Research Article

Teachers' Instructional Practices and Learners' Academic Achievement in Science

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ABSTRACT

The implementation of Philippine K-12 curriculum brings hope to its educational system on lifting up the poor academic standing of Filipino learners in national and international assessments. With its implementation in 2012, rectification in the instructional practices of science teachers was expected to boost the academic performance of learners. This study aimed to document the instructional practices of teachers and its correlation to the academic achievement of learners in science. A total of 96 teachers and 240 grade 10 learners were randomly selected from 6 schools in provincial and city areas of *Albay, Philippines*. This was employed through paper survey to the identified respondents with focus in the quantitative aspect of the study. Results revealed instructional practices emphasizing the use of differentiation for planning, spiraling and inquiry in the delivery, and product-focused and differentiation in assessment. Negligence in the use of technology is attributed to effort and preparation issues, age, and computer anxiety. Academic achievement of learners across all curricular programs in science was below the expected standards of the national policy indicating that learning is not at par with the prospects of Philippine K-12 curriculum. Correlational test revealed high relationship between academic achievement and instructional delivery, while moderate relationship to planning and assessment of instruction. It was concluded that teachers were not proficient enough in applying K-12 curriculum instructional practices to enhance the academic achievement of learners. The need to participate in ICT-based seminars in science, and paralleling instructional planning, delivery, and assessment practices were suggested.

Keywords: teaching practices, academic achievement, science learning, K-12 curriculum

Received: 18 Oct. 2021 ◆ Accepted: 15 Feb. 2022

INTRODUCTION

Philippines has been constantly battling to improve its academic achievement across major learning disciplines. Its academic achievement downfall was observed in many national and international assessments attributing the failure to its congested Basic Education Curriculum (BEC) with numerous competencies to be learned in limited time frame. Notwithstanding the vigorous observation the Department of Education (DepEd) is imposing changes in the Philippine curriculum, the same academic achievement result is reflected in the subsequent years.

Science is considered as one of the most difficult subjects in the country. In National Achievement Test (NAT), high school science consistently ranked the lowest among 6 assessed learning areas from 2004 to 2012 (Philippine Basic Education, 2013). This report was further supported by the result of the recently concluded 2019 TIMSS ranking the Philippines at the bottom among 58 participating countries both in science and in math (Bernardo, 2020). Despite the amplification of science instruction and learning throughout the world, the Philippines remained lagged behind following the results from many competency-based assessments. Numerous attempts were also made to bring change into the way science is taught and proposals for remodeling science teaching were adapted to improve this academic learning (i.e., The Open University, 2018). One proposal was the implementation of K-12 curriculum in response to the preceding failure of the Philippines in 2003 TIMSS (Iglesias, 2016). With the K-12 curriculum's state-of-the-art scheme decongesting science competencies while expanding desirable instructional practices for teaching, does this mean its imposition brought significant changes in the academic achievement of learners and instructional practices of teachers in science? In this study, academic achievement of learners and instructional practices of science teachers were probed and correlated to assess its attainment of the demands of the standards of national curriculum policy.

Literature Overview and Related Works

Statistics from PISA revealed that 18% of learners, on an average, were low performers in science with at least 1 among 10 learners is struggling among 9 identified low-performing countries. Nevertheless, all countries that participated in 2012 PISA have sizeable share of low performers in science, math, and reading (OECD, 2016). Also, records

from 2019 TIMSS showed that among 46 tabulated countries, 24 of which were below the TIMSS scale centerpoint based from the average science achievement, which is almost 50% of participating countries with poor performance in science (IEA, 2020). Results of these international assessments signified the assumption that science is one of the most difficult learning areas taught in schools.

Majo (2016) indicated the factors affecting the poor performance of learners in science like lack of learning materials and teachers, poor attitude of learners towards the subject, and poor teaching methods. The study concluded the lack of pedagogical skills of teachers in effecting learning. Whichever is the reflection of the truth whether it is the lack of teaching competence or the hard nature of the science subject itself that contribute to poor academic performance, reports have shown that academic achievement has something to do with teaching practices (Blazar, 2016; Johnson, 2017). Recalibration of school curricula was made to adjust and improve ways on how science is taught, in the belief that it will improve academic outcomes.

In USA, new curriculum standards were integrated like training programs for teachers aiming to change their beliefs and teaching practices (Capps et al., 2012) to address the alarming poor academic performance of American learners in standardized science assessments (OECD, 2009). Literature accounts also showed the revisiting of science curriculum standards and teaching approaches to address the changing world arena appropriate to the working realm of learners (Salazar, 2018). Also, didactic method of teaching is still prevalent even on the recent era of science education since it is believed to improve science achievement and performance gaps (Smerdon et al., 1999).

For many years, assessment of teachers' pedagogical-content knowledge (PCK) has been the focus of many research frontliners and educational reformers to level off their practices in the demands of the standards of policy, and as reflected on academic achievement of learners. Park and Oliver (2007) defined PCK, as follows:

> … understanding and enactment of how to help a group of learners understand specific subject matter using multiple instructional strategies, representations, and assessments while working within the contextual, cultural, and social limitations in the learning environment (p. 264).

With the advent of PCK, assessment of science education has been an integral part of research and review (Abell & Siegel, 2011). Expanding upon the records of literature, attempts have been made to improve science teaching strategies and academic achievement of learners. Many proposals were integrated into school curriculum like adaptation of constructivist view of learning (Garbett, 2011), integration of inquiry-based approach for teaching (Abdi, 2014), ICT integration (Palomares-Ruiz et al., 2020), contextualization or culture-based instruction (Bibon, 2021), and brain-based strategies (Bornilla, 2019). Although educational reforms improved the competency for teaching and learning science from the past years, Filipino learners have continuously failed in scholastic assessments whether national or international. This pressing issue becomes the subject of educational institutions to further intensify instruction in the country and investigate what went wrong in the system (Chanco, 2021) via implementation of the Philippine K-12 curriculum.

Theoretical Underpinnings and Its Operational Use in the Study

Educational reformers all over the world assumed that the key to improving learning performance lies in improving schools. If alignment is observed among curriculum, assessment methods, and teaching level the standards demand, learner performance will progress. In fact, large amounts of money were allocated to enhance schools and reproduce teaching materials to carry changes in what learners learn or how teachers teach (Barrett, 2018).

