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# Achievement level of Science Process Skills of Junior Secondary Students: Based on a Sample of Grade Six and Seven Students from Sri Lanka

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**ABSTRACT**

Science proces–skills are vital for the development of formal thinking ability of students for the betterment of a country. The aim of this study was to assess the level of understanding of basic science process skills (BSPS), among the grade six and seven students. The sample consisted of 3183 grade six students and 3289 grade seven students from one of the educational zones of Central Province of Sri Lanka. This sample symbolizes very rural, less privileged schools to super grade well equipped schools. A test was used to measure the level of understanding of BSPS and the research was conducted as a quantitative research. The data were analyzed using statistical package for social sciences (SPSS). The findings of the study revealed that the majority of the students in both grades, achieved a medium level of understanding of BSPS. However, results for both grades, indicated that there are statistically significant differences in the level of understanding of BSPS between the medium of instruction (English and native languages) as well as between national and provincial schools. In addition, gender too plays a similar role for sixth graders. Nevertheless, no relationship was identified between the understanding level of SPS and gender for seventh grades.

**KEYWORDS**
Science Process Skills, Basic science process skills, Integrated science process skills, Junior secondary students

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## Introduction

Scientific method skills are significant to teach ways of arriving at conclusions based on existing knowledge. Different terms have been used to describe these skills such as scientific method, scientific thinking and critical thinking etc. However, during the last two decades, the phrase "science process skills" (SPS) has become more commonly used (Bybee & DeBoer, 1993).

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According to Özgelen (2012) Science process skills can be categorized into two, as basic science process skills (BSPS) and integrated science process skills (ISPS). Author named observing, using space/time relationships, inferring, measuring, communicating, classifying, and predicting as BSPS and controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, formulating models, and presenting information as ISPS. Chiappetta and Koballa (2002) introduce SPS such as identifying the problem, identifying and controlling variables, formulating hypotheses, interpreting data, defining operationally, reading/constructing graphs and experimenting as integrated SPS and also as more complex skills than the basic skills.

### *Importance of learning the basic science process skills*

Padilla, Okey, and Dillashaw (1983) examine the relationship between science process skills and formal thinking abilities of middle and high school students (grade 7–12 students) and found a strong relationship between the two. Ostlund (1992) argues that science process skills are important and defines them as tools to acquire information about the world. Students need these skills when carrying out scientific investigations during their learning process (Harlen, 1999; Taconis, Ferguson-Hessler, & Broekkamp, 2000). Further, SPS are considered to be able to assure that the students receive the meaningful learning experience because they assist students to acquire higher order thinking (Germann & Aram, 1996; Lee, Hairston, Thames, Lawrence, & Herron, 2002). Moreover, the authors say that the BSPS provide the intellectual groundwork in scientific inquiry. Regarding the BSPS, Ango (1992), describes that basic (simpler) process skills provide a foundation for learning the integrated skills. Further, according to the author, BSPS are vital for science learning, and concept formation in the primary and junior secondary school levels, ISPS are difficult and more appropriate in the secondary and tertiary school levels.

According to Olufunminiyi and Afolabi (2010), SPS enable students to be probed to creativity, problem solving, reflective thinking, originality and invention, which are vital ingredients for the development of science and technology of any nation. Several researchers have done studies on the teaching and acquisition of BSPS. For example, Padilla, Cronin, and Twiest (1985) present a study based on a survey about the BSPS of grade eight students who were not trained with special science process skills. They found that only 10% of the students scored above 90% correct. Wideen (1975) has found that teaching BSPS increases levels of skill performance of students. He reports a comparison study of student outcomes for Science - A Process Approach (PA) and traditional science teaching for third, fourth, fifth, and sixth grade classes. Wideen found a significant difference in the overall science process skills acquisition; the students of the PA programme were better than that of the students in the traditional science programme. Further, Thiel and George (1976) report about an investigation on the development of prediction skills among third and fifth graders and found that the experimental group, which received a training on BSPS, performed better. Tomera (1974) also report about a study on the skill of observing among seventh graders, and he found that their observation skill had improved dramatically. From these studies, it can be concluded that basic skills can be taught and that when learned, they readily transfer to new situations (Tomera, 1974).

Germann and Aram (1996) report a study on seventh-grade science students' performances on the science processes of recording data, analyzing data, drawing conclusions, and providing evidence. According to the findings, only 61% of students performed the activity and recorded data, successfully. Nevertheless, by conducting research on purpose and procedures for assessing SPS, Harlen (1999) argues that it is a content-dominated view of science education rather than the technical difficulties that has inhibited the development of effective procedures for assessing process skills to date. Beaumont-Walters and Soyibo (2001) have analyzed the performance on selected ISPS of a sample of high school students' from Jamaica. They considered five integrated science process skills and identified that there were statistically significant differences between their performance and their gender, grade level, school location, school type, student type and socioeconomic background (SEB). Among these a positive, statistically significant relationship was found between students' SPS performance and school type. However, the relationships among their student type, grade level and SEB with performance were weak.

