A STUDY OF TEACHERS' KNOWLEDGE AND PRACTICES ON SCIENCE PROCESS SKILLS IN TEACHING SCIENCE

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Abstract

The primary purpose of this study was to investigate teachers' knowledge and practices on science process skills in teaching science at the middle school level. The design adopted was a descriptive research design. Four townships were randomly selected from four districts in Yangon Region. Two high schools and two middle schools were selected by using a stratified random sampling technique. The population in this study consists of (640) Grade 5 students and (77) teachers who are teaching science. Three instruments: knowledge and practices questionnaires for junior science teachers and science achievement test were employed. Teachers' knowledge and practices questionnaires involved (33) items. Science achievement test for students involved (18) items. One-Way ANOVA, dependent samples *t*-test and a correlation technique were used in this study. As a result of the research, there was a significant difference between experienced teachers and inexperienced teachers of knowledge and practices on science process skills. And, there was also a significant difference between basic and integrated science process skills of those teachers. Moreover, teachers who were well-trained got higher mean for knowledge and practices than teachers who were partially trained. Also, it was found that science teachers are familiar with basic science process skills. The research findings proved that teachers' knowledge and students' achievement were moderately related and teachers' practices and students' achievement were not correlated in all the selected schools. This indicated that if teachers' knowledge on science process skills is high, they can arrange their teaching learning situation more systematically to teach their students more effectively.

Keywords; science, knowledge, practice, science process skills

Introduction

Education is a product of experience. One of the most important and pervasive goals of schooling is to teach students to think. Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical

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world and reasoning from data. Science process skills are transferable intellectual skills, appropriate to all scientific endeavors (NSTA, 2002). Individuals with these skills have the ability to make a major contribution to the improvement of society and these skills can be developed interaction with their teachers. Teachers play vital role in helping students to develop their science process skills. They must be proficient and must have the knowledge and understanding about science process skills. It is important for teachers to demonstrate a sound knowledge and be able to perform well on test items involving novel situations of the science process skills. Therefore, this study attempted to examine teachers' knowledge and practices on science process skills.

Objective

The main purpose of this study is to investigate teachers' knowledge and practices on science process skills in teaching science at the middle school level.

Research Questions

(1) Is there a significant difference in the teachers' knowledge of the science process skills in teaching science by science teaching service?

(2) I s there a significant difference in the teachers' practices on science process skills by science teaching service?

(3) Are there significant correlation in teachers' knowledge and practices on science process skills and their students' academic achievement in teaching science?

The Importance of Science Process Skills

All skills have to be used in some context and scientific process skills are only scientific if they are applied in the context of science. Learning with understanding involves linking new experiences to previous ones and extending ideas and concepts to include a progressively wider range of related phenomena. Learning with understanding in science involves testing the usefulness of possible explanatory ideas by using them to make prediction or to pose

questions, collecting evidence to test the prediction or answer the questions and interpreting the result; in other words, using science process skills.

The role of the process skills in this development of understanding is crucial. If these skills are not well developed, them the emerging concepts will not help understanding of the world around. Thus the development of scientific process skills has to be a major goal of science education (Harlen, 1999). The main reason must surely be the inhibiting influence of a view of science education as being concerned only with the development of scientific concepts and knowledge (Tobin et al., 1990). The technical problems can be solved where there is a will to do so. But first it is necessary to counter the argument that science education is ultimately about understanding, that using science process skills is only a means to that end and thus only the end product needs to be assessed.

Science process skills are at the heart of what learning is all about. They help teachers think critically and are the intellectual raw materials for problem solving and decision making. Science - A Process Approach (SAPA) defined these skills as a set of broadly transferable abilities, appropriate to many science disciplines, and reflective of the behavior of scientists. SAPA grouped process skills into two types. They are: basic science process skills and integrated science process skills.

Basic Science Process Skills

The basic science process skills are the skills teachers use when they do science. Students use these skills to actively explore the natural world. These skills are essential to effective elementary classroom science lessons (Rezba et al., 2007). There are seven basic science process skills.

Observing Skill

Observing is an essential part of science. Causal observation spark almost every inquiry teachers make about their environment and organized observations form the base from which every step in a structured investigation proceeds (Tek, 1999). Observing is becoming aware of an object or event by using any of the senses to identify properties. It is the fundamental science process skill. There are two types of observations: qualitative and quantitative

observations (Rezba et al., 2007). The simplest observations are qualitative observations. This made using only the senses such as color, shape and texture are examples of qualities. Quantitative observations are descriptions of quantities or amounts such as length, volume, mass, weight and times are quantities.

Classifying Skill

Classifying is the process of arranging objects or events according to some property (Ebenezer & Connors, 1998). Classifying is at the root of all understanding. This progress also involves using classification schemes to identify objects or events to show similarities, differences and interrelationships.

Inferring Skill

Inferring is interpreting or explaining what is observed and suggesting relationships between objects or events. The value of inference is that it can lead to testable predictions (Ebenezer & Connors, 1998). In making an inference students use information already known from past experience and new information students directly observe through their senses (Rezba et al., 2007). In science, inferences about how things work are continuously constructed, modified and even rejected on the basis of new observations.