This study is grounded on constructivism of teaching and learning where "mental construction" is the process of learning acquisition. Build up of learning is achieved based from the context on how the information is taught, as well as with the belief and attitude of the learners for learning assimilation. Meaning to say, learners accommodate new information based from what they already know through knowledge accumulation and experiences (Olusegum, 2015). Constructivism orbits around two important notions; *tabula rasa* is not real, and learning is active (Phillips, 1995). Acquisition of the new learning is supervised by the experiences in the field and interconnected to the learners' prior knowledge. Based from the theory, experiences of the learners for knowledge construction is operationally referred to as the teaching and learning process. Prior to these experiences, teachers' instructional practices need to be established to ensure smooth transition and delivery of learning. In Philippine K-12 curriculum, instruction has 3 major components namely: planning; delivery; and assessment (DepEd Order No. 42, 2016). Planning includes lesson preparation and material development while delivery is the teaching proper of the developed plan. On the other hand, assessment is the strategy used by the teacher in measuring the knowledge acquisition of the learners. Instructional practices were bombarded with numerous suggested strategies deemed relevant in the development of learning. Furthermore, science learning has been remodeled following the spiral approach. Contradictory to the previous curricula, the structure of science teaching in Philippine K-12 curriculum jumps from one science discipline to another, per quarter, with increasing difficulty per grade level (Montebon, 2014). Completion of basic science competencies attainment is guaranteed when a learner successfully finishes junior high school level. Learning acquisition in science is determined by the academic achievement assessed through competency-based assessment (**Figure 1**).

With the advent of Philippine K-12 curriculum, it is therefore significant to re-assess the instructional practices of teachers and the academic achievement of learners in science to determine the changes and improvement both in instruction and learning. The result of the present study assessed the competency level of teachers and learners to verify the effectiveness of Philippine K-12 curriculum in altering teaching and learning in science, which in turn predicts the future academic standing of Filipino learners in national and international assessments.

Objectives of the Study

The study primarily aims to determine the instructional practices of science teachers and the academic achievement in science of grade 10 learners across different curricular programs in the province of *Albay, Philippines*. Specifically, the study was sought to answer the following research objectives:
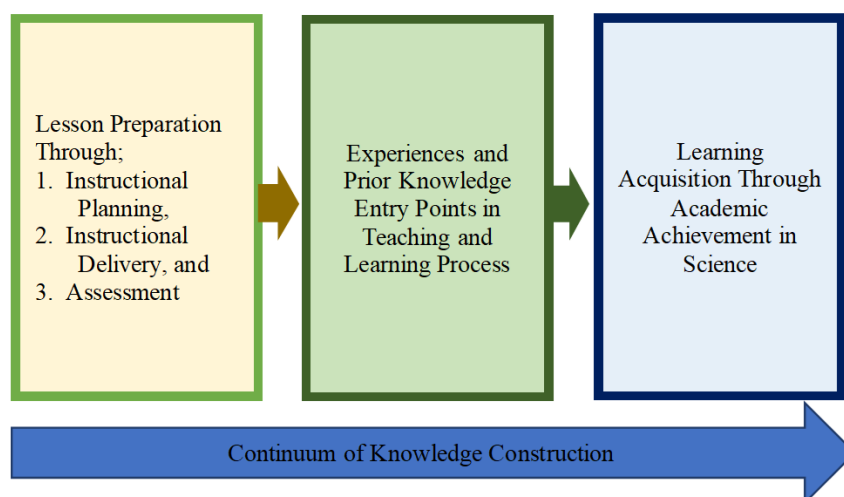
Figure 1. The operational use of the theory based from the context of the study

Table 1. The number of teacher- and learner-samples taken in every school to participate in the study

Category	Mega schools	n	
		Teachers[1]	Grade 10 learners[2]
Provincial schools	School A	16	40
	School B	16	40
	School C	16	40
City schools	School D	16	40
	School E	16	40
	School F	16	40
Total		96 randomly selected science teachers for every curricular program	240 randomly selected grade 10 learners for every curricular program

[1]Four science teachers were randomly selected for each curricular program in every school

[2]Ten grade 10 learners were randomly selected for each curricular program in every school

1. Determine the instructional practices of provincial and city teachers in terms of (i) planning, (ii) delivery, and (iii) assessment in science,
2. Measure the academic achievement of grade 10 learners in science across all curricular programs in public secondary schools, and
3. Correlate the instructional practices of science teachers to the academic achievement of grade 10 learners in science across all curricular programs.

MATERIALS AND METHODOLOGY

The Research Design, Method, and Location

This study focuses on quantitative aspects using paper survey method to determine the instructional practices of teachers and academic achievement of grade 10 learners in science within the mega schools in *Albay, Philippines*. A mega school has more than 50 teaching staff and offers various curricular programs. Provincial and city mega schools were considered for the study since they offer the curricular programs like *Basic Education Curriculum, STEM, Special Program for Arts*, and *Special Program for Sports*. *STEM* focuses in mathematics, science, and engineering; *Special Program for Arts* focuses in the development of innate talents of learners; *Special Program for Sports* focuses in athletics; and *Basic Education Curriculum* is a general curriculum for learners. Provincial schools refer to the non-city secondary schools within the province of *Albay*, whereas city schools refer to secondary schools within the 3 city municipalities within *Albay* province.

The Respondents

Among the 6 mega schools, 3 of which were categorized as provincial schools while the other 3 were under city schools. For every curricular program, ten grade 10 learners and 4 science teachers were randomly identified. Grade 10 learners were considered in the study because of their full grasp of science competencies from grades 7 to 10.

For research goal 1, on the instructional practices of science teachers, a total of 96 science teachers were randomly surveyed across all curricular programs in 6 mega schools.

For research goal 2, on the academic achievement of learners in science, a total of 240 randomly identified learners across all curricular programs in 6 mega schools were tested in the study.

Identification of the learner and teacher samples was conducted through fishbowl technique. **Table 1** shows the distribution of teacher- and learner-samples across all 6 mega schools.

Research Instrumentation

Two research instruments were used in the study; a 5-point Likert-type scale for teachers with open-ended questions, and a competency-based test for the grade 10 learners.

For research goal 1, on the instructional practices of science teachers, a 5-point researcher-made Likert-type scale was used to measure the instructional practices of science teachers across sub-sections as to planning (8 indicators), delivery (9 indicators), and assessment (8 indicators). In addition, five open-ended questions related to experiences in K-12 teaching were constructed to saturate narrative data as support to the quantitative findings of the study.