Harrell and Bailer (2004) report a study on the use of mealworms to develop SPS. Moreover, Monhardt & Monhardt (2006) report a study about creating a context for the learning of SPS through picture books for primary level grades. Özgelen (2012) conducts a study to examine the differences in SPS test scores among sixth and seventh grade students of a private school in Turkey. He points out a statistically significant difference between sixth and seventh grade students of both private and public schools in Turkey.

## *Science Education in the context of Sri Lanka*

In Sri Lankan education system, basic sciences are taught in Grades[1]1-5 a component part of integrated Environment Related Activities (ERA). Formal science education initiates at the age of eleven in grade six, where science is taught as a subject which is the entering point to the junior secondary education level of Sri Lanka. Even though a comprehensive amount of research in the field of the effectiveness of education and curriculums for junior secondary students has been reported, no reports were available either in science education, learning abilities or on SPS in Sri Lanka (World Bank report 2014).

## *Research aim and objectives*

The aim of this study was to assess the understanding of SPS, among the grade six and seven students who should receive a good foundation about scientific processes.

Research objectives were

1. To examine the level of understanding of basic science process skills among grade 6 and 7 students in the Gampola Educational Zone of the Central Province
2. To investigate the differences between the students' understanding level of BSPS and
   a. School type
   b. School functional groups
   c. Medium of instruction
   d. Gender

In this study, to understand the above research objectives, achievement tests were administered and tests were conducted for the students of grade six and seven.

## Methodology

### *M.1 Sample of study and the population*

The study was based upon the data collected from grade six and seven students of all the schools [2](Type; national/provincial and Functional groups; 1AB/1C/type 2/type 3) in the Gamploa Educational Zone of the Central Province of Sri Lanka. This sample represented a cross section of school categories in Sri Lanka. Moreover, the sample symbolizes very rural, less privileged estate schools to super grade well equipped national schools. Therefore, this educational zone was purposively selected as schools in this educational zone ~~it~~ represents all the types, socioeconomic levels and medium of instruction in Sri Lanka (Table 1).

Table 1. *Composition of the study Sample according to the school type, functional group and medium of conduct*

| | School Type | | Functional group | | | | Medium of conduct | | | Difficulty level | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | National | Provincial | 1AB | 1C | Type 2 | Type 3 | Sinhala | Tamil | English | Congenial | Not difficult | Difficult |
| No. of schools | 05 | 79 | 09 | 25 | 44 | 06 | 53 | 32 | 11 | 32 | 28 | 24 |

### *M.2 Population of the sample*

Altogether 3183 students of grade six and 3289 students of grade seven participated in this study.

### *M.3 Research instruments*

As mentioned above, this study was mainly focused on the students' understanding of basic science process skills, since they are vital for science learning and concept formation at the primary and junior secondary school levels (Ango, 2002). The approach of this study was entirely quantitative and the data were collected using a research instrument in the form of achievement test papers (two).

Questions on the Science Process Skill Achievement Test papers (SPSAT) were developed based on the relevant literature (Zeidan & Jayosi, 2015; Rubba & Anderson, 1978). Zeidan and Jayosi (2015) developed the science process skills test (SPSAT) containing 18 items where 10 items on the basic science process skills and 8 items on the integrated science process skills. This has been used to study the SPS of secondary students of age category of 17. The Nature of Scientific Knowledge scale (NSKS) was developed by Rubba and Anderson (1978) to measure the secondary students understanding levels. It comprised of 48 statements using a five Likert-type scale. However, in our pilot studies,

student responses for both SPST and NSKS were poor. In their feedback students have mentioned that both test papers were difficult and most of them did not like Likert-type questions with answers ranging from "strongly agree to strongly disagree".

Therefore, test papers were modified and developed especially for this study based on the following reasons; (1) age of our study sample was 12 & 13 years and the above tests were advance, (2) science syllabus of grade six & seven (3) more emphasis on basic science process skills, and (4) modifications were needed to suit the Sri Lankan student culture.

Further, the number of questions and the science process skill to be tested were decided based on the content of the science syllabus of the respective grade (grade six & seven) of Sri Lankan National science curriculum.

Science Process Skill Achievement Test 1 (SPSAT 1): A test paper for six graders was consisted of fifteen multiple choice questions to assess students' understanding of science processing skills of observing, measuring, classifying, identification of variables, inferences and logical reasoning.

Science Process Skill Achievement Test 2 (SPSAT 2): Twenty multiple choice questions were made to assess the understanding levels of SPS of seven graders. The concerned SPS were; observing, measuring, classifying, identification of variables, inferences & logical reasoning, hypothesizing and experimentation. More questions were included in SPSAT 2 as more SPS were concerned in grade seven.

### *M.4 Validation of the research instruments:*

Both test papers were piloted with a group of 20 students (of each grade) to ensure their comprehensibility, reliability and validity. The students who were selected for the validation of the instruments were from a different educational zones and they were not included in the main study.

