Physics Content Knowledge of Junior High Schools in HEI-supervised and DepEd School in the Philippines

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Abstract *-The study was carried out to determine the literacy level, described in terms of science content knowledge along concept and application domains, and the factors that affect the content knowledge in Physics of junior high school students. It involved a total of 256 students and 15 teachers which were selected through purposive sampling technique and total enumeration, respectively from Higher Education Institution (HEI)-supervised and DepEd schools in Camarines Sur, Philippines. The study used descriptive-inferential method and a developed questionnaire with a high degree reliability of 0.932. The data gathered was analysed using ANOVA and chi square. The results showed that the literacy level on science content knowledge along concept domain of 246 out of 256 students or 96.1% belongs to a very low mastery level; while only 10 students or 3.9% belongs to moving towards mastery.The literacy level on science content knowledge along application of 253 out of 256 students belong to low mastery while only 3 students or 1.2% attained mastery. Overall, this showed a significant difference, (p-value 0.001) among the science content knowledge of HEI-supervised and DepEd public and private schools.The analysis also revealed that teacher factors including educational attainment, p-value of 0.005; number of years in teaching, p-value 0.013; number of subjects taught, p-value of 0.010; number of classes handled, p-value 0.015 are significant to the level of literacy on science content knowledge of the students.Student-related activities, which include field work, p-value 0.012, Science Exhibits with a p-value 0.002; and stargazing, p-value 0.033 are also found to be significant to the student's science content knowledge. While only the textbook with a p-value 0.016 is significant in the teaching resources.*

Keywords:*Application Domain, Content Domain, Science Content Knowledge, Science Literacy, Junior High School students.*

INTRODUCTION

The goal of science education is to enhance students' science literacy; that is, to help students grasp essential science concepts, to realize the relevance of science and technology to their lives, and to willingly continue their science study in school, or beyond school. Researches and science educators in over a decade have presented different perspectives on improving science teaching and literacy of the students [1], [2] and among these are through experiential learning or mimicking the work of scientists and presenting science as the method of inquiry rather than as a ready-made knowledge of facts and laws; a more involved-and-activity-based practical approach according to Hodson[1] or adopting an "informal learning environment" aside from formal or classroom setting by Ash and Klein [2]. In achieving science literacy, the Project 2061 of the American Association for the Advancement of Science (AAAS) [3] fundamental premise is for the schools to teach more effectively on what is essential rather than the need to teach more and more content. AAS stressed that what the future holds in store for individual human beings, the nation, and the world depends largely on the wisdom with which humans use science and technology. Science literacy is, unquestionably, a necessity for success in the modern world; no aspects of life should be considered without reference to science literacy [4].

Science literacy has been investigated using domains. Concept domain, for instance, which includes facts, laws and theories had been studied by Yager and McCormack [5]; application domain, on the other hand, had been studied by Gronlund [6]. These two domains are important because they are related. Application domain can indicate how concepts and processes are learned when applied to new situations especially those that involve everyday life activities. The performance of students in the annual achievement test given by DepEd reveals that science literacy among elementary and high school students is potentially alarming. Reports of these tests show a low mastery level among many schools and a mastery level to some schools. The differences of the performance of schools is usually attributed to the quality of education conducted in the school, level of student's engagement and participation to science related activities. Science literacy is influenced by education, age, gender, level of teaching engagement, teaching quality of textbooks used and participation in extra-curricular scientific activities and social class [7]. Likewise, teaching, assessment, the quality of textbooks used, student's participation in in-school and out-of school extra-curricular scientific activities are important factors influencing the students' science literacy level [8].

Given that improving science literacy become a major concern of the K to 12 Science education [11] and the numerous importance it has for a person having a sufficient level of science literacy and to provide data on the ability of the education system to generate scientifically literate students, it is important to assess the skills of the students science content knowledge. The purpose of this research is threefold. First, to assess the science literacy level of the Junior high school students of HEI-supervised and DepEd schools along the concept and application; Second, to know the relationship of science literacy to the types of schools and the conditions in teaching science; and Third, to determine the relationship of the science literacy level of the JHS students and the prevailing conditions in HEI-supervised and DepEd schools in Camarines Sur.

OBJECTIVES OF THE STUDY

The study assessed the science literacy level on content knowledge of Junior high school (JHS) among HEI-supervised and DepEd public and private schools. Specifically, it sought to determine the literacy level on science content knowledge of the JHS along Concept and Application; compare the literacy level on science content knowledge of JHS students among HEI-supervised schools and DepEd schools; Determine the prevailing conditions in the HEIs-supervised and DepEd schools in terms of teacher-related factors, student-related activities, school facilities and equipment; and determine the relationships of the Science literacy levels on content knowledge of the JHS students and the prevailing conditions in HEIs and DepEd schools.