Table 2. Descriptive equivalent of the means of proportion

Range	Descriptive equivalent
4.20-5.00	Always
3.40-4.19	Often
2.60-3.39	Sometimes
1.80-2.59	Rare
1.00-1.79	Never

Table 3. Descriptive equivalent of percentage scores in the competency-based test (DM No. 160, 2012)

Percentage range	Mastery level
96-100%	Mastered
86-95%	Closely approximating mastery
66-85%	Moving towards mastery
35-65%	Average
15-34%	Low
5-14%	Very low
0-4%	Absolutely no mastery

Indicators of the Likert instrument were adapted and modified from Abundo (2019), Benosa (2017), and Sergio (2018). Since the Likert-type scale was researcher-made with modified indicators, it was validated with a *Cronbach alpha* reliability coefficient of 0.86 indicating internal consistency of the sample responses from a dry-run in a nearby host school, with a *Cohen's kappa* (kappa statistics) value of 0.79 connoting a higher inter-rater agreement from the pool of expert validators who validated the instrument.

For research goal 2, on the academic achievement of grade 10 learners, a competency-based researcher-made test with 80 items was used. Items were structured based on TIMSS and utilized learning competencies of Philippine K-12 Science curriculum. Validation of the test through dry-run revealed a KF21 coefficient equivalent to 0.77 interpreted as good for classroom assessment. Item analysis was also conducted to determine the individual assessment of the items in the test. Difficult items were reconstructed to soften its impact to learner-respondents while ensuring its relevance to the competency being tested.

Data Collection and Analyses Plan

After letter of approval was secured from the Schools Division Offices to implement the study, visitation to target mega schools was conducted for scheduling of data collection to teachers and learners. Upon visitation, a list of names of science teachers and enrolled learners across the curriculum programs was requested for sampling. Sampling was conducted through fishbowl.

For research goal 1, on the instructional practices of science teachers, the Likert scale with open-ended questions was distributed to the identified science teacher-respondents. Analysis of the quantitative data was done through descriptive statistics by determining the mode, its means of proportion, and rank since the nature of the collected data is nominal. Interpretation of the means of proportion to determine the degree of usage of an instructional practice indicator was guided by the scale in **Table 2**.

Narrative data taken from the open-ended questions were interpretatively analyzed for narrative analysis. This was done to support the quantitative findings of the study. Rationale for sequencing quantitative with narrative findings allowed for collecting rich and comprehensive data, flexibility in methodology, collection of different point of views, scholarly interaction, and comparison between numerical and narrative findings (Wisdom & Creswell, 2013).

For research goal 2, on the academic achievement of grade 10 learners, the researcher tested the academic achievement of the identified grade 10 learner-respondents by answering the competency-based test in science. Descriptive statistics used mean and percentages to treat the scores. **Table 3** shows the academic achievement, mastery level, of the corresponding percentage score of the learners in the test.

Inferential statistics was also performed through t-test to compare the academic achievement percentage scores of grade 10 learners between city schools and provincial schools per curriculum programs.

For research goal 3, on the correlation of instructional practices and academic achievement, Pearson *r* correlation was used to determine the degree of relationship between teachers' instructional practices and learners' academic achievement in science.

RESULTS

The retrieval rate of the instruments used was 100% both for teachers and learners. The narrations below were the significant findings of the study on teachers' instructional practices and academic achievement in science of grade 10 learners.

Teacher's Instructional Practices in Science

Instructional practices of teachers were categorized into 3; planning, delivery, and assessment. Discussion of results was categorized in accordance to the prescribed instructional practices of educational institution. The discussions below were the identified instructional practices of science teachers in the advent of Philippine K-12 curriculum.

Instructional planning practices

A broad look in the planning practices of provincial school teachers revealed spending considerable amount of time in anchoring planned instruction to differentiation by using the background of learners. This was shown in the cast of means of proportion indicating "*selects appropriate content for instruction, resources, examples, and materials that are known and suited to the learners for differentiation of learning*" and "*uses present data of learners to design instruction that is differentiated based from the individual learning needs of learners*" with topmost number of responses from provincial school teachers. Meanwhile, city school teachers recorded the highest mean of proportion in the indicator "*uses data to plan for differentiated instruction to allow for the variations in individual learning needs.*" **Table 4** shows the ranking of instructional planning practices between provincial and city school science teachers based from the means of proportion.

Though both provincial and city school science teachers put premium in differentiating instruction, the foundation of doing so vary as city school teachers rely on existing school data, like grades, to plan for differentiation while provincial school teachers depend directly on the cultural background of the learners. Nevertheless, instruction integrating differentiation was practiced occasionally by provincial and city school teachers as supported by the "*Sometimes*" descriptive equivalent of the mean of proportion. Consistent with this finding, in the University of Texas, Permian Basin (2021) indicated that teachers prioritize differentiation of lesson planning to put emphasis on the importance of child upon lesson implementation. The differentiation of lesson is deemed one of the most important aspects of K-12 curriculum

Table 4. Ranking of instructional planning practices of provincial and city school science teachers in Philippine K-12 curriculum

Instructional planning	M of proportion					
	Provincial schools			Provincial schools		
	Mean	Desc.	Rank	Mean	Desc.	Rank
Uses and analyzes information of learners to design instruction that meets the diverse needs of learners and leads to ongoing growth and achievement.	0.36	R	7	0.54	S	3
Assesses teaching materials for its relevance to the learning competency attainment and needs of learners.	0.54	S	3.5	0.48	S	5.5
Uses present data of learners to design instruction that is differentiated on the individual learning needs of learners.	0.48	S	5	0.56	S	1
Creates and plans strategies that allow multiple learning areas to be integrated in the lesson.	0.54	S	3.5	0.52	S	4
Accesses and uses ICT in the design of instruction to engage learners' attention and improve the caliber of teaching.	0.15	N	8	0.19	N	8
Selects appropriate content for instruction, resources, examples, and materials that are known and suited to the learners for differentiation of learning.	0.56	S	1.5	0.46	S	7
Uses sociodemographic information regarding learners' background like culture, family structure and status, and communities in planning instruction suited to the needs of the learners.	0.56	S	1.5	0.48	S	5.5
Develops plans of the lesson based on previous responses and feedbacks of learners to further improve the planning of the repeated lesson.	0.46	S	6	0.55	S	2
Overall mean	**0.46**	**S**		**0.47**	**S**	

Note. N: Never; R: Rare; S: Sometimes; O: Often; A: Always

to cater individual differences in classroom instruction (Robinson, 2020). Even on the previous curricula of Philippines, it has been widely practiced among teachers to individualize instruction to provide sense of belonging among learners (Magayon & Tan, 2016). The response of the science teachers on planning of lesson for differentiation is a testimony for setting a child-centered instruction, and a justification to the existing literature in educational practice.

