CONSTRUCTIVISM AND PEDAGOGICAL PRACTICES OF SCIENCE TEACHERS

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ABSTRACT

This study generally aimed to determine how the theory of constructivism has been translated into pedagogical practices of science teachers among the selected schools in Metro Manila. The study utilized case study adapting passive observation, document analysis and semi-structured interview in the data gathering and thematic interpretation in data analysis. Results uncovered that teachers' practices of planning learning episodes elicit active engagement as an evidence of meaning making. Various learning activities have been conceptualized to thoroughly activate prior knowledge on essential information and concepts and link these to new knowledge being introduced in the lesson through designed activities. The art of questioning has been observed to initiate and induce engagement among learners and was evident in the implementation of different strategies such as pre-assessment, reflection, collaboration, and use of language. Assessment procedures planned and implemented by teachers embodied a constructivist approach in terms of assessing students' understanding of concepts, creation of new knowledge, and integration of ideas to other disciplines. Results of the study further implied to revisit the curricular preparation of teachers in terms of its alignment to the various postulates of constructivist-approach of teaching and learning.

Keywords: Assessment strategies, Constructivism, learning outcomes, pedagogical practices, and teachers' preparation.

INTRODUCTION

K to 12 science curriculum framework is built on the philosophy of constructivism, which focuses on inquiry approach. Teachers are expected to prepare, deliver and adapt assessment tools that use methods and techniques guided by constructivism

theoretical assumptions. This research aims to determine the parallelism of the science curriculum framework to the actual teaching-learning activities happening at the classroom level. The findings of the study can serve as guidelines to policymakers and educational leaders for necessary changes in the present science K-12 framework that will better equip the frontrunners of education and the implementers of the curriculum, the teachers.

Over the past years, a long tradition of research on constructivism and related teaching models in science conclusively state positive results to teaching and learning (Ayaz and Sekerci, 2015). The critical part is on how teachers use these research claims in the preparation and delivery of their lesson. The effective use of an educational philosophy relies heavily on the foundational knowledge of the teacher to a teaching strategy that is anchored on its philosophical assumptions. If science teachers are aware that constructivist theory is the most effective approach to teach science, then teachers should create a classroom atmosphere that promotes learning and allows the learner to be part of the process (Bada, 2015). Furthermore, constructivist teaching approach was said to be effective in relation to the students' academic achievement, self-concept and learning strategies, (Barman and Bhattacharyya (2015). Therefore, this could help in overhauling the instructional, pedagogical and assessment practices to make them more relevant for the students of the 21st century. It is in this aspect related to learning processes from which students acquire knowledge that constructivist teaching and learning theory have much to offer (Fernando and Marikar, 2017). Teachers are provided with daily lesson log templates that utilize the 5E model. This model developed by Roger Bybee was framed as the most conducive among the several available constructivist models (Singh and Yaduvangshi, 2015). Thus, a typical lesson plan based on this 5Es had been framed as an attempt towards design learning strategy for science classrooms, which may help in realizing the primary goal of constructivism. However, it is only through actual execution in the classrooms that the assumptions of constructivism can be observed.

It is imperative to revisit the extent to which the K-12 science curriculum is being taught in the public secondary schools. The quality of the students produced under the curriculum is contingent on the quality of the teachers. Part of the classroom assessment of constructivist teachers is to encourage their students to assess their own progress in understanding the lesson (Bada, 2015). Because of the high-quality standards stipulated in DepEd policies (DepEd Order No. 7, Series of 2015) in hiring teachers, it can suffice to say that teachers on the field are competent in terms of content and pedagogical knowledge. The K-12 curriculum is primarily designed in the framework of constructivism. This study aimed to determine the gap of theory into practice in terms of the implemented curriculum and describe teachers' delivery of the lesson through classroom observation interview, and questionnaire. Teachers utilize pedagogical practices that manifest constructivism. However, time constraint in covering the content and lesson preparation pose challenges in strictly implementing constructivism techniques. Teachers balance the expectations of the curriculum with the context of their learners and realities of the classroom situation.