METHODS

In this study, several conditions that promote the development of science literacy of junior high school students are investigated. These conditions include resources and science-related activities and type of schools. The study used descriptive-inferential method. The students were selected through purposive sampling technique and total enumeration of science teachers from the HEIs-supervised and DepEd schools in Camarines Sur, which were the respondents of the study. The data gathered was subjected for further analysis and statistical tools including ANOVA, chi square and Duncan Multiple Range Test was employed.

Respondents of the Study

The respondents in this study were science teachers and junior high school students of HEIs-supervised and DepEd schools in Camarines Sur. The schools that represent the categorization are finalized after sending letters and phone calls to the principals as to their participation in the study. The willingness of their participation is an important factor considered in identifying the schools since the test questionnaires for students are quite lengthy which needs double period (40-minute/period) in answering. Also, teachers attend to several concerns and the time for answering the questionnaire may be an additional work for them.

Table 1 showed the school that participated in the study and the distribution of teacher and student-respondents. The total respondents of the study are 271 composed of 256 students and 15 teachers. The study involved all science teachers were those teaching for school year 2017-2018 in Camarines Sur. The 56 student-respondents belonged to the junior of the selected schools were enrolled for school year 2017-2018.

Table 1. Summary of Respondents

Schools	Teachers	Total Students	Overall
Public Secondary School (Big School)	9	127	136
Public Secondary School (Small School)	2	31	33
HEI-supervised Public School	3	17	20
HEI-supervised Private School	1	81	82
Total	15	256	271

Research Instrument

The science literacy of the students on science content knowledge (concept and application), a teacher made test is used to gather the data. The test is face-validated by five Physics teachers. The computed Cronbach's Alpha coefficient was 0.932 which indicate a high internal consistency.

The science content knowledge covered only the Science content for Junior of the K to 12 Curriculum [9]. The content in the science curriculum is organized around core or big ideas and important understandings that students should retain after they have completed their basic education which is term as enduring understanding. The enduring understanding includes the general concepts of force, motion and energy which are: (1) Matter and energy interact. Their interaction involves forces; (2) There are four basic forces in nature: gravitational force, electromagnetic force, strong nuclear force, and weak nuclear force; (3) These forces have different characteristics and vary in strength; (4) Forces can change the shape and motion of objects. Changes in the motion of an object depend on the strength and direction of the applied force; (5) Energy exists in many forms. It can be transferred and transformed. During these processes, the total energy remains the same; (6) Technologies are available for harnessing energy from various sources. Each energy resource has its advantages and disadvantages; (7) Energy resources should be used wisely and managed properly because they can impact living conditions and the environment; (8) Energy is involved whenever change occurs in matter; and (9) The amount of matter and energy in the universe remains the same [10].

Data Gathering

Pilot of the study. The questionnaire for students, Science Literacy Questionnaire (SLQ), was piloted to Junior high school students of Computer Science High School of Bicolandia, Pili, Camarines Sur. This pilot testing helped to determine the average time of completing the instrument and whether it could be finished within the 40-minute time allocation of Physics subject. The SLQ has 7 sections, section 1 is on the demographic profile and sections 2-7 are for the two domains framework of science literacy – content and application. After administering the trial test, suggestions like giving the test for two meetings to sustain student's interest and other relevant concerns where included and considered. The teacher questionnaire was subjected to face validity which involved four teachers from Central Bicol State University of Agriculture and one teacher from other University.

Final Survey. The final instruments were administered to four secondary schools, which were categorized as HEI-supervised and DepEd private and public schools. An endorsement from the principal to each school facilitated the implementation of the test easily for the students and the survey for the science teachers.

Statistical Treatment of Data

Several statistical procedures were used in this study. The frequency count and percentage techniques were used to describe the level of science literacy on content knowledge of respondents. The overall science literacy on content knowledge was conveyed in terms of Mean. The mastery level was described according to the criteria set by the Department of Education as shown below [11]:

MPS	Descriptive Equivalent
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

The analysis of variance (ANOVA) was used to determine whether the performance of the students in concept and application domain was affected by types of school. Chi squared test was employed to determine the significance of relationship between types of school.