Predicting Skill

Predicting is making forecast of future events or conditions expected to exist. Predicting is closely related to observing, inferring and classifying. Predicting is an excellent example of one process skill being dependent on other process skills. The ability to construct reliable predictions depends on careful observations and inference made about the relationships among observed events (Rezba et al., 2007).

Measuring Skill

Measuring is one of the skills that are essential for most scientific investigation (Tek, 1999). It is making quantitative observations by comparing to a conventional standard. As science investigations require more accuracy,

students will use different units and different measuring device, expending their concepts of measurement. A major goal of measurement is to learn how to select appropriate measuring instruments and read a variety of balances and scales. Measurement plays an important role in science (Ebenezer & Connors, 1998).

Communicating Skill

Communicating is a process not only of science but of all human endeavors (Tek, 1999). It is a skill that is collecting information, organizing it in meaningful way and communicating it to someone else. The teachers focused on getting children to stretch the number of ways they are able to communicate through the use of graphs, charts, maps, symbols, diagrams, mathematical equations, visual demonstrations and spoken word etc. Effective communication is clear, precise and unambiguous (Rezba et al., 2007).

Using Space / Time Relationships

Using space / time relationship is a process that develops skills in the description of spatial relationships and their change with time (Tek, 1999). It includes a study of shapes, symmetry, motion and rate of change.

In learning the science process skills, teachers not only mastered the skills but teachers also learned something about how these skills can be learned. By using this knowledge teachers can begin making some important instructional decisions about teaching science, especially the science process skills. The decisions teachers make can significantly enhance the quality of science in which their students are engaged.

Integrated Science Process Skills

When teachers have mastered the basic process skills, they will be ready to learn the skills that lead to experimenting, the integrated process skills. By combining the integrated process skills with the basic science process skills, they can create a classroom climate where children explore, investigate, and discover. In classroom where children are learning the integrated process skills, they inquire about how things work and they seek answers to their own

questions by designing and conducting experiments. There are six integrated science process skills.

Operational Definitions

An operational definition is one that is made in measurable or observable terms. The major function of operational definitions is to establish the parameters of an investigation or conclusion in an attempt to gain a higher degree of objectivity (Jinks, 1997).

Hypothesizing Skill

A hypothesis is a possible explanation for a set of observations, recorded data or inferences. Hypothesizing is a complex skill which integrates several simpler skills. Thinking about observations leads scientists to seek causes for events. To broaden their understanding of their environment, they then generalize their students' explanation. This process of generation is called hypothesizing skill (Jinks, 1997).

Experimenting Skill

This process is a systematic approach to solving a problem. The purpose of the process is to judge the extent to which a hypothesis might be true and to set a standard whereby that judgment is made (Jinks, 1997).

Controlling Variables

In conducting an experiment, some of the factors that may affect the result are inclined to change. Before carrying out an experiment, teachers should therefore identify all the variables that may affect the result. The process of controlling variables is pervasive in scientific inquiry. The most definitive results of an investigation are obtained when the variables can be identified and carefully controlled (Jinks, 1997).

Interpreting Data

It provides for the development of skills that can be transferred to a variety of experiences in and out of the school. The ability to interpret data is essential in science (Tek, 1999).

Formulating Model

A simplified model of a complex system permits students to focus on the important aspects of the system that is being studied, and thus better understanding it. The teachers should also realize that drawings are also, effectively models. At higher - grade levels, the teacher might point out that even equations are effectively models. They may be considered to be models because they can predict some aspect of the behavior of a system represented by the equation, and often the equation provides a good insight (Ebenezer & Connors, 1998).

Learning these skills empowers students to answer many of their own questions. Each time teachers learn a new skill, ask themselves the questions and use their answers to guide their instructional decisions when teaching science.

Research Method

The main purpose of this study is to investigate teachers' knowledge and practice on science process skills in teaching the Grade 5 General Science Textbook.

Research Design and Procedure

The research design for this study was a descriptive research design. The sample schools were selected by using a stratified random sampling method. This research involved collecting data concerning about teachers' knowledge and practices on science process skills in teaching science. So, the knowledge and practices on science process skills questionnaires for junior science teachers and achievement test for Grade 5 students were developed based on Barbara Houtz (2008) science process skills and 5 chapters form chapter (2) to (6) in Grade 5 General Science Textbook. Validity for these instruments was determined by the expert judgments. After getting the validity of these instruments, a pilot study was conducted with (22) junior science teachers and (30) Grade 5 students in Mingalardon Township, Yangon. After the pilot study, the data collection was conducted in the selected schools.

Instruments

The instruments used for this study were teachers' knowledge and practices on science process skills questionnaires and a test to measure their students' academic achievement. They were based on Houtz (2008) and Grade 5 General Science Textbook prescribed by Basic Education Curriculum, Syllabus and Textbook Committee (2016).

