. Teacher should improvise physical manipulative which can convey the lesson meaningfully towards and the mastery of skills and science concept. Parts of the manipulatives include (1) content and visuals, (2) safe - based materials, (3) guidelines of usage, (4) moving parts of the manipulatives and (5) optional: answer key

Summary

The manipulative before the lesson should have three considerations in mind such as learning conditions, learner characteristics and attention. According to Reimer (2005), manipulative arouse interest towards an engagement in learning and to some extent affective action-reaction that facilitates learning. Manipulative research implied in terms of its usage should be congruent with the intended learning outcomes. To ensure the quality of the whole learning experience, lessons with manipulative should undergo lesson study with the following process: first planning, second presentation, and then critiquing in workshop or seminar.

The manipulatives are used for collaborative learning activity for general chemistry classes in the first semester for college students to master skills in converting units to target units and its effect towards their performance after the intervention.

Electric circuits and the flow of current is investigated through the use of physical manipulatives and virtual manipulatives. In understanding the process of electrical circuit, virtual manipulatives are able to assist well more than physical manipulatives.

The researchers utilize journals and interviews with the learners and video data. The control group has easier access to the crisscross method rather than interlocking building blocks, the same group proficient at correctly executing the chemical formula from the compound name. Word problems in chemistry take the time of students to solve the problem. The statistical tools are pretest and posttest with t test and p values computed. The lesson topics for manipulatives are dimensional analysis, ionic formulas, molecular shapes and stoichiometry.

Manipulative skills are still necessary to STEM education, not only the cognitive intellect value of the student. The MSTT or Manipulatives Skills Transition Task is used as a tool to measure the comprehension of students from the laboratory tools and equipment or experimental tasks in the science classroom. The tasks performed by the students are measuring temperature, and volume of chemicals, drawing of specimens, and cleaning and storing experimental laboratory tools equipment and calculating data or writing data from the executed science laboratory exercises.

The Education Department in the Philippines provided a book to guide teachers in the assessment and evaluation of the learning resource material. Part of the resource book entitled, Guidelines and process for LRMDS Assessment and Evaluation, is the Manipulatives used in the basic education Junior High School which the researcher's study focuses upon. The checklist with corresponding points has five components. Factor A deals with factual information, Visuals, typographical layout design, material durability, usability and appropriateness and will attract learners, content alignment from learning competency. Factor B focuses on various errors in the academic publishing context, factor C guided activities that will support teacher and learner progressive learning development, safety and materials use and motor skills compatibility. Philippine Science High Schools do have assessment of instructional materials and have four aspects to consider. First, the content includes precise information, gender, cultural sensitivity with the integration of values, lifelong activities and presents original creation out of established ideas, the second is instructional value. It includes visuals and graphic organizer safety use and flexibility of the manipulative material with the pacing of the learners, and it develops higher order skills which develop creative thinking, critical thinking and problem- solving skills, sequence of content from simple to complex and learning objective is seen by learner. The third is language mechanics that includes grammar and word usage appropriate to learners which spark interest, instructions, questions, exercises and problem solving are straightforward and also provide proper citing of references, and fourth quality is production quality design layout illustration and font size and style catch attention and sustain learners' interest.

Bloom's taxonomy of education outlines educational objectives in terms of psychomotor skills, extending the hierarchy to include the evaluation level. The seven columns represent the levels, with the second column specifying subclassifications and the third column indicating the expected knowledge type for each subclassification task.

Simple manipulative skills are introduced to first-year college students to facilitate understanding of complex biological processes. Students undergo assessments before and after exercises from textbooks and laboratory manuals. Various learning resources are utilized to identify student strengths and misconceptions.

A study comparing virtual, physical, and combined manipulatives on physics undergraduate students' conceptual understanding of heat and temperature revealed that a combination of virtual and physical manipulatives is more effective than using either alone. Physical manipulatives promote understanding of heat and temperature concepts.