One of the critical results of the study is the negligence of science teachers in designing instruction integrating technology. In the data, the indicator "*accesses and uses ICT in the design of instruction to engage learners' attention and improve the caliber of teaching*" revealed the lowest mean of proportion both in provincial and city school teachers with a descriptive equivalent of "*Never*" practiced. With the technological advances in the new era of learner generation, a link shall be launched between education and the digital world to unify learners' cognition with technology (Tomaro, 2018). In fact, digital ability should be mastered both by learners and teachers in the 21st century (Mazariegos, 2020). In science, for example, many abstract concepts need to be computer-aided to carefully explain and visualize the lessons to learners (Taub et al., 2014). These data only show the incompetence of science teachers on integrating technology-aided instruction in preparation and planning of lesson, which in turn manifests lagging behind from the instructional policy of integrating technology in educational practice. Reviewing the pool of literature, many studies have, in fact, concluded the negligence of teachers in using technology for reasons related to technology anxiety (e.g., Fernandez-Batanero, 2021), and lack of ICT support (Glasel, 2018). Narrative responses of science teachers were reviewed in the open-ended questions to support this quantitative finding. The question "*Which aspects of K-12 curriculum instructional practice do you feel inconvenient using?*" Restrictions in the use of technology dominated the narrative responses while its negligence for usage was attributed to the laborious demand of time and effort of preparation. Sample snippets of responses were shown below:

1. The use of technology because it takes a lot of effort and consumes more time in preparation and

2. Technology in planning for instruction uses and requires us to provide more effort despite the fact that we have hectic time schedule. Not everyone in school can direct a computer-aided instruction.

Hyndman (2018) significantly noted that effort and time were some of the major limitations for using technology in classroom. This holds support to the reflection of science teachers on their decline to incorporate technology in planning lessons. The DepEd classrooms in Philippines were supplied with adequate technological tools for teaching but the classroom structures are not suitable and fit for technology use (Department of Education, 2020). This perhaps explains why science teachers disregard incorporation of technology use in their planning because classrooms are not ready for technology usage which will consume much of their time for restructuring and preparing. This pressing issue in the desertion of teachers to use technology must be given impetus by educational reformers to address concerns of teachers regarding technology usage particularly in the era of 21st century.

Instructional delivery practices

The use of powerful teaching strategies is one of the most substantial factors involved in the process of learning (Han, 2021). In a school where science curriculum is one of the focal concerns, unconventional instructional delivery practices are required since the primary goal of science education is to assist learners in achieving a functional understanding of scientific concepts linked to real-life situations, attitudes, and values necessary for their daily life encounters (Johnson, 1962). In the extent of analyzing the responses in instructional delivery of science lessons, the top indicator was determined as "*discusses lessons in increasing level of complexity and difficulty*" for provincial school teachers whereas "*Uses varying perspectives, theories and methods of investigation and inquiry in instructing the concept of the lesson*" was the top indicator for city school teachers. **Table 5** shows the ranking of instructional delivery practices between provincial and city school science teachers based from the means of proportion.

Provincial school teachers implied awareness on the spiraling of concepts which was stated in the K-12 science curriculum guide where lessons must be presented with increasing levels of complexity from one grade level to another (K-12 Curriculum Guide, 2016). Furthermore, this puts emphasis on the awareness of the provincial school teachers on the gist of Philippine K-12 instruction where spiraling of concepts is a mandatory approach. Indeed, SEAMEO INNOTECH (n. d.) described this feature of K-12 as "*ensures smooth transition between grade levels and continuum of competencies*". On the other hand, city school teachers focus on instructional delivery where learners were immersed

Table 5. Ranking of instructional delivery practices of provincial and city school science teachers in Philippine K-12 curriculum

	M of proportion					
Instructional delivery	Provincial schools			Provincial schools		
	Mean	Desc.	Rank	Mean	Desc.	Rank
Discusses lessons in increasing level of complexity and difficulty.	0.56	S	1	0.48	S	3.5
Connects prior knowledge of the learners to the new information of the lesson.	0.52	S	3	0.48	S	3.5
Facilitates a learning environment where sense of belonging of learners through individual differences is respected.	0.48	S	7.5	0.46	S	5.5
Uses varying perspectives, theories and methods of investigation and inquiry in instructing the concept of the lesson.	0.52	S	3	0.56	S	1
Provides opportunities for learners to engage in activities of inquiry, critical thinking, and evidences of discipline.	0.50	S	5.5	0.46	S	5.5
Demonstrates fluency in technology system, uses technology to support instruction and enhance learning, and designs learning experiences to develop learner skill in the application of technology appropriate to the disciplines.	0.13	N	9	0.17	N	9
Employs various ways on explaining concepts to scaffold learning while correcting misconceptions ad misunderstandings.	0.52	S	3	0.33	S	8
Ensures that learning experiences of the learners were relevant and connects to other curriculum content areas.	0.48	S	7.5	0.38	S	7
Incorporates experiences into instructional practices that relate to a learner's current life.	0.50	S	5.5	0.50	S	2
Overall mean	**0.47**	**S**		**0.44**	**S**	

Note. N: Never; R: Rare; S: Sometimes; O: Often; A: Always

in situations of investigation and analysis to understand the essence of the subject matter. Inquiry-based approach was, in fact, proven to be one of the most effective teaching approaches which improves learners' conceptual understanding (Laksana et al., 2019), metacognition (Nunaki et al., 2019), and attitude for learning science (Veloo et al., 2013). Nevertheless, spiraling and inquiry were the top 2 mostly practiced indicators for provincial and city mega schools.