Knowledge and Practices Questionnaire for Teachers

Knowledge questionnaire for teachers was developed on Houtz (2008) science process skills and it consisted (33) items with multiple choices. Validity for this instrument was determined by the expert judgments. According to their suggestions, the knowledge questionnaire was modified again. Then, a pilot testing was done with (22) junior science teachers from Mingalardon Township, Yangon. The internal consistency of the knowledge questionnaire was (0.598) by Cronbach's alpha. And also practices questionnaire for teachers was developed on Barbara Houtz (2008) science process skills and the content area is chapter (2) to (6) from Grade 5 General Science Textbook. The questionnaire items have five - point Likert - scale to be described by five responses: (1 - never, 2 - seldom, 3 - sometimes, 4 - often, 5 - always). Arbitrary scoring weight (1, 2, 3, 4, 5) was assigned for positive. After preparing the measuring scale, content validity was determined by expert judgments. Then, a pilot testing was done with a sample of (22) junior science teachers from Mingalardon Township. According to the pilot study, some items were modified to adapt to teachers' understanding. The internal consistency of the practices questionnaire was (0.728) by Cronbach's alpha.

Science Achievement Test for Grade 5 Students

In order to measure the students' science process skills an achievement test was conducted. Firstly, the table of specifications was prepared including number of items according to science process skills. The achievement test was consisted of multiple choice items, short questions and long question items. In order to get expert validity, they were distributed to corresponding subject experts. According to their suggestions, the achievement test questions were modified again. The allocated time for this achievement test was (45) minutes.

The marking scheme for the achievement test was also presented. The pilot study was administered to (30) Grade 5 students in Mingalardon Township and the reliability of achievement test items is Cronbach's Alpha (0.72).

Population and Sample Size

All participants in the sample were junior science teachers and Grade 5 students from the Yangon Region by using a stratified random sampling method. There are four districts in Yangon Region. In each district, a township was selected by using a sample random sampling method for the study.

The sample schools were selected by using a stratified random sampling technique. Two high schools and two middle schools from each township were selected. So, eight high schools and eight middle schools included in this study. The number of junior science teachers was (77) and Grade 5 students were (640). Students in this study were selected by using a systematic random sampling technique. Table 1 shows the number of population and the sample size in the selected schools.

Table 1: Population and Sample Size in the Academic Year (2016 - 2017)

No.	Township	School	Populations		Sample
			Teachers	Students	Students
1.	Shwepyitha	BEHS 1	7	476	40
		BEHS 3	4	270	40
		BEMS 3	5	226	40
		BEMS 4	3	198	40
2.	Yankin	BEHS 1	4	171	40
		BEHS 2	4	282	40
		BEMS 2	3	80	40
		BEMS 5	4	91	40
3.	Myangone	BEHS 1	8	275	40
		BEHS 2	10	555	40
		BEMS 4	2	98	40
		BEMS 5	4	162	40

No.	Township	School	Populations		Sample
			Teachers	Students	Students
4.	Dala	BEHS 1	4	254	40
		BEHS 2	7	400	40
		BEMS 1	4	277	40
		BEMS 2	4	84	40

Note. BEHS = Basic Education High School
BEMS = Basic Education Middle School

Research Findings

Findings of Teachers' Knowledge on Science Process Skills in the Selected Schools

In order to find out teachers' knowledge on science process skills, knowledge test questionnaire for teachers was used. The average mean is (18.719) and standard deviation is (2.338). The scores for teachers' knowledge on science process skills ranged from (10) to (28). According to the results, the lowest mean and the highest mean were (13.50) and (27.00) respectively. It was found that the teachers' knowledge on science process skills of BEHS (2), Yankin was the lowest and that of BEHS (1), Yankin was the highest among the selected schools.

Moreover, to measure whether there is a significant difference in teachers' knowledge on science process skills among the schools, One-Way ANOVA was used. It was found that there were significant differences among the schools concerning teachers' knowledge on science process skills (F (15, 61) = 11.168, $p < .001$) (see Table 2). This means that teachers' knowledge on science process skills differs among schools.

Table 2: ANOVA Results of Teachers' Knowledge on Science Process Skills in the Selected Schools

	Sum of squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	935.895	15	102.423	11.168	.000***
Within Groups	340.806	61	5.587		
Total	1276.701	76			

Note. *** $p < .001$

Table 3 shows teachers' knowledge on science process skills in schools based on the means. It was divided into three groups, namely, high, moderate and low. The full score of teachers' knowledge on science process skills test was 33. The average mean and standard deviation were (18.719) and (2.338) respectively. If the mean in the school was higher than (21.057), it is defined as high knowledge group and if the mean was between (16.381) and (21.057), it is defined as moderate knowledge group and if the mean was less than (16.381), it would be defined as low knowledge group on science process skills.

Table 3: Percentage of School Groups (Teachers' Knowledge on Science Process Skills)

Teachers' knowledge on Science Process Skills	**No. of School**	**Percent (%)**
High	5	31.25
Moderate	7	43.75
Low	4	25
Total	16	100

Based on the results, figure 1, the percentage of the levels of school knowledge on science process skills. It obviously describes the percentage of teachers' knowledge level on science process skills.