Another study focused on the use of manipulatives in the conceptual learning of pulleys. Physical manipulatives were found to be effective for understanding effort, force, distance pulled, and mechanical advantage, while virtual manipulatives were beneficial for understanding work. The sequencing of manipulative use (virtual to physical or vice versa) impacted student learning gains.

Psychological research with instructional manipulative that inform classroom learning theories are enumerated such as dual coding theory, Bruner's constructivist theory, embodiment theory and the like.

Research Design

The one group pre-test post-test research design was utilized in this study. Moreover, an experimental design involving one group that is pretested, exposed to a treatment then post tested (Frankel &Wallen, 2009). This study utilized pretestposttest manipulative skills test and pretest-posttest science performance of Grade 9 learners with the intervention of instructional approach with manipulative in science matter domain. In addition, themes were added to the study to capture the experiences among Grade 9 learners after intervention. Themes, according to Frankel and Wallen (2009), means organizing and interpreting data in a content analysis by grouping codes as the interpretation progresses.

One-Group Pretest-Posttest Design

One Group (Physical Manipulatives) _ _ O 1 _ _X _ _ O 2_ _

Legend:

O1 = pretest X = Treatment

O2= posttest

Figure 2.Research Design: One group pretest-posttest design

Methodology

The Respondents. This study was conducted at Tiu Cho Teg Ana-Ros Foundation Integrated Farm School Located at Lanit, Jaro, Iloilo City. The Schools Division of Iloilo City supervises Andres Tiu Cho Teg Ana-Ros Foundation Integrated Farm School with complete grade level from kinder to senior high school. The school is surrounded by plain agricultural land. Most of the people in the area near the school are of poor to average economic status.

The respondents of this study were the Grade 9 Junior High school learners in Tiu Cho Teg Ana-Ros Foundation Integrated Farm School. There were Grade nine (9) learners enrolled in the said school. The researcher conducted the intervention in mixed heterogeneous grouping of ten (10) learners as group 1 and mixed heterogenous group were chosen as two group, respectively and ten (10) learner as control group these ten (10) completed pretest and posttest on both science performance and manipulative skill. They were chosen based on the following criteria: (a) they are Grade 7 learners and are currently enrolled in the school; (b) they belong to a class section with learners of mix average and low average academic performance; (c) willing to join as respondents in the study, and (d) have submitted pretest-posttest for science performance and manipulative skill test, able to receive and use manipulatives and have attended day one (1) to last day online class, and able to submit feedbacks, slips.

Research Instruments

The three instruments used were the following: (1) Teacher-made manipulative skill test, and (2) Teacher-made Performance test, (3) Feedbacks (written).

Teacher-made Manipulative Skill Test. According to Ferris and Azzis (2005), there are six psychomotor domains from lowest to highest such as (A) recognition of tools and materials, (B) handling of tools and materials, (C) basic operation of tools, (D) competent operation, (E) expert operation of tools, (F) planning of work operations, and (G) evaluation of outputs. There are 19 expected observable skills. To orient the user of this test from one main category, he

or she shall choose one observable skill and the rest will have zero value if not applicable. Teacher will put a score to the observed skill, then, he will choose one from the three magnitudes with numerical value and description, namely: not observed (0-1), observed low (2-3) and observed high (4-5) teacher rate learner according to the observable skills listed. The scaling with respect to the mean value are as follows: Very High (4.51-5.00); High (3.51-4.50); Average (2.51-3.50); Very low (1.51-2.50); Low (1.00-1.50). The validators of this instrument were the two expert Science teachers.

Teacher- made Performance Test (Pretest-Posttest). The science performance test was composed of questions with four choices in each item. It was a correct answer type of test covering topics in Grade 9 Science as indicated in the table

of specification (refer to the next page). Table of Specification on Grade 9 Science
Matter Domain is reflected in Appendix 3.