It was also noted that among the 9 indicators, the "*demonstrates fluency in technology system, uses technology to support instruction and enhance learning, and designs learning experiences to develop learner skill in the application of technology appropriate to the disciplines*" showed the lowest mean of proportions for provincial and city school science teachers at descriptive equivalent of "*Never*" practiced. This result runs parallel to the findings in the instructional planning where use of technology is never integrated in instruction due to factors like time restrictions and additional effort on the part of teachers for crafting the lessons. In addition, the question indicated as "*Which instructional practices do you find difficult to follow from the instructional delivery practices written in the table?*", revealed that middle adulthood science teachers (40-60) dealt with problems on technology fluency. This result implies that ignoring technology use in instruction is associated to age and anxiety. Consistent with these findings, result of Zarina et al.'s (2017) study noted that most of the adults have technophobia and computer anxiety. Nevertheless, further studies need to be conducted on this matter since majority of teachers who participated in the study were in the middle adulthood. Sample responses regarding evading the use of technology were quoted below:

1. It is not easy to manipulate computers during class discussions. Also, technical problems are hard to fix when you are not guided by a computer expert. We do not have a computer expert, and

2. My skill in computers is not enough to supervise a good technology-based instruction inside the classroom.

As stated in DepEd Order No. 42 (2016), the K-12 curriculum has strongly urged teachers to use technology in aiding learning. Numerous studies have already testified for the effectiveness of a technology-aided instruction in the absorption of solid knowledge and concepts taught at school (Bochniak, 2014; Bulman & Fairlie, 2016). Ramesh (2011) concluded that the use of technology in teaching will develop interest and attention as learners become more focused in the instruction to

stimulate learning. Grounded on the basis of the literature, it can be inferred that the instructional delivery practices of provincial and city school teachers delimit the ability of learners in providing optimal learning in absorbing scientific knowledge.

Instructional assessment practices

The objective of planning and conducting instruction is to help learners learn new content and behaviors. Consequently, planning lessons shall include some formal measures to determine whether learners have learned the desired objectives and to identify areas of misunderstanding or confusion (Galindo, n. d.). The most critical part of assessment practice is the technique of application as it needs to understand learners based on corrective measures, and differentiation of methods to validly measure the amount of learning.

The instructional assessment practices revealed that the indicator "*provides assessment that allows learners to work individually or in groups through independent/cooperative learning*" is mostly practiced by provincial school science teachers, whereas city school science teachers often "*provides opportunities for the development of product-based assessment*" with both descriptive equivalents of "*Often*" practiced. **Table 6** shows the ranking of instructional assessment practices between provincial and city school science teachers based from the means of proportion.

The result of this survey showed that provincial school teachers' concern of assessment is the engagement of learners in evaluation methods incorporating independence and collaboration. Somehow, related to planning where provincial school teachers stress the need for differentiation, this assessment technique provides varied assessment avenue for learners to work either unaided or in groups. This result shows parallelism to the instructional planning of teachers weighing the importance on the need for instructional practice that is varied and diverse. Bondie et al. (2019) mentioned that learners who went through instruction of multiple techniques of strategies and teaching approaches are more likely to achieve higher test scores and academic achievement. Same result was obtained by Pham (2011) and Smale-Jacobse et al. (2019) pointing out the importance of unifying varied instructional tools and strategies to make the instruction not lame for learners. As to the assessment practices of city school teachers, the focus of instruction is the use of product-based assessment where they assess learning based from the outputs they generate per lesson/competency. Putting premium in this kind of assessment practice leads to the development

Table 6. Ranking of instructional assessment practices of provincial and city school science teachers in Philippine K-12 curriculum

| Instructional assessment | M of proportion | | | | | |
| | Provincial schools | | | Provincial schools | | |
	Mean	Desc.	Rank	Mean	Desc.	Rank
Provides opportunities for the development of product-based assessment.	0.51	S	5	0.63	O	1
Provides opportunities for the development of performance-based assessment.	0.38	S	8	0.42	S	8
Shows relevance and connection between topic discussed vis-à-vis assessment strategy.	0.60	S	3.5	0.46	S	6
Uses multiple assessment methods, including adjusted pacing and flexible grouping, to engage learners in active learning opportunities that promote the development of critical and creative thinking, problem-solving, and performance capabilities.	0.62	O	2	0.56	S	3.5
Provides multiple assessment strategies for the differentiation and accommodation of individual differences.	0.42	S	6	0.54	S	5
Provides assessment that allows learners to work individually or in groups through independent/cooperative learning.	0.65	O	1	0.58	S	2
Uses learning materials like module, activity sheets, SIM etc. that evaluates learning inside and outside the school.	0.40	S	7	0.56	S	3.5
Creates assessment method that is sustainable and with continuity to trace behavioral and cognitive changes of learners through time.	0.60	O	3.5	0.44	S	7
Overall mean	**0.52**	**S**		**0.44**	**S**	

Note. N: Never; R: Rare; S: Sometimes; O: Often; A: Always

Table 7. Academic achievement of grade 10 learners across all curricular programs in provincial and city schools

| Curricular programs | Provincial schools | | | City schools | | | p-value | Sig. (0.05) |
	Mean rating %	SD	Desc.	Mean rating %	SD	Desc.		
Basic education curriculum (BEC)	52.67	1.52	A	54.71	1.93	A	0.012	S
STEM	66.79	3.39	MTM	64.54	3.90	A	0.185	NS
Special program for arts	46.42	2.37	A	45.38	3.03	A	0.403	NS
Special program for sports	44.83	1.94	A	46.63	2.16	A	0.066	NS
Overall mean	**52.68**	**9.07**	**A**	**52.81**	**8.23**	**A**	**0.944**	**NS**

Note. A: Average; MTM: Moving towards mastery; S: Significant; NS: Not significant

of learners' higher order thinking skills (HOTS) (Mohamed & Lebar, 2017), while allowing learners to take chance of correcting and revising their output if they see irrelevant or relevant information. Product-based assessment is a good assessment tool to help teachers and learners revisit progress in learning through time. This way, teachers can easily spot among the outputs the ones made by novice, skilled, and expert learners (Laosinguan, n. d.). Whether the assessment practice employs differentiation or product-based assessment, further tests need to be conducted to fully understand the reason why provincial and city school teachers venture in these type of assessment practices.

Nevertheless, the result of the survey revealed that no indicator is "*Never*" practiced. Majority of the responses were "*Sometimes*" practiced with accounts of "*Often*" practiced indicators.

Academic Achievement in Science of Grade 10 Learners

The level of performance of grade 10 learners in science was measured through a competency-based researcher-made test composed of 80 TIMSS-like items.

The National Achievement Test (NAT) mandates a 75% MPL for all schools in the country to be considered as qualifier in the academically performing schools (Maligalig & Albert, 2008). However, the percentages tabulated in **Table 7** were less than the expected national average score. The achievement per school curricular program ranges from 44.83% to 66.79% for provincial schools while 45.38% to 64.54% to city schools. Though grade 10 learners gained academic achievement descriptive equivalents of "*Average Mastery*" and "*Moving Towards Mastery*", the percentages of the scores are distantly not enough to be considered a national qualifier. This indicated that learners' academic achievement in science was below the expectations of the policy. A research conducted by Mendoza (2013) in the locale of the study also showed parallel result where learners were unable to attain

the 75% MPL in science to be considered a national performer in NAT, or an achiever at par with their foreign peers.