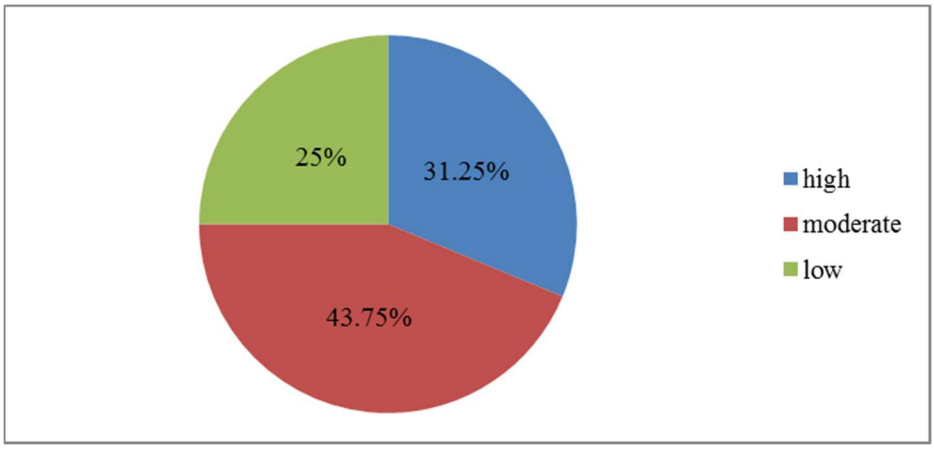

Figure 1: Percentage of School Groups (Teachers' Knowledge on Science Process Skills)

Findings of Teachers' Knowledge on Science Process Skills in terms of Science Teaching Service

The mean of teachers' knowledge on science process skills (20.74) for (≥ 21) group are higher than the mean of teachers' knowledge on science process skills (19.00) for (11 - 20) group, the mean of teachers' knowledge on science process skills (19.00) for (11 - 20) group are higher than the mean of teachers' knowledge on science process skills (16.94) for (0 - 10) group (see table 4). It can be interpreted that knowledge level of science process skills of teachers who have longer length of service in science teaching are higher than those who have shorter length of service in science teaching.

Table 4: ANOVA Results for Teachers' Knowledge on Science Process Skills in terms of Science Teaching Service

Science Teaching Service	N	Mean	Std. Deviation	*F*	*df*	Sig.
0 - 10	35	16.94	2.950	7.071	76	.002**
11 - 20	23	19.00	3.643			
≥ 21	19	20.74	5.290			
Total	77	18.42	4.099			

Note. $^{**}p < .01$

Based on the results, figure 2 illustrate the comparison of means in terms of science teaching service.

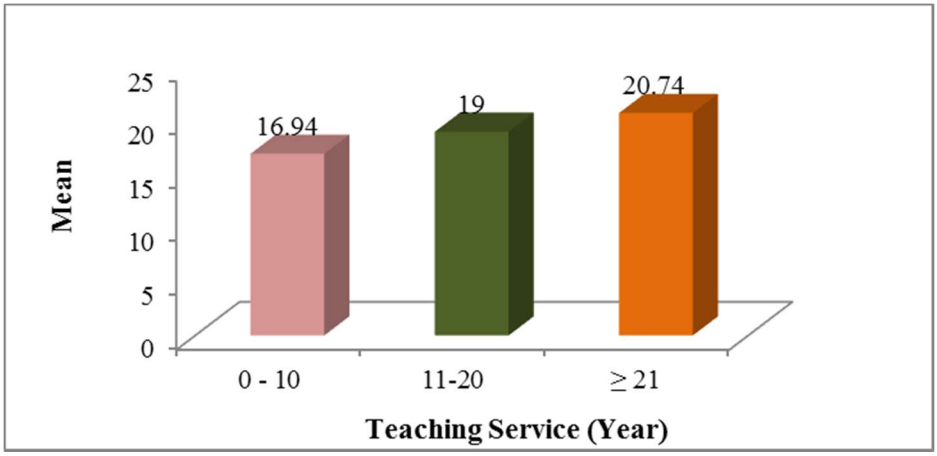

Figure 2: Comparison of Means for Teachers' knowledge on Science Process Skills in terms of Science Teaching Service

Findings of Teachers' Basic and Integrated Knowledge on Science Process Skills

Table 5 shows the means for basic knowledge and integrated knowledge on science process skills of teachers. Inspection of the group means indicates that the average mean of basic knowledge on science process skills of teachers (12.87) is higher than that of integrated knowledge on science process skills of teachers (5.57). It can be interpreted that the basic knowledge on science process skills of teachers is higher than the integrated knowledge on science process skills of teachers. There were significant differences among the basic and integrated knowledge on science process skills of teachers.

Table 5: '*t*' Value for Teachers' Basic and Integrated Knowledge on Science Process Skills

	N	**Mean**	**Mean Percent**	**Std. Deviation**	***t***	***df***	**Sig.**
Basic Knowledge	77	12.87	61.35%	2.948	23.181	76	.000***
Integrated Knowledge	77	5.57	46.65%	1.874			

Note. *** $p < .001$

Findings of Teachers' Practices on Science Process Skills in the Selected Schools

In order to find out teachers' practices on science process skills, practices questionnaire for teachers was used. The average mean is (116.365) and standard deviation is (9.942). The scores for teachers' practices on science process skills ranged from (69) to (136). According to the results, the lowest mean and the highest mean were (92.00) and (132.00) respectively. It was found that the teachers' practices on science process skills of BEMS (2), Yankin was the lowest and that of BEMS (5), Myangone was the highest among the selected schools.