OBJECTIVES OF THE STUDY

This study generally aimed to determine how the theory of constructivism has been translated into pedagogical practices of science teachers. 1) Describe how science teachers design learning activities that will engage students in linking their prior knowledge to new knowledge; formulating their own understanding of concepts; and creating new knowledge. 2) Discuss how science teachers assess learners in terms of the following Understanding concepts; Creating new knowledge; and Integrating knowledge to other disciplines. 3) Examine

the learning outcomes that are formulated by science teachers which manifest assumptions of constructivism.

MATERIALS AND METHODS

This study utilized a case study research design. This study was conducted on selected schools in and outside Metro Manila this School Year 2019-2020 from July to September. The following schools were: Manuel G. Araullo High School, San Juan National High School, PUP Laboratory High School, and Jose P. Laurel High School. It involved eight Science teachers from different grade levels. Selection of respondents followed a non-purposive sampling. Data collection had three primary components: Passive observation, often called direct observation, teacher resource material like daily lesson plan (DLL); and interviews from the teachers being observed. The interview was conducted in different phases in accordance to the needs and extent of the study. The first-round interviews examined the teachers' experiences and their orientations to science teaching. The second-round interviews concerned on planning of lessons for a specific class they were teaching. After observing the class, teachers were interviewed about teaching the lesson in general, the different modes of assessments and particular classroom instances noted during the lesson. In order to uncover the possible challenges and gaps in teaching science designed using constructivism, the study adopted a semi-structured questionnaire developed by the researchers. It was validated by selected professors in the same field of expertise. It comprised three major parts: the first part of the questionnaire discussed the preparation of Science teachers' design learning activities that will engage students in (a) linking prior knowledge to new knowledge; (b) formulating their own understanding of concepts; and (c) creating new knowledge. The second part dealt with: how science teachers assess learners in terms of the following: (a) understanding concepts; (b) creating new knowledge; and (c) integrating knowledge to other disciplines. Lastly, the questionnaire covered the learning outcomes that were formulated by teachers that manifest assumptions of constructivism. Responses were analyzed using thematic analysis by Braun & Clarke (2006).

The researchers asked permission from the Schools Division Superintendent of City Schools of Manila and respective Principals of each school. Participation in the study was voluntary and participants who consented can withdraw at any time. The researchers provided full disclosure information to participants about the class observation, interview and copy of their daily lesson plan. This helped them make an informed decision to participate, and that translated to an autonomous decision without coercion. The participants were provided with a copy of the signed consent form. For confidentiality and anonymity, the names of the participants were not being disclosed. The participants were also given freedom to withdraw as a participant of the study at any time.

RESULTS AND DISCUSSION

1. Science teachers design learning activities that will engage students

1.1 Linking students' prior knowledge to new knowledge. This explored the instructional practices of teachers in terms of bridging students' prior knowledge or schema to current lesson. Being one of the assumptions of constructivism, eliciting prior knowledge from learners involves soliciting from them what they have already in mind as brought about by their instructional exposure and experiences. Guided by this postulate, researchers probed how science teachers facilitate the extraction of prior knowledge whenever they teach a new topic. In delving into the practices by the teachers, this portion inquired the way they activate prior knowledge and linking it to present lesson as corroborated from their perceived experiences drawn from

the conducted interviews; instructional manifestations in the lesson planning and actual teaching observations.

1.2 Activating prior knowledge. Majority of the respondents firmly assumed that whenever they tackle a new lesson, learners are expected to have diverse skills and disposition about the lesson which most of the time causes heterogeneity in terms of learning preparedness and differences in the way they acquire new skills and concepts embedded in the new lesson. All their designed instructional plans have stipulated portions that call for the "recall" of prerequisites lessons that were deemed to be essential in understanding the present lesson. For them to be guided, the "elicit" portion of their lesson log enumerated the set of guide questions that they will ask the students as a form of activating their prior knowledge. The questioning techniques of teachers were the prevailing practices that initiate and induce engagement among learners in the beginning of the lesson. Most of the teachers observed have guiding questions that revolved into topical and essential questions. The topical questions were commonly observed as a "recall" of the previous lesson such as "*What is biodiversity? How can you differentiate low biodiversity from high biodiversity?"* While the essential questions call for the affective domain of the students in making meaning of what they have learned such as "*What are the advantages of having high biodiversity in an ecosystem?"* questioning is a stimulant that activate students' cognitive skills (Aydemir, 2008) and is considered to be an effective teaching strategy in ensuring active participation and boost critical thinking among students.