Comparison of the academic achievement of grade 10 learners between city and provincial schools revealed differences in the mean rating. Across all curricular programs, provincial schools scored higher in STEM and Special Program for Arts yet differences are statistically not significant (p>0.05). This implies similarity in the academic achievement of 2 curriculum programs although descriptive equivalents of rating for STEM vary at *Moving Towards Mastery* (Provincial) and *Average Mastery* (City). Variation in the descriptive equivalents was the result of percentage scores cutting across the boundaries of the percentage ranges in **Table 3** (Descriptive equivalent of scores). The same statistical tie in academic achievement scores (p>0.05) was documented in Special Program for Sports curricular program with "*Average Mastery*" descriptive equivalents although city schools scored comparatively higher than provincial schools. One significant finding of the result was the statistical difference (p<0.05) in the academic achievement test scores of BEC learners. The result shows that BEC learners from provincial schools are lagging behind compared to the BEC learners of city schools as supported by the mean of percentage rating in **Table 7**. The result is quite alarming since majority of the junior high school learners were enrolled in BEC, and in provincial schools. Further analysis and study must be conducted to verify the result of this testing. **Table 7** shows the science academic achievement of grade 10 learners in provincial and city schools across curriculum programs.

The academic achievement result implies that schools offering multiple curricular programs shall also invest effort in recalibrating instruction for non-science curricular programs. This is to enhance the academic achievement of low performing curricular programs in science, thus enabling a school to provide equal opportunities to all

Table 8. Correlation between teachers' instructional practices and learners' academic achievement in science

Curricular programs		Planning		Delivery		Assessment	
		r	p	r	r	p	r
Provincial schools	BEC	0.378	0.00	0.818	0.00	0.331	0.00
	STEM	0.413	0.00	0.716	0.00	0.466	0.01
	Special program for arts	0.314	0.00	0.737	0.00	0.333	0.00
	Special program for sports	0.521	0.00	0.720	0.00	0.418	0.02
City schools	BEC	0.423	0.00	0.718	0.00	0.428	0.01
	STEM	0.542	0.00	0.735	0.00	0.489	0.00
	Special program for arts	0.392	0.00	0.734	0.00	0.417	0.01
	Special program for sports	0.361	0.00	0.722	0.00	0.406	0.00

learners for scientific inquiry and learning regardless of the curricular program engagement. Science is vital for living and has never been as important as it is today (Rull, 2014). In fact, some schools were boosting their science instruction for non-science curricular programs, like sports and arts, through contextualization and following the principle of individual differences to improve learning outcomes (Borja, 2019).

During the implementation of the test, reactions regarding its content were primarily noted from learners of curricular programs for Arts and Sports. During break time, learners both in provincial and city schools primarily converse regarding the unfamiliar topics in the test, which gave them a hard time answering the items. The finding is appalling since the need to teach all topics in science is vital as a springboard to a higher grade level for the spiraling of concepts. Knowing the fact that the items of the researcher-made test were made following the competencies of the Philippine K-12 curriculum, this suggests that some teachers in Sports and Arts curricular programs were skipping lessons. Reviewing the narrative responses of teachers in the open-ended question, the question "*Do you feel confident teaching the topics in every strand of science discipline?*" yield the frequently responded answers on skipping lesson particularly in curricular programs for sports and arts. Three sample responses were shown below:

1. Sometimes. The implementation of K-12 curriculum made field-focus science teachers to teach all science discipline without the adequate content mastery of the topic. This results to my skipping of lessons for challenging teaching and learning tasks for my learners and me,

2. Yes. However, the learners [from Arts and Sports] are often busy with their specialized training skill which limits teacher-learner interaction in the classroom causing majority of the topics to be not covered before the school year ends, and

3. No. I cannot give what I do not have especially teaching science disciplines not my field of specialization. Learners may suffer from wrong concepts I could give.

Based from the responses of science teachers teaching in curricular programs for Sports and Arts, it can be inferred that defiance to follow the science curriculum competency guide is due to factors like content mastery issues and learner schedule. These perhaps explain the reason why Sports and Arts learners scored significantly lower (p<0.05) from BEC and STEM learners. In some schools where content mastery is an issue of teachers in handling multiple science disciplines in one grade, team teaching was deemed an important solution to address the problem (Smith et al., 2020). Team teaching approach showed higher

improvements both in teaching efficacy (Jensen, 1966), and reinforced academic performance (Smith et al., 2020). This can be adapted by science teachers teaching in curricular programs for Sports and Arts. As to the learner schedule, a need to revisit their curriculum must be established to carefully plot academics and skills-related training, or further decongest the competencies in the learning areas.