One-Way ANOVA was used to examine the differences among the schools. It was found that there were significant differences among the schools concerning teachers' practices on science process skills (F (15, 61) = 2.355, $p <$ .05) (see Table 6). This means that teachers' practices on science process skills differ among the schools.

Table 6: ANOVA Results of Teachers' Practices on Science Process Skills in the Selected Schools

	Sum of Squares	***df***	**Mean Square**	***F***	**Sig.**
Between Groups	6484.817	15	432.321	2.355	.01*
Within Groups	11196.170	61	183.544		
Total	17680.987	76			

Note. *$p < .05$

Table 7 shows teachers' practices on science process skills in schools based on the means. It was divided into three groups, namely, high, moderate and low. The full score of teachers' practices on science process skills test was 165. The average mean score and standard deviation were (116.365) and (9.942) respectively. If the mean in the school was higher than (126.307), it is defined as high practices group on science process skills. If the mean in school was between (126.307) and (106.423), it is moderate practices group. If the mean was less than (106.423), it would be defined as low practices group.

Table 7: Percentage of School Groups (Teachers' Practices on Science Process Skills)

Teachers' Practices on Science Process Skills	No. of Schools	Percent (%)
High	3	18.75
Moderate	12	75.00
Low	1	6.25
Total	16	100

Based on the result, figure 3 illustrates the percentage of the levels of school practices groups on science process skills.

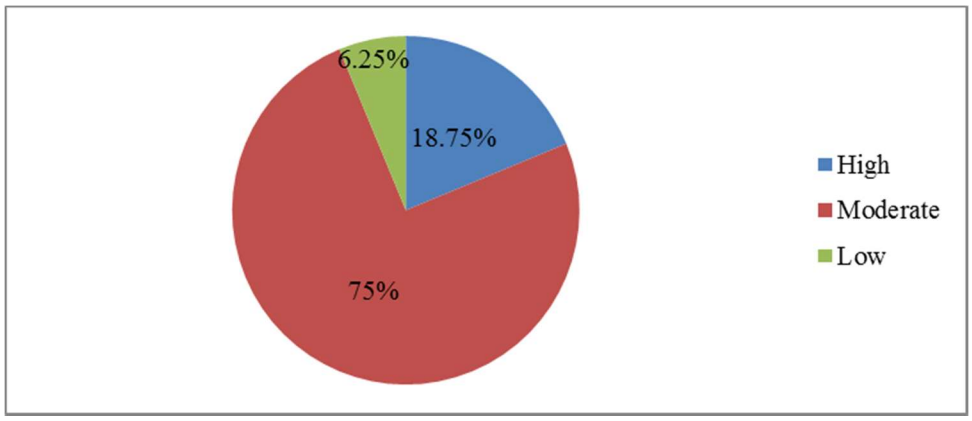

Figure 3: Percentage of School Groups (Teachers' Practices on Science Process Skills)

Findings of Teachers' Practices on Science Process Skills in terms of Science Teaching Service

Table 8 shows that the teachers who have longer length of service in science teaching were significantly different from those who have shorter length of service in science teaching. Inspection of the group means indicates that the mean of teachers' practices on science process skills (124.42) for (≥ 21) group is higher than the mean of teachers' practices on science process skills (122.04) for (11 - 20) group, the mean of teachers' practices (122.04) for (11 - 20) group is higher than the mean of teachers' practices (106.11) for (0 - 10) group. It can be interpreted that practices level on science process skills of teachers who have

longer length of service in science teaching are higher than those who have shorter length of service in science teaching.

Table 8: ANOVA Results for Teachers' Practices on Science Process Skills in terms of Science Teaching Service

Science Teaching Service	N	Mean	Std. Deviation	*F*	*df*	Sig.
0 - 10	35	106.11	14.694	18.871	76	.000***
11 - 20	23	122.04	10.555			
≥ 21	19	124.42	7.891			
Total	77	115.39	14.743			

Note. *** $p < .001$

Findings of Students' Achievement in the Selected Schools

In order to find out the students' achievement for valid teachers' practices, an achievement test was administered. The scores for students' achievement ranged from (3) and (25). According to the results, the lowest mean and the highest mean were (9.578) and (15.882) respectively. It was found that the achievement level of BEHS (1), Shwepyitha was the highest and the achievement level of BEHS (1), Dala was the lowest among the selected schools.

Moreover, One-Way ANOVA was used to examine the difference among the schools concerning the students' achievement in science, ($F(15,624) = 13.825$, $p < .001$) (see Table 9). This means that the achievement of students in science differs among the selected schools.

Table 9: ANOVA Results of Students' Achievement in Science in the Selected Schools

	Sum of Squares	Mean Square	*df*	*F*	Sig.
Between Groups	2187.373	145.825	15	13.825	.000***
Within Groups	6581.775	10.548	624		
Total	8769.148		639		

Note. *** $p < .001$

Table 10 also shows the students' achievement in schools based on the means of students' achievement. It was divided into three groups, namely, high, moderate and low. The full score of students' achievement test in science 25.The average mean and standard deviation were (12.73) and (3. 152) respectively. If the mean in the school was higher than (15.882), it is defined as high achievement group. If the mean was between (15.882) and (9.578), it is defined as moderate achievement group. If the mean was less than (9.578), it would be defined as low achievement group (see Table 10).