RESULTS AND DISCUSSION

Content Knowledge of Junior High School Students Along Concept Domain

Concepts are essential in learning science. Learning the concepts is the starting point to construct understanding and moving from concrete to abstract learning. The concept domain as indicator of science literacy in this study was determined using a 40–item teacher-made test where competencies in Physics of the K-12 curriculum were considered and reflected in the prepared table of specifications. Analysis showed that acombined 96% (N = 245) of the total students (N = 256)did not achieve the 75% threshold Mean Percentage Score (MPS) required by DepEd; 67% (N=171) belong to Average Mastery, 27% (N= 69) belong to Low Mastery and 2% (N=5) belong to Very Low Mastery.

Table 2. Concept Domain Achievement Level

Achievement Level	Public Secondary School (Big School) (N=127)		Public Secondary School (Small School) (N=31)		HEI-supervised Public School (N=17)		HEI-supervised Private School (N=81)		All Schools (N=256)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Moving towards mastery (66-85%)	4	3.1			1	5.9	5	6.2	10	3.9
Average mastery (35-65%)	82	64.6	16	51.6	15	88.2	59	72.8	172	67.2
Low mastery (16-34%)	39	30.7	15	48.4	1	5.9	14	17.3	69	27.0
Very low mastery (5-15%)	2	1.6					3	3.7	5	2.0
Mean score out of 40 items	x̄=15.58		x̄=16.31		x̄= 18.59		x̄= 17.41		x̄=16.93	

The 96.1% of the total students are those that can be classified as having no mastery of science concepts necessary for them to learn. When students failed to learn the basic concepts, in turn, may not be able to link to other related concepts. Only 3.9% (N=10) of the students belong to "Moving Towards Mastery" level where considered to understand science concepts and ready to move from concrete to abstract learning and can engage in discussions pertaining to science technology. The details of the performance of the four schools in the concept domain are presented in Table 2.

One notable data from this result is the performance of Public Secondary School (Small School) which showed that no student achieved a "MovingTowards Mastery" level. Looking into the mean scores of all the schools, no school reached even 50% or 20 out of 40 items. The overall mean score of all the schools is 16.93, which is considerably low. When students failed to learn the basic concepts, in turn, may not be able to link to other related concepts. Students understanding of science concepts is important in developing science literacy and crucial in teaching and learning process [3], [12]. Without understanding these concepts, it would be difficult for the students to participate in public discussions or public issues pertaining to science and technology.

Content Knowledge of Junior High School Students Along Application Domain

This domain is important because it involves students using concepts and processes to solve a new problem. It enables students to make connections of their learning in science to their lives. The Philippine Science Framework of Science Education argued that when students cannot make connections, they may view science ideas as unrelated and discrete instead of unifying and holistic. The application domain was computed based from the scores of the students in science literacy questionnaire (SLQ). This is a teacher made and a multiple-choice test based from the K to 12 Curriculum learning standards. Analysis showed that 98.8% (N=253) out of 256 students did not achieve the 75% threshold level required by DepEd. The achievement level of most students falls into averagemastery 46.1% (N= 118), low mastery 46.9% (N = 120), very low mastery 4.7% (N = 12) and absolutely no mastery 1.2% (N = 3). Only 1.2% (N = 3) students have achievement level of moving towards mastery (0.4%) and closely approaching mastery (0.8%). The table below provides a detailed account of the achievement level of the students in the application domain.

It is good to note in this result that the Public Secondary School (Big School) has two students getting a "Closely Approaching Mastery" achievement level, the highest level, yet the school's mean score is the lowest among the four schools. With the achievement level of most students categorized as "Average Mastery and "Low Mastery" and a mean score below the required mark, these results together with the concept domain is alarming. The low achievement level of the 96.1% of the students in concept domain is consistent to the low achievement level of the 98.8% of the students in application domain.

Application domain is most important because it involves students using concepts and processes to solve a new problem. The high percentage (98.8%) of students with low achievement level along this domain denotes that these students may not make connection of their learning in science to their lives and may not be effective in solving new problems.

Table 3. Application Domain Achievement Level

Achievement Level	Public Secondary School (Big School) (N=127)		Public Secondary School (Small School) (N=31)		HEI-supervised Public School (N=17)		HEI-supervised Private School (N=81)		All Schools (N=256)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Closely Approaching Mastery (86-95%)	2	1.6	0	0.0	0	0.0	0	0.0	2	0.8
Moving towards mastery (66-85%)	0	0.0	0	0.0	1	5.9	0	0.0	1	0.4
Average mastery (35-65%	61	48.0	7	22.6	8	47.1	42	51.9	118	46.1
Low mastery (16-34%)	57	44.9	24	77.4	7	41.2	32	39.5	120	46.9
Very low mastery (5-15%)	4	3.1	0	0.0	1	5.9	7	8.6	12	4.7
Absolutely no mastery (0-4%)	3	2.4	0	0.0	0	0.0	0	0.0	3	1.2
Mean score out of 30 items	$\bar{x}$= 10.96		$\bar{x}$= 11.35		$\bar{x}$= 11.29		$\bar{x}$= 18.59		$\bar{x}$= 10.95	