Teachers under study adhered to the practice that appropriate questioning can discern how well the students process information. The kind of knowledge students generate and communicate is dependent on teacher's questioning approach (Pedrosa-de-Jesus and da Silva Lopes, 2011). In the observed classes, it was unfolded that questions coming from teachers served as a stimulus that activates how the students will bridge their scheme into what it being communicated at the present.

To execute the questioning techniques in activating prior knowledge, teachers design a variety of strategies that will engage students to respond to the guide questions calling for a mental modeling of background knowledge about the lesson. The questions stipulated in the elicit portion of their learning logs served as the framework in the design and nature of activities. From the lesson logs and interview conducted, it appeared that teachers exhibited a great deal of creativity in conceptualizing activities. This was consistent to the work done by Ozel and Luft (2013) about teaching practices and deliver of inquiry-based activities in science class.

From the pool of practices shared by the teachers in the interview, these practices can be deduced into the following categories: *traditional pre-assessment strategies (test-based), reflective strategies, collaborative strategies and language strategies*. In pre-assessment strategies, teachers typically used assessment tools such as paper and pencil test (diagnostic test), K-W-L chart, matching of words and direct question and answer. Teachers administered this prior to the discussion of the new lesson in which the contents and items were anchored to the set of questions enumerated in the daily lesson log. Through this, teachers can assess how well the students demonstrate understanding of the prerequisite lessons needed prior to the discussion of the new lesson. These pre-assessment strategies assist teachers in designing corrective plan by guiding the students to correct some misconceptions and align it to the desired skills and learning outcome (Al-Thubaiti, 2014).

When inquired how the teachers process the solicited responses of the students regarding their prior knowledge, teachers typically conduct item analysis, identifying misconceptions and reiterating concept development. Through this, they could identify the critical points necessary in

bridging what the students know into the upcoming lessons.

In terms of reflective strategies, common practices include audio-visual presentation, picture analysis, puppet show and writing reflection paper. Through these, teachers can account of other underlying conceptions and comprehension of the students. It was also observed that teachers took this as the opportunity in guiding the students in the "meaning-making" process of the lesson. This had further taken a lead in deepening what the students have already in mind.

Since many instructional videos were available online, teachers utilized them by not just extracting the actual information but also the "meaning" of it in the perspective of the students. Koong, Yang, Wu, Li, and TsengKoong (2014) described this instructional phenomenon as a process of grasping new values by integrating past knowledge, experiences and actions.

Another way of activating prior knowledge is through the collaborative strategies. Teachers also utilize flexible groupings to bring out the prior knowledge of the students. Some strategies raised were group written work, demonstration activity and scenario-based activity. These activities were designed to initiate brainstorming and generate information from one another. More often, collaboration among students also served as a reflection to see how their ideas vary.

Lastly, language strategies include those activities that involve focus on science keywords lifted from the previous lesson such as matching of words, puzzle and word hunts, decode-me-activity, word wall and jumbled letters. From among the many practices shared by the respondents, this account was the most common way of opening a new lesson which served as a learning recall of the students. As a way of activating prior knowledge, different ways of language strategies enabled learners to see connections and organizations of key concepts that they can use to grasp the relevance of it to the current information.

1.3 Linking prior knowledge to the present lesson. In drawing the framework of the lesson extracted from the students' prior knowledge, it was observed that the art of questioning and probing appeared to be the most frequently used. Teachers typically posed processing questions to facilitate. From the performance done by the students in activating their prior knowledge, teachers typically process them by letting the students do a synthesis and generalization on what concepts are embedded in the activating strategies which were essential as foundation in the introduction of the new lesson. Since the curriculum being followed by the teachers is spiral, teachers usually let the students view how the concepts came up and where it should go to the next lesson. However, the depth of this practice was not concretely observed in the classroom observation. Teachers merely considered the stimulating activity as part of formative requirements.

In addition, it can also be deduced from interview and classroom observation that teachers have the same way on how to activate prior knowledge and how to link it in the current lesson. All teacher respondents considered the use of designed activities as a way to gauge whether the former understanding was well-articulated in the recently discussed lesson.