Table 10: Percentage of School Group (Students' Achievement)

Students' Achievement	No. of School	Percent (%)
High	2	12.50
Moderate	14	87.50
Low	-	-
Total	16	100

Based on the results, figure 4 illustrates the percentage of the levels of school achievement groups.

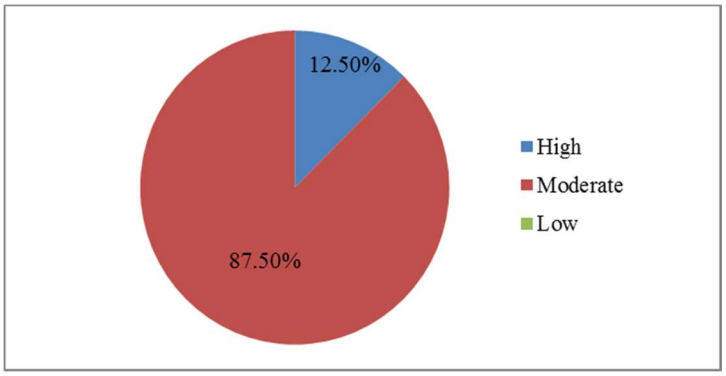

Figure 4: Percentage of School Groups (Students' Achievement)

Comparison of Teachers' Knowledge and Practices on Science Process Skills and Students' Achievement in the Selected Schools

As regards teachers' knowledge on science process skills for the selected schools, five schools gained high knowledge level, seven schools got moderate knowledge level and four schools obtained low knowledge level on science

process skills. The names of schools with high level of knowledge on science process skills were BEHS (1), Yankin, BEMS (4) and BEMS (5), Myangone and BEMS (1), Dala. The schools with low level of knowledge on science process skills were BEMS (3), Shwepyitha, BEHS (2) and BEMS (2), Yankin and BEHS (2) Dala. The rest schools were moderate knowledge level.

Also as regards teachers' practices level for the selected schools, three schools obtained high practices level, twelve schools gained moderate practices level and one school got low practices level. The names of schools with high practices level were BEHS (1) and BEMS (5), Yankin, and BEMS (5), Myangone. The lowest practices level school was BEMS (2), Yankin. The rest of the schools were moderate practices level.

As regards students' achievement level for the selected schools, two schools gained high achievement level and fourteen schools obtained moderate achievement level. There was no low achievement level school. The names of high achievement level schools were BEHS (1), Shwepyitha and BEHS (1), Yankin. The rest schools were moderate achievement level. Table 4.15 points out the teachers' knowledge and practices on science process skills and students achievement level in the selected schools.

Table 11: Teachers' Knowledge and Practices on Science Process Skills and Students' Achievement Level in the Selected Schools

School No.	Teachers' Knowledge on Science Process Skills	Teachers' Practices	Students' Achievement Level
S1	21.86 (H) > 21.057	126.307 < 113.00 (M) < 106.423	17.18 (H) > 15.882
S2	21.057 < 17.75 (M) < 16.381	126.307 < 121.25 (M) < 106.423	15.882 < 12.00 (M) < 9.578
S3	13.80 (L) <1 6.381	126.307 < 120.25 (M) < 106.423	15.881 < 13.70 (M) < 9.578
S4	21.057 < 18.33 (M) < 16.381	126.307 < 117.33 (M) < 106.423	15.882 < 11.67 (M) < 9.578
S5	27.00 (H) > 21.057	128.00 (H) >126.307	16.38 (H) >15.882
S6	13.50 (L) < 16.381	126.307 < 125.25 (M) < 106.423	15.882 < 13.93 (M) < 9.578
S7	15.00 (L) < 16.381	92.00 (L) < 106.423	15.882 < 10.93 (M) < 9.578
S8	21.057 < 21.00 (M) < 16.381	131.50 (H) > 126.307	15.882 < 11.85 (M) < 9.578
S9	21.057 < 17.13 (M) < 16.381	126.307 < 106.63 (M) < 106.423	15.882 < 11.43 (M) < 9.578
S10	21.057 < 17.00 (M) < 16.381	126.307 < 111.10 (M) < 106.423	15.882 < 12.85 (M) < 9.578
S11	24.00 (H) > 21.057	126.307 <122.50 (M) < 106.423	15.882 < 14.08 (M) < 9.578
S12	22.75 (H) > 21.057	132.00 (H) > 126.307	15.882 < 11.53 M < 9.578

School No.	Teachers' Knowledge on Science Process Skills	Teachers' Practices	Students' Achievement Level
S13	**14.75 (L) < 16.381**	**126.307 < 107.25 (M) < 106.423**	**15.882 < 12.45 (M) < 9.578**
S14	**21.057 < 17.14 (M) < 16.381**	**126.307 < 113.29 (M) < 106.423**	**15.882 < 10.30 (M) < 9.578**
S15	**16.75 (H) > 21.057**	**126.307 < 107.00 (M) < 106.423**	**15.882 < 11.25 (M) < 9.578**
S16	**21.057 < 21.75 (M) < 16.381**	**126.307 < 113.75 (M) < 106.423**	**15.882 < 12.18 (M) < 9.578**

Note. L = Low Level, M = Moderate Level, H = High Level

Relationship of Teachers' Knowledge on Science Process Skills and Students' Science Achievement

To examine the relationship between teachers' knowledge on science process skills and students' science achievement in the selected schools, Pearson product - moment correlation was used. This result shows that teachers' knowledge on science process skills and students' science achievement were moderately related (see Table 12).