The students who can "apply" what they have learned to new situations provide evidence that they understand the concepts [13]. Failure to learn the concepts would be difficult to make applications to concrete situations. Wiggins and McTighe [14] termed application as enduring understanding which he characterized as enduring value beyond the classroom, uncovering of abstract ideas and offer the potential for engaging students. When students grasp the enduring understandings, they could rethink other ideas theyalready know and generate new ideas. The overall result showed that only 1.2% of all the students can grasp enduring understanding, empowered to think in new ways and may transfer ideas in new contexts while the 98.8% cannot.

Significance of Difference in the Performance of JHS Students in Concept and Application Domains as Affected by Types of School

Table 4. Analysis of variance of scores in concept domain and application domain of Junior High School students of the different schools

Sources of Variation	Df	Concept Domain		Application Domain	
Schools	3	161.9905		14.4261	
Error	252	21.5655		16.5516	
Computed F		7.512	**	0.872	ns
p value		0.000		0.456	
cv (%)		28.81		38.45	

*Ns = not significant; ** = significant at 1% level*

Analysis of variance Table 4 showed that the effect of the type of school was significant with F(3, 252) = 7.512, p = 0.000 on concept domain but not on application domain with F(3, 252) = 0/872, p = 0.456. Post hoc analyses using the Duncan's Multiple Range Test (Table 5) indicated that the mean score of JHS students of HEI-supervised Public HS in concept domain was significantly different to the mean scores of Public Secondary School (Big and Small) but not to the mean score of Private HS.

Table 5. Mean scores in concept domain and application domain of Grade 10 students of the different schools

Schools	Concept Domain	Application Domain
Public Secondary School (Big School) (n=127)	15.6 b	10.7
Public Secondary School (Small School) (n=31)	13.4 c	9.5
HEI-supervised Public School (n=17)	18.6 a	11.3
HEI-supervised Private School (n=81)	17.3ab	10.7

1 Means followed by a common letter are not significantly different at 5% level (DMRT)

This difference can be attributed to factors such as in Public Secondary School (small school), no teacher is major in Physics, no science laboratory available and no science-related activities implemented. According to McDermott [15] it is necessary to engage students at a sufficiently deep intellectual level to bring about a significant conceptual change. Therefore there is a need for instructional materials that foster the active mental participation of students in the learning process and an assessment mode that complements it. Contrary to concept domain, the mean score in application domain of all schools is not significantly different. The performance of the students along this domain in four schools is the same.

Prevailing Conditions among Schools in terms of Teacher Related Factors.

This study considers the educational background of teachers, the length of service, number of subjects taught and experience as a prevailing condition contributing to the learning outcomes of the students. A total of 15 teachers from the four schools were able to participate in the survey. Analysis of the data collected reveal that all teachers are a graduate of Bachelor of Secondary Education and pursuing master's degree. Seven of the respondents have been teaching for 15 years already. Most teachers are handling at least 3 - 4 subjects for overs 6 years now. Teachers in this study are described to possess the required qualifications to teach the subject, most of them are experienced teachers handling several science subjects for a considerable period.

Student Related Activities

Activities identified include science quiz bee which is conducted by 14 teachers, science exhibits by 12 teachers, stargazing by 9 teachers, field work by 8 teachers, planetarium by 6 teachers and a surprising 6 teachers only doing laboratory experiment/exercises. The conduct of laboratory experiment which is notcommon among the teachers surveyed is not only a cause for concern but more of a question. Nevertheless, the answer lies on the availability of laboratory materials. In the absence of these materials, teachers employ improvisation and increased time allocation on seat works and problem-solving exercises.

School Facilities and Equipment.

In this study, the extent of use of resources by teachers and students was determined rather than the listing of available resources. Hence, school resources such as textbooks and internet are always used, projector is sometimes used, TV on the other hand, is never used.