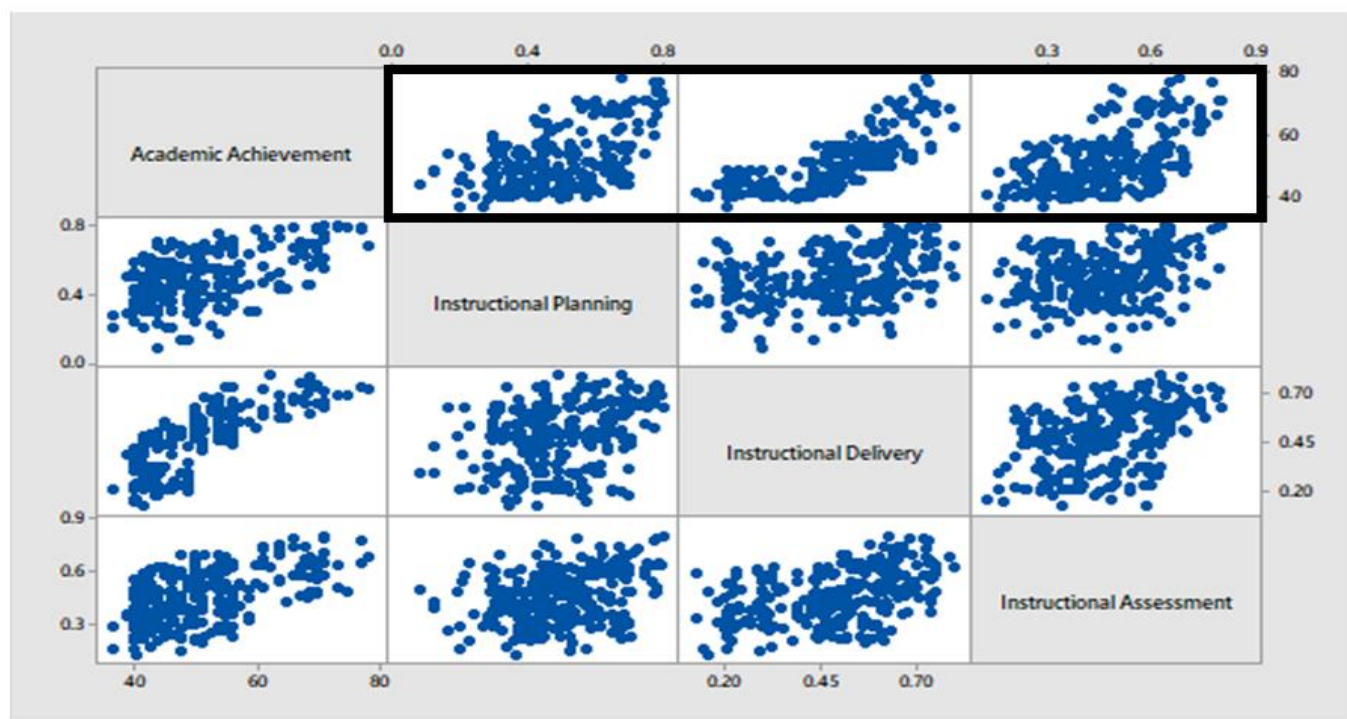### Correlation of Teachers' Instructional Practices and Learners' Academic Achievement in Science

Table 8 shows the degree of relationship between academic achievement in science and the instructional practices of teachers in provincial and city schools using Pearson *r*.

The results showed that there is a consistent moderate relationship of academic achievement to planning and assessment of lesson. On the other hand, a high relationship of academic achievement to delivery of the lesson was observed. These results were true to all curricular programs in provincial and city schools. This means that the academic achievement of grade 10 learners in science is significantly dependent to the direct transfer of information- the delivery. Therefore, teachers need to enhance their instructional practices in delivering the lesson to improve academic achievement of learners. If teachers would alter and invest commitment in adapting the suggested instructional delivery practices in to "*Often*" to "*Always*" practiced, a great leap in academic achievement of learners will be expected. Meanwhile, certain researches have also testified that the lesson delivery showed a positive high relationship to learning (Canales, 2020). Though there are some accounts indicating that academic achievement is also affected by other extraneous variances aside from school (Owusu-Acheaw, 2014), majority of the documented studies emphasized that teachers played the most significant role in the learning process of learners (Berry et al., 2010). These consolidated amounts of literature and current findings of this study infer that instructional practices of teachers were bridge of the learners in learning and understanding concepts in science. To support the correlational test presented in **Table 8**, a matrix plot was presented to visualize the distribution of academic achievement scores of grade 10 learners in correlation to the instructional practices of their teachers. The matrix plot was presented in **Figure 2**.

DISCUSSION

Gleaned from the findings of the study was the focus on instructional practices of both provincial and city schools in the differentiation of lesson during instructional planning. Although grounds on the differentiation vary like use of learners' existing data, and cultural background, the findings suggested that planning of lessons is learner-centered. This was parallel to the local findings of the study

Figure 2. Matrix plot of the combined grade 10 scores in science and the instructional practices of science teachers in provincial and city mega schools (see boxed figures)

by Baldez (2018) and Romualdo (2017) who noted that regardless of teachers' location, premium was given to developing lessons that ensure individual belonging of the learners in the instruction. In fact, the science curriculum of Philippine K-12 is described as learner-friendly (DepEd Order No. 21, 2019). Records in the literature body had documented that designing lesson following the individual interests and nature of learners is daunting yet a forefront in empowering learners to acquire learning in their own contexts and terms (McCarthy, 2018). Consonance with these results was harnessing data from learners to be used for educational monitoring, school education, and quality assurance by the Standing Conference of the Ministers of Education and Cultural Affairs of Germany (KMK, 2006). In addition, the Dutch schools also believe in the power of harvesting feedback data from learners to produce change (Visscher, 2008); while policy makers shall consider learner data as baseline to instructional decisions to increase learner performance (Schildkamp & Kuiper, 2010). Although the current study revealed moderate relationship between instructional planning of teachers and academic achievement scores of learners, literature holds significant amount of findings connoting the positive effect of lesson planning to the development of learning (Haider, n. d.) and attitude for schooling (Mirapa, 2019). The accounts in the literature implying strong relationship between lesson planning and learner achievement were contradictory to the findings of current study suggesting sufficient evidence that the relationship of the tested variables was not carefully established, and must be explored further to truly understand how instructional planning affects learning, or the delivery of lesson itself.

Delivery of the lesson showed a high relationship to the academic achievement of the learners. True enough that this practice has direct link towards the acquisition of knowledge through teaching and effecting to learning process. Many accounts in the field of educational practice revealed that direct teaching is the very foundation of learning,

and that learning has a higher or positive relationship to pedagogy (Canales, 2020; Hoge, 2016; Peterson et al., 1978; Smith et al., 2001; Wenglingsky, 2002). Curriculum standards around the world have also indicated the need to integrate numerous teaching methods to provide the learners with multiple arrays of learning experiences to limit boredom, stress, and academic burnout (Barcenas & Bibon, 2021). School curricula in majority of the countries focus in the inquiry of instruction (Applebee et al., 2003; Marx et al., 2004), which was reflected as the practice in city schools of the current study. On the other hand, provincial schools focus on the spiraling of concepts which is the major facet of K-12 curriculum. Spiraling of concepts is basically teaching the learners with increasing levels of complexity (K to 12 Curriculum Guide, 2016). Whether it is spiraling or inquiry, both approaches were grounded on the constructivism approach where learners build their knowledge based from their learning experiences (Lister, 2015; McLeod, 2019), thus improving academic achievement. Delivery is the product of planning; knowing that delivery showed higher relationship to academic achievement, this result presumes that planning must also run parallel with this finding. However, correlational tests of the study revealed that planning has moderate relationship to academic achievement which turns out that there is a gap between instructional planning and delivery. This assumption is an evidence that teachers of provincial and city schools were not transcribing what they have planned into delivery practice. Moreover, this was supported by the claim in the findings that the delivery of instructional practices focuses on spiraling and inquiry paving away from the differentiation of the lessons as originally planned. Furthermore, this could be a manifestation that teachers detour from their lesson designs to capture the contexts of the demands of delivery which were not foreseen during lesson planning. Conformable to these findings were the accounts from Kibret (2016) who noted that teachers do not follow what they have planned in the lesson to allow flexibility

for teaching based from diversity of learners. She further noted that differentiation in practice does not often happen to accommodate differences in learning. Nevertheless, alignment of the planning and delivery instruction is believed to enhance cognitive understanding of the learners (Peterson et al., 1978).