Table 12. Correlation between Teachers' Knowledge on Science Process Skills and Students' Science Achievement

Correlations			
		Teachers' Knowledge on Science Process Skills	Students' Science Achievement
Teachers' Knowledge on Science Process Skills	Pearson Correlation	1	.395**
	Sig. (2 – tailed)		.001**
	N	77	77
Students' Science Achievement	Pearson Correlation	.395**	1
	Sig. (2 – tailed)	.001**	
	N	77	640
**Correlation is Significant at the 0.01 level (2 – tailed)			

Moreover, it is necessary to examine the relationship of teachers' knowledge on science process skills and students' science achievement in each school. It was found to be highly related in eight schools, moderately related in five schools, and nothing related in the remaining schools. S5 has the highest

significant correlation between teachers' knowledge on science process skills and students' science achievement.

Relationship between Teachers' Practices on Science Process Skills and Students' Science Achievement

Pearson's product moment correlation was conducted to examine the extent of strength and direction of relationship between teachers' practices and students' science achievement in all the selected schools. The result shows that there was no correlation between teachers' practices and students' science achievement because there were different practices among the selected schools (see Table 13). Most of the teachers applied their knowledge in teaching science. Some teachers cannot apply their knowledge in teaching science.

Table 13: Correlation between Teachers' Practices on Science Process Skills and Students' Science Achievement

		Teachers' Practices	Students' Science Achievement
Teachers' Practices	Pearson Correlation	1	.254
	Sig. (2 – tailed)		.026*
	N	77	77
Students' Science Achievement	Pearson Correlation	.254	1
	Sig. (2 – tailed)	.026*	
	N	77	640
*Correlation is Significant at the 0.05 level (2 – tailed)			

The Summary of the Findings

To sum up, the findings for teachers' knowledge on science process skills, their practices and students' science achievement in the selected schools can be generalized as follows:

- For teachers' knowledge on science process skills, the percentage of low, moderate and high level of knowledge on science process skills in all the selected schools are (25%), (43.75%) and (31.25%) respectively.
- There were significant differences in teachers' knowledge on science process skills among all the selected schools andteachers who have more science teaching service was higher than that of teachers who have less science teaching service.
- There was a significant difference between basic and integrated skills of teachers because teachers' basic knowledge on science process skills was higher than that of integrated knowledge.
- For teachers' practices, the percentage of low, moderate and high level of practices on science process skills in all the selected schools are (18.75%), (75%) and (6.25%) respectively.
- There were significant differences in teachers' practices among all the selected schools. Teachers' practices that have more teaching service on science process skills were higher than those that have less science teaching service.
- For students' science achievement, the percentage of low, moderate and high level of achievement in all selected schools are (0%), (87.50%) and (12.50%) respectively.
- Knowledge on science process skills of teachers has moderately related with science achievement of students.
- Practices of teachers on science process skills in teaching have no correlation with science achievement of students in all the selected schools. Because there were different practices among the selected schools.

Discussion, Suggestions and Conclusion

Discussion and Suggestions

Statistical analysis of the data shows that the total mean of teachers' knowledge on science process skills was (18.719) teachers who have the knowledge of science process skills teach these skills more actively in their classroom (Dowing & Gifford, 1996).

Based on the research, teachers may not be promoting a positive attitude toward science among students in their classroom because of their poor conceptual knowledge. BEHS (2), Yankin got the lowest mean in teachers' knowledge on science process skills among all the selected schools. It was assumed that some teachers have a few teaching service in science and low interest in their science teaching. Most of the science teachers in that school use lecture method and rarely use practical work. So, they got the lowest mean. BEHS (1), Yankin got the highest mean in teachers' knowledge on science process skills among the selected schools because teachers have positive attitudes towards science education. They are interested in their teaching. Thus, their classrooms are well facilitated with sufficient teaching learning materials and the separate are spatial classrooms.

Moreover, there was a significant difference between the teachers who have longer length of service in science teaching and those who have shorter length of service in science teaching. Teachers who have experience in science teaching have mastery of the subject and they are well-prepared for their teaching. They also have acquired cumulated classroom management skills and strategies to handle different classroom problems. This may imply that inexperienced teachers could get confused, do not know clearly science process skills about the topics and how to prepare for their teaching. So, teachers' knowledge on science process skills differs in terms of experience.