Feedbacks (Written) The nine learners after the lesson will write their feedback on each the lesson in a piece of paper and submit it to the science teacher to record their experiences

Validation of the instrument was determined by the two Science teachers with five years' experience in classroom in secondary school science. To produce reliable test in science performance, a pilot test was conducted in one of the national high school, with 20 respondents. The Cronsbach's Alpha result value is the statistical method to utilize for reliability. The scales to interpret the result are scale in mean and scale in variance as follows: High (above 16); Average (14-26); and Low (Below 14).

Data Collection Procedure

Pre-experimental stage. Prior to the actual implementation of the intervention, pilot testing for the teacher made-achievement test from Fort San Pedro National High School was conducted on March 10, 2022. Permission to conduct the research was secured from the Schools Division Superintendent of Iloilo City and the School Principal. Moreover, a permit or informed consent from the parents and respondents was secured. Preparation of lesson plans and compilation of a bunch of manipulatives in science were also done at this stage. Moreover, preparation of Microsoft PowerPoint presentation by the teacher and hand-outs reprinting ahead for the learners to get copies right away were also done. The "sim" cards with loads and temporary "google" account to access "google" meet were made ready for use.

Experimental stage. After the conduct of the pre-test for achievement test and teacher made manipulative skills test, Grade 9 learners were exposed to intervention. The researcher conducted the intervention for less than six (6) weeks. Teaching with manipulative in this study was implemented with "7Es" Lesson Guide in which the teacher let the students use the physical manipulatives. The topic and the manipulatives utilized are presented in Appendix 10.

For example, the first "E" is Elicit: getting the attention of the learners by showing or introducing manipulatives and how to operate them. The second "E" is Engage: Learners sustained their focus towards the lesson by knowing the objective of the lesson using a teacher-made manipulative to bridge the lesson to its science concept with the teacher demonstrating the science concept together with the manipulatives.

The third "E" is Explore: Learners' hands-on experience started, and the fourth "E" is Explain: Learners will present to the class the output and will show how to come up with the correct answer using the manipulative. The fifth "E" is Elaborate: For the learners to appreciate more the lesson, the science concept is integrated or contextualized into real life situation or is practiced many times. Example of the science concept is word problem in chemical mass and moles using the manipulative. The sixth "E" is Evaluate: Test learners' knowledge and skills by paper and pencil test or record their performance or take pictures of their output, and the seventh "E" is Extend: More practice exercises to master the science concept or the science skills are given where they can still use their manipulatives here.

Learners' written feedbacks are gathered after every content standard to provide experience as to their usage of the manipulative. There are four main content in this quarter as follows: first, electronic structure of matter, chemical bonding, variety of carbon compounds, and lastly mole concept.

Post-experimental stage. After the implementation of the intervention, the post-test on achievement test and manipulative skill test were administered. The results of this testing procedure will determine if there was improvement in science performance of Grade 9 learners in matter domain through the use of teacher - made achievement test and will further determine observable skills gained after intervention by using the manipulative skill test. Furthermore, the teacher gathered and processed the data for appropriate statistical analysis.

Data Analysis Procedure

Mean. Mean was determined by adding up all of scores from pre-exposure and post-exposure science achievement and manipulative skills and then dividing this sum by the total number of scores from pre-exposure and post-

exposure. Science achievement and manipulative skills were used to describe level of science performance and level of manipulative skills in the Grade 9 Science matter domain.

Standard deviation. This was utilized to determine the homogeneity and heterogeneity of the mean score of each learner in terms of the pre-exposure and postexposure science performance and manipulative skills in the Grade 9 Science matter domain.

Wilcoxson-sign rank. This was used to determine the difference between pretest and post-test of learners in Grade 9 Science achievement and manipulative skills test gained scores, respectively.