Indicators of Constructivism in Learning Assessment

As gleaned from Table 1, there were three modes of transfer of learning that came from the data collected using document analysis in lesson logs, interviews, and classroom observations.

Table 1

Science Teachers' Learning Activities in Assessing Learners' Understanding of Concepts, Creating New knowledge, and Integrating Knowledge to other Disciplines

Modes of Transfer of Learning								
Formative Assessment			**Authentic Assessment**			**Interdisciplinary Learning Outcomes**		
Lesson Log	**Interview**	**Class Observation**	**Lesson Log**	**Interview**	**Class Observation**	**Lesson Log**	**Interview**	**Class Observation**
Formative assessment is present in the lesson plans through providing guide questions	Teachers facilitate the following student activities: such as: -diary completion	Teachers provide activities to see the relationship of concepts through fill in the blanks	-	Teacher provides diary activity sheet for students	Teachers asked learners to work in dyads, or triads to create mind maps	Does not contain interdisciplinary learning outcomes (there is a standardized daily lesson plan)	Teachers provide performance task where students apply concepts they have learned and guided by rubrics	Integration of concepts to other fields in science, economy, health and communication skills.
-	Teachers check with the class if the objectives are met	Group discussions of concepts guided by power-point presentation of teacher	-	-reflective essay	Group activities during performance task such as poem-making, poster-making, jingle making, role playing, and reporting	-	-	Linking the lesson in news-related science.
-	Guide questions that lead to the discovery of the concepts	-	-	performance -based activities such as role plays, jingle-making, and reporting	The use of Venn diagram in organizing the lessons learned	-	-	-
-	Worksheets and task cards,	-	-	-listing of concepts	-	-	-	-
-	Teachers provide guide questions	-	-	-future logs	-	-	-	-
-	paper and pencil examinations.	-	-	-	-	-	-	-

These modes of transfer of learning indicate science teachers' learning activities they provided in assessing learners' understanding of concepts, creating new knowledge, and integrating knowledge to other disciplines. Accordingly, data revealed that these modes of transfer of learning included the presence of *formative*

assessment in assessing learners' understanding of concepts; *authentic assessments* were given to measure learners' creation of new knowledge*;* and there was an integration of knowledge to other disciplines through the activities observed in the data for *interdisciplinary learning outcomes.*

2. Science teachers' assessment for learners in terms of the following:

2.1 Understanding of concepts. Teachers provide a *formative assessment* to students for them to understand concepts being taught in the forms of preparing guide questions, diary completion, objective tracking, worksheets and task cards activities, paper and pencil examinations, filling in the blanks for checking relationship of concepts, and group discussions. These data revealed that teachers provide a variety of activities to check understanding of learners of the concepts being taught. In fact, Wilson (2017) stressed that teachers could maximize significant impressions on the learning of students when the data of their formative assessment activities were properly utilized in the teaching and learning process.

2.2 Creating new knowledge. In addition, creation of new knowledge by the students were assessed by teachers using *authentic assessments* such as giving of activity sheets according to subject matter; reflective essays; performance-based activities like poem making, poster making, jingle-making, role plays, and reporting; concept listing; future log-making; dyads and triad activities in creating mind maps; and the utilization of Venn diagrams in organizing lessons learned. However, authentic assessments were not reflected on teachers' daily lesson log. These data showed that teachers handed over *authentic assessment* activities to students for them to create new knowledge. Allowing students to create new knowledge from what they learned is a significant indication of the presence of constructivism in the teaching and learning process. Accordingly, Jaleel and Verghis (2015) emphasized that the culture of creating knowledge among students could be attained through understanding the nature of knowledge by focusing on content delivery, media used, and quality of the instructional materials. This implies that the variety of authentic assessments given by the teachers based on the data could create the culture of new knowledge making.

2.3 Integrating knowledge to other disciplines. Teachers integrate knowledge of students to other disciplines by seeking *outcomes of interdisciplinary learning*. These interdisciplinary learning outcomes were reflected in their performance task where students apply the concepts they have learned. Additionally, teachers encouraged learners to also integrate concepts learned to other fields of science, economy, health, communication and linking learned concepts to news-related issues in science. However, there were no data found about activities on engaging students to interdisciplinary learning outcomes in the daily lesson log. Accordingly, this is due to the fact that in public schools, there is a standardized content of lesson logs across year level. In spite of this missing activities in the lesson logs, other data indicate that there are ways where teachers encouraged learners to connect learning to other disciplines. This supports Bada's (2015) idea that knowledge is generally visualized that it should be dynamic and therefore should be changing with students' new experiences. This implies that integration of learned concepts to other disciplines is essential in developing a dynamic knowledge formation among students.