As to assessment practices, it showed moderate correlation to the academic achievement of learners in science. This means the mostly practiced instructions as to product-based assessment (city schools), and ICL activities/differentiation (provincial schools) do not necessarily contribute in the academic performance of the learners. Assessment strategies were the direct measurement of learning acquisition (Kannapel et al., 2005). This connotes that the assessment measures of science teachers do not fully harness the academic achievement of learners in science. Literature has noted that effective assessment strategies should reflect in the academic performance of the learners, and must be relevant to harvest the full acquisition of learning outcomes. This low correlation might be a representation that those assessment strategies employed by the science teachers were inappropriate, and do not fully quantify the knowledge acquisition. Therefore, solid assessment measures must be carefully studied and applied to document the development of learning. As to assessment strategies, performance-based measures produce concrete and reliable assessment scores that truly attest to the skill or knowledge acquisition of learners. This assessment strategy revealed higher correlation to the academic achievement of learners across all fields of academic disciplines (Alkhateeb, 2018).

One significant finding on the instructional practices of science teachers is the poor practice of integrating ICT/technology whether it is in planing, delivery, or assessment. Philippine K-12 curriculum has encouraged teachers to integrate the use of technology in response to the new era of 21st century skills development. Many published and unpublished works have already testified for the truthfulness of ICT effectiveness when utilized as medium for instruction (Ghavifekr & Rosdy, 2015; Ocfemia, 2016). In fact, ICT use in teaching was suggested to be integrated in many curricula across all grade levels in different educational platforms (Capuk, 2015; Maribe & Darko, 2015). However, there are also reports that despite the movements to utilize the power of technology in classroom, neglect on the part of teachers is documented related to factors like lack of digital fluency, anxiety, and the labor demanded by the ICT instruction, plus the hectic preparations. The findings of current study were aligned with the existing records suggesting the decline of ICT usage in science instruction. Thorough investigation on this matter needs to be explored since majority of the science-teacher respondents for the study were in middle-adulthood. Adult teachers experience age-related anxiety and technophobia when encouraged to use technology in teaching (Zarina et al., 2017). Making an inclusive assessment measure across all ages of science teachers is needed to solidify this assumption of the study.

In the theory of constructivism, learners build their knowledge from their prior knowledge, experiences, and the context on how the new information was taught. This signified that teaching practices of science teachers were significantly affecting the development of academic achievement of learners in science. Academic achievement of learners in science was found to hit below the expectations of the policy further indicating that instructional practices were not effective enough to deliver the desirable learning outcomes. Among the instructional practices, delivery showed the higher relationship to academic

formation which must be given value to ameliorate the academic achievement standing. Findings on the academic achievement of learners in science were actually parallel to the previous reports of other researchers who also noted that learners were not learning at par with the standards of the competency-based learning (Mendoza, 2013). However, it is also significant to note that potential biases and extraneous variances in the results might have affected the result of academic testing. This includes the overall structure of the competency-based test, sampling error on the part of learner selection, and the use of mega schools for testing.

CONCLUSIONS

The study was conducted to determine the instructional practices of 96 randomly selected science teachers in relation to the academic achievement of 240 randomly selected grade 10 learners in science across different curricular programs of 6 mega schools in *Albay, Philippines*. This was studied to assess the instructional and academic standing of teachers and learners in the implementation of Philippine K-12 curriculum to address the poor academic status of Filipino learners in national and international assessments.

The cast of academic achievement scores revealed relationship particularly in the instructional delivery with focus on spiraling and inquiry. The academic achievement revealed to be consistent with the previous records in national and international assessments indicating lack of competence to be at par with other global learners. These findings lead to the inference that educational reformers need to explore, validate, alter, and study further the instructional practices of teachers and academic achievement in science of grade 10 learners in *Albay, Philippines*. In relation to the objective of the study, this concludes the need to improve instructional practices, and exhibit parallelism among planning, delivery, and assessment measures to improve academic achievement outcomes in science through engagement in pedagogy-related seminars and training programs of DepEd.

Recommendations for Further Research

The study has limitations itself. The context of findings applicability is only true to the learners and teachers of *Albay, Philippines* as the locale of the study. On the other hand, learner-respondents were taken from the 4 major curricular programs which indicate that the data do not reflect the overall academic achievement status of the entire learner population, especially the ones in other curricular programs. Mega schools were considered suggesting the need to replicate the study in small, medium, and large schools for a more inclusive result of testing. Moreover, instructional practices of teachers were products of their self-assessment and do not reflect the observed assessment of the instruction receivers. As mentioned earlier on the technophobia experienced by teachers, the sampling revealed that majority of the teacher-respondents were in middle adulthood which is a limited reflection of data reliability thus, it does not reflect the digital competence of the entire teacher population. Since K-12 is new in the Philippines, the collected data might no longer be applicable for the years to come. Therefore, longitudinal and delayed posttest study must be done to review the solid and long-term impacts of Philippine K-12 curriculum both in teaching practices and academic achievement. Grounded on these study limitations, the following recommendations were proposed.

The study generally recommends further studies and adjustment on the following concerns:

1. compare instructional practices of teachers and academic achievement of learners between schools practicing team teaching and non-team teaching approaches,

2. allow learners and school heads to do teacher assessment of observed practices to verify self-assessment of teachers,

3. compare academic achievement of learners and instructional practices of teachers in science in other provinces of Philippines,

4. conduct teaching and learning assessment in science to elementary schools,

5. conduct teaching and learning assessment in science to other school curricular programs like late afternoon class sessions (LAC), special education curriculum, alternative learning system curriculum, etc.,

6. educational institutions may host seminars and training to science teachers on the application of instructional practices particularly in the use of technology, and

7. study other factors contributing to the academic achievement of learners other than the direct effect of teaching.

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