There are two types of science process skills, namely basic and integrated process skills. In the present study, the percentages of means are 61.35% for basic science process skills and 46.65% for integrated science process skills. The results pointed out that there was a significant difference between basic and integrated process skills. The scores of basic process skills of teachers are higher than that of integrated process skills of teachers. The

interview results also indicate that most of the teachers are more familiar with basic skills than integrated skills. This result is consistent with Ergin and Aktamic (2008) who found that there was a significant difference between the basic and integrated skill scores of teachers and this difference was in favor of basic skill scores. It can be concluded that science teachers have more opportunity to develop integrated skills.

Settlage et al. (2007) stated that teaching with an eye toward science process skills is an appropriate entry point for beginning elementary and middle school teachers. They can serve as a very important way for science teaching. Therefore, teachers should possess a strong conceptual understanding and be able to perform well on the science process skills if they have to teach them effectively in their classroom.

According to the teachers' practices on science process skills, there were significant differences among the schools concerning teachers' practices on science process skills. Among them, BEMS (2), Yankin got the lowest mean in practices. In this school, teachers have low knowledge on science process skills and so they cannot use these skills in their teaching. They have a little practical work due to the large class size and spatial classroom situations. Thus, teachers from this school got low practices level on science process skills.

According to teachers' practices on science process skills in terms of teaching service, there was a significant difference between the groups. The group of more experienced teachers has strong knowledge on science process skills, so they can effectively apply these skills in their teaching and do more practical work. This result is consistent with Anderson (2002) who suggested that teachers who lack science process skills or have a poor knowledge of science process skills are less equipped to inquiry teaching strategies and as such may not be using it in their classroom. Therefore, the group of more experienced teachers should help the group of less experienced teachers to enable them to use more teaching aids in teaching science.

Despite teachers' knowledge and practices have low level on science process skills, students' science achievement is not at low level at BEMS (3), Shwepyitha, BEHS (2) and BEMS (2), Yankin and BEHS (1), Dala, teachers' knowledge and practices on science process skills are at low level. But in these schools, students' science achievement was at moderate level. One reason is that

although teachers have low level of knowledge on science process skills, they can do practices about some topics. The second reason is that they may teach their lesson through repetition and drills. Thus, students understand of the content of the topic. And so, students' achievement was at the moderate level.

Based on the results of Pearson's correlation coefficients, there was a positive moderate relationship between two variables in all the selected schools. This means that teachers with a high score on knowledge on science process skills are likely to have students' science achievement. But in three schools there is a little relationship between the two variables among the selected schools. This means that teachers' knowledge on science process skills in teaching science provides no indication of students' science achievement. This situation shows that a range of studies should be conducted to develop science process skills of teachers. Mutisya et al. (2013) emphasized that teachers should understand science process skills cognitively to make their students gain these skills at a desired level.

Moreover, there was a little relationship between the teachers' practices on science process skills and students' science achievement in all the selected schools because each school has different class-size and different situation. Seven schools have a positive high relationship and six schools are a positive moderate relationship between the two variables. It means that teachers with a high score on practices are likely to have a high score on students' science achievement. But in two schools there is a little relationship between the two variables. It means that teachers' practices on science process skills in teaching science provide no indication of students' science achievement. Nevertheless, in BEHS (2), Yankin, there is a negative high relationship between the two variables. It means that although teachers' practices on science process skills are low, students' science achievement is at the high level. Teachers' competence in the science process skills has been found to promote positive attitudes towards science (Dowing, Filer & Chamberlin, 1997, cited in Miles, 2010). Thus, science process skills enable students to develop a deeper science understanding.

New research should focus more on the element of conceptual knowledge. Teachers with low conceptual knowledge of science process skills may not effectively convey the true definitions, meanings and understanding of

concepts and skills to their students. Initial teachers training should support the use of practical work in science teaching. Ministry of Education should organize regular seminars and workshops for the teachers to refresh their memories about new developments and skills.

Recommendations for Further Research

This research was conducted with the junior science teachers in Grade 5 at the middle school level. More research is needed to study all grades at the middle school level. Teachers' knowledge and practices on science process skills play a key role in students' science achievement and activity-based learning through the process skills. It is also needed to carry out more studies concerning with exploration of ways and means to improve teachers' knowledge of science process skills.

As the size of the sample is small, this result may not be generalized to a bigger population. Thus, carrying out a larger research in a nationally representative area in a longer duration is highly recommended to validate the present research results.

Conclusion

Process skills in science are very important presentation of science to children. They are the basic steps for the development of useful skills and in making teaching-learning process more dynamic, stimulating and meaningful. The achievements of science have glorified the modern world and transformed the modern culture into a scientific one. According to Rauf, 2013, teachers play an important role for teaching science process skills in class through planning and arranging learning activities and teaching how to reach scientific information. So, teachers must possess an adequate level of knowledge on science process skills so that they can teach effectively their students.

Although teachers' knowledge and practices cannot be only one reason for low or high achievers in science, it is one of the reasons for low or high achievement of the students. A better understanding of scientific knowledge and practices is needed in order to help students to become high achievers in science. So, teachers must have a sound foundation of knowledge on science process skills and make classroom activities. Science process skills

may be a potent vehicle in affecting students' outcomes. This study will be of great use to students and teachers to take care of science process skills in schools. Therefore, today science teachers should emphasize science process skills in their teaching for improving the quality of education.

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