Results and Discussion

A one group pretest-posttest research study was done to determine the effect of intervention, that is, teacher-made manipulatives on the performance in science (Matter domain) of Grade 9 learners of Tiu Cho Teg Ana-Ros Foundation Integrated Farm School in Barangay Lanit, Jaro, Iloilo City. The manipulatives were the research instruments used for scoring the manipulative skills improvement and for the performance in science. A 39- item multiple choice test was given to the learners-respondents. Six psychomotor domains were focused, namely: recognition of tools and materials, handling of tools and materials, basic operation of tools, competent operation, expert operation of tools and planning of work operations use. There were nineteen (19) observable skills among these six (6) psychomotor domains.

The results are given below:

1. The pretest science performance has the mean score of 14.6, “average” in description. Science performance posttest resulted to 26.9 “high” by description.
2. The manipulative skill pretest score gained is 3.64 which is “high” by description. The manipulative skill posttest value is 3.95 which is considered “high” by description.
3. Science performance difference between pretest and posttest of science performance using Wilcoxon signed rank with $Z= -2.871$, $p < 0.05$. The result indicates that the intervention is effective in improving science performance.
4. In manipulatives skills, there is a significant difference on manipulative skills of Grade 9 learners before and after exposure to instructional approach with teacher-made manipulatives, $Z=-2.312$, $p<0.05$. These results indicate that the intervention was effective in improving science performance.

Conclusions

Based on the results presented, the following conclusions are made: Majority among Grade 9 learners gained average in description since learners have prior knowledge on elements or atom, carbon compounds, conversion of units and solving word problems. Almost all Grade 9 learners’ posttest scores which are high in description improved a lot. It shows that many of the Grade 9 learners were able to master the content of the lesson.

Grade 9 learners are receptive to the materials they received and very adaptive to the teacher-made manipulatives especially to how to operate the material and the skills embedded therein. The teacher-made manipulatives were found effective since posttest scores yield higher scores compared to their pretest scores.

Table 4 brought the data which connote that the skills set added up and skills set level increased as compared to the pretest. Learners are viable to accomplish task easily with the help of the teacher-made manipulatives and with the presence and guidance of the teacher.

Recommendations

Based on the results presented, the following are recommended:

1. The researcher recommends that Grade 9 Science (matter domain) requires thorough lesson study, competencies alignment and learners’ and teachers’ collaboration to enhance further the materials used, examples are teacher-made manipulatives, and the content of the lesson with respect to the learners’ response towards the accomplishment of the objectives of the lesson.
2. Teacher-made manipulative (physical) can be effective at some other domains in science or in some other “lesson-topic” in science. In this case, it is suggested that these manipulatives, specifically be reviewed across other subject areas with the same “lesson-topic”, be modified to improve its effectiveness in developing and improving skills, and further master the skills in specific subject areas.
3. Improvement of the teacher-made science performance test by reviewing further the curriculum guide in Science 3 to Science 8 and the review curriculum guide from Mathematics 3 to Mathematics 8 by virtue of focus group

discussion with a written report as an output be given preferential attention by the DepEd. After review and revisions, table of specifications be provided.

4. Teacher-made manipulatives skill test must be up to date to be relevant and aligned to the content of the subject. Manipulatives skill set must be incorporated with study and thinking skills, work-related skills, life skills and survival skills as deemed appropriate.

Implication

For theory. Grade 9 learners after the use of teacher-made manipulative implied that the conventional lecture approach facilitate them to the formation of abstract intellectual operation in science concepts. Learners have the opportunity to discover and actively engage in learning Science through the use of manipulatives. The prior experiences and learning they got from inside and outside the classroom activities are factors contributory to organize their previous knowledge which leads to the transformation of new information.

For practice. In constructing lesson plans, teachers carry out a discovery approach using the manipulatives to deliver the abstract topic. Teachers, as facilitators of learning, have to provide set of guide questions to provoke students to be critical thinkers attempting to answer the classroom activity using manipulatives as support component of the learning process. Teachers will initiate and motivate journal writing inside the classroom as to the learners' experience and difficulties they have been through. With this, they would victoriously arrive to the correct answer. Asking learners their own words regarding science ideas can help establish their self-consciousness to be responsible individuals in their studies.

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