The three modes of transfer of learning involved a variety of learning activities facilitated and conducted by the teachers during the teaching and learning process to make students understand concepts, create new knowledge, and integrate knowledge to other disciplines. Notably, these learning activities found in formative assessments, authentic assessments, and integration of

learning outcomes to other discipline provided by the teachers involved diverse assessment tools, collaborative learning strategies, reflective learning strategies, and mind mapping strategies.

3. Indicators of Constructivism in the Learning Outcomes

The results indicate that constructivism was manifested in the learning outcomes introduced by the teachers to the students. The teacher's Daily lesson logs (DLL) used questions to elicit knowledge and learning creation from the students. In this context, teachers used probing questions such as: "What is your vision for the future in relation to biodiversity?" as well as what are the suggested ways to arrive at the environmental envisioned future?" These kinds of questions clearly suggest that students really have to think and come up with their own interpretation from their understanding of the discourse. Based on the study conducted by De Vera and Marasigan (2020), a learning environment that is open for discussion and questioning facilitates growth and learning from the student by coming up with his/her own interpretation of the experience relative to his point of view which is unique and appropriate for his consumption. This was evident when conducting a science activity. This premise was seconded by Yaman in 2010 in his study on learning platform supported by technology. During the interview with the teachers, it was explained that students were provided with opportunities to explore the lesson then finally came up with definitions and practical applications of the concept. This speaks parallel during the classroom observation. Each or some of the students were asked to provide their understanding and learning of the concepts.

Further, DLLs indicate that questions asked to students by the teachers were patterned to Bloom's Taxonomy specifically low level of questions instead of maximizing the standard and generic 7 E's (engage, explore, explain, elaborate, extend, elicit, and evaluate) as a provided format in the government basic education. This manner elicits creative thinking (Dewey, 1955) which in turn creates something new out of it as intended by the learner (Garrison, 1999) in this context, the student. This representation vividly corresponds to the idea that all performance tasks were a connotation of constructivism as discussed by Bada (2015) in his article on constructivism learning theory. The greater point of it is the ability of the students to come up with a new "skill" that can relate to their experience or to new situation (Adewunmi and Idika, 2015) as a result of the learning initiated by the teacher.

CONCLUSIONS

The results of this research determined the manifestations of constructivism in the pedagogical practices of science teachers inside the classroom. Therefore, the following conclusions were made:

1. Committed to the principles of this learning theory, teachers aimed for the development of understanding among the students through planning learning activities that elicit active engagement. Various learning activities have been conceptualized to thoroughly activate prior knowledge on essential information and concepts; and link these to new knowledge being introduced in the lesson through designed activities.
2. Questioning, a common practice among the teachers observed, has been used to initiate and induce engagement among learners and was evident on the implementation of different strategies (traditional pre-assessment strategies, reflective strategies, collaborative strategies and language strategies) at the beginning of the lesson.

3. Furthermore, assessment procedures planned and implemented by the

teachers embodied constructivist approach in terms of assessing students' understanding of concepts, creation of new knowledge, and integration of ideas to other disciplines. This was clearly shown in the use of various formative and authentic assessment tasks during classroom instruction which allowed students to exhibit knowledge formation and creation.

RECOMMENDATIONS

The notion of mind actively constructing knowledge, as viewed by the teachers, reflects on students' completion of a performance task and conception of answers. The following recommendations should be addressed accordingly.

1. As this research focused more on the perspective of the teachers, a separate study may be conducted to analyze students' mindset about constructivism in the classroom.
2. Different topics may also be investigated as there are scientific concepts far removed from everyday experience of the students which may limit their ideas and prior knowledge.
3. Also, it is important to study the practices of teacher education institutions on training prospective science teachers on how to successfully and appropriately incorporate constructivist approach in teaching. This is to avoid superficial knowledge and misconceptions among teachers about the various techniques imbued with constructivist principles that can be used in teaching science.

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