Statistical Analysis of the Content Knowledge and the Prevailing Conditions among Schools

Table 6. Test of relationship of the teacher-related conditions and content knowledge among schools

Teacher-related factors	Science Content Knowledge		Interpretation
	Chi-Square Value	p-value	
Educational attainment	23.333	0.005	Significant
Length in Service	21.000	0.013	Significant
No. of Subjects Taught	26.250	0.010	Significant
No. of Classes Handled	29.167	0.015	Significant
No. of Years Teaching Science	9.722	0.373	Not Significant

Using Chi-square, the relationship between the content knowledge and the prevailing conditions was determined. Table 6. Above presents the teacher-related factors that conceivably influenced the science content knowledge of the students among the different schools.

The teacher educational attainment is a prime factor that affects the science content knowledge of the students. This result is supported by the statement of Adeyemi [16] that teachers' experience and educational qualifications were the prime predictors of students' academic achievement. The finding of the number of subjects taught with a p-value of 0.010, and the number of classes handled with a p-value of 0.015 exhibit significant relationships to the science content knowledge of the students. Interestingly, the factor number of years teaching science did not yield a significant p-value.

The educational attainment with a p-value of 0.005, the length in service with a p-value of 0.013, the study also agrees to the findings of Ajayi [17] that a well-trained teacher has mastery of the subject matter, sense of organization, ability to clarify ideas, ability to motivate students, good imagination, ability to involve the students in meaningful activities throughout the period of teaching, management of the details of learning and frequent monitoring of students' progress through tests and examinations. These characteristics directly influence students' engagement and learning outcomes. The low achievement level in concept and application domains of the students in this study, however, may signify that these characteristics may not be present or not collectively performed by the teachers. In terms of the relationship between the students' related activities and content knowledge, the Science Field Work with a p-value of 0.012, Science Exhibits with a p-value of 0.002, and stargazing with a p-value of 0.033 are all interpreted as significant. Hence, these activities impact the student's science content knowledge.

Table 7. Test of Relationship of the students related activities and content knowledge among schools

Students - related activities	Content Knowledge Chi-Square Value	p-value	Interpretation
Laboratory experiments/ Exercises	4.286	0.232	Not Significant
Quiz Bee	5	0.172	Not Significant
Science Field Work	11	0.012	Significant
Science Exhibits	15	0.002	Significant
Stargazing	8.75	0.033	Significant
Planetarium	6.667	0.083	Not Significant

Table 7 summarizes this analysis and further show that Laboratory experiments/ Exercise, Quiz Bee, and Planetarium do not show a significant p-value thus, it implies that these activities do not affect the science content knowledge of the students.

While activities outside the room can boost self-esteem and it had favourable effects on standards test scores in academics according Cosden [18.]The analysis between the school resources and content knowledge is presented in Table 8. It shows that the textbook with a *p-value* of 0.016 is the only school resource that is significant.

Table 8. Test of Relationship of the school Resources and content knowledge among schools

School Resources	Content Knowledge Chi-Square Value	p-value	Interpretation
Internet Connection	4.286	0.232	Not Significant
Projector	5.174	0.522	Not Significant
TV	8.417	0.493	Not Significant
Textbook	15.64	0.016	Significant

The use of textbook is predominantly in all schools since this is the only school-resources readily available for the students in all schools. Other school resources, e.g. internet connection, projector and television are available on a limited quantity, as observed. More so the students have no open access on the use of such rather being used by the teachers in the preparations and the actual conduct of lessons.

CONCLUSION AND RECOMMENDATION

The content knowledge along concept domain in Physics of the majority of the Junior high school students in this study is poor- *falls below the 75% mean percentage score (MPS) set by the Department of Education*. This result is consistent to a low MPS of the majority of the students in application domain. There is a small percentage only of the students that can make connections of their learning in science to solving new problems. The conceptual framework of K to 12 Curriculum in Physics is presented in spiral progression scheme which would pave way to a deeper understanding. However, the mean scores of the majority of the students in all schools speak otherwise.

Several school conditions such as teacher-related factor, the availability of teaching resources and student activities are considered that impact the science content knowledge of the students. Along teacher-related factors, the educational qualification, the teaching work load and the teaching experience but not the number of years teaching science has significant relationship to the achievement level of the students. Along student-related activities, science field work, science exhibits and stargazing found to have a relationship in the students' content knowledge. Students prefer the use of textbooks over other teaching resources considering its availability in the school. The school conditions mentioned are tested in terms of its relationship to the science content knowledge of the students only. The extent of its impact/effect is not considered, thus, maybe considered in the future studies. It is also recommended that a more focused study on the performance of students in another set of schools is recommended. The details on how the activities are conducted and the resources are used can also be investigated further. This study reveals that students under K-12 curriculum are not performing well. This alone needs a very important attention and further investigation in a larger scale.

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