### *M.5 Data Collection*

Tests were administered to the sample by teachers personally in their usual classroom settings. Students were asked to mark their responses on an answer sheet and 60 minutes were allocated for the test.

*Assumption:* It was assumed that the students individually answered the questions on their own without any help and did not answer by chance.

### *M.6 Analysis of data:*

Test papers were marked and the total marks were calculated as a percentage. Scores were obtained for each multiple choice answer sheet, tabulated and the scores were analyzed using Statistical Package for Social Sciences (SPSS) 20. Descriptive statistics (frequencies, mean scores and standard deviations) were computed for each grade to determine the level of understanding of the BSPS as a total.

*Score categories:* To analyze the level of understanding of SPS by each student in both grades, scores were categorized into three groups as specified in Table 2 and percentages for each score category were obtained.

Table 2. *Score categories of grade six and seven students*

| Score category | Score range (out of 100 marks) |
|---|---|
| Low scores | Up to 35 |
| Medium scores | 36-79 |
| High scores | Over 80 |

To determine the level of understanding of different BSPS skills, a random sample of 200 students was selected from each grade and descriptive statistics (frequencies) were computed for responses to each question of the both test papers (SPSAT 1 & SPTAS 2).

Furthermore, an Independent sample t-test was used to determine the variations in the means by school type, and gender. Subsequently, one-way Analysis of variance (ANOVA) was used to examine whether or not there were statistically significant differences in the level of understanding of students' science process skills with the school functional groups, and medium of instruction.

## Results and Discussion

This section presents the results based on the two objectives of the research.

*R.1 Results and discussion for Objective 1; The levels of understanding of science process skills among grade six and seven students*

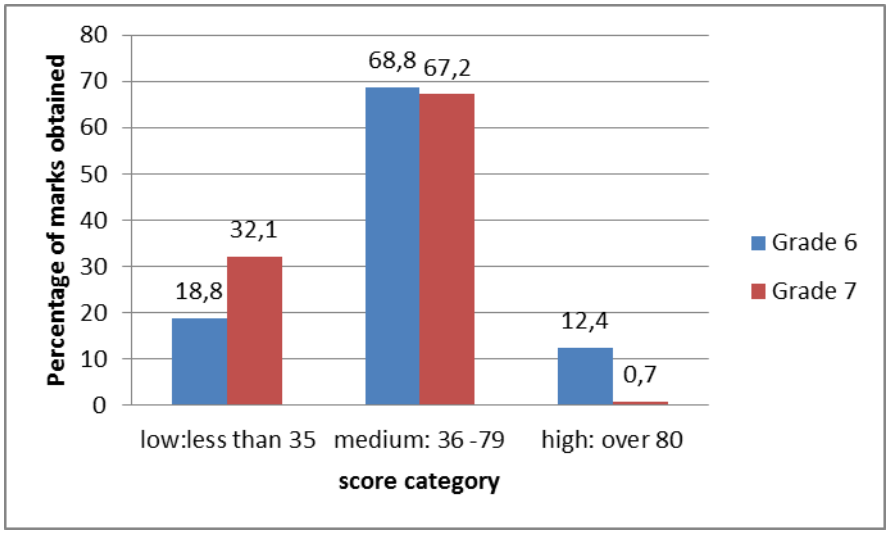
First, the understanding of science process skills as a whole (total) by students of grade six and seven were calculated. The mean scores and the standard deviation of the total group are given in Table 3.

Table 3. Details of the test given to measure the level of understanding of science process skills by the grade six and seven students of the Gampola Educational Zone

| | Grade six | Grade seven |
|---|---|---|
| No. of questions given | 15 | 20 |
| No. of students | 3183 | 3289 |
| Mean mark obtained (out of 100 marks) | 54.4 | 43.9 |
| Standard deviation | 2.881 | 2.881 |

As shown in Table 3, the mean value of the scores of grade six students is higher than that of the grade 7 students. However, the deviation of scores is similar for the both graders.

Figure 1: Percentage of marks obtained according to score category by grade six and seven students




The above figure (Figure 1) shows the percentage values of marks obtained by students, according to score categories as stipulated under the section on methodology. The majority of the students in both grades, achieved a medium level of understanding of the science process skills (68.8% and 67.2%). In general, if obtaining 35 marks is considered as the pass mark in the achievement test, 81.2 % of grade 6 students were able to pass the achievement test (68.8+12.4) and only 67.9% students of grade 7 were able to achieve the same level (67.2+0.7). Further, 12.4% of grade 6 students could achieve a high score, over 80 marks where the performance of grade 7 of the same category was negligible (0.7%).

Secondly, the understanding of different science process skill by grade six and grade seven students were examined.

*Grade six:* A random sample of 200 of six graders (out of the total sample of 3183) was considered for this analysis. Understanding levels of BSPS; observation, measuring, classifying, identifying variables, Inferences & logical reasoning was tested and Table 4.a shows the analyzed data using descriptive analysis (percentages).

According to the table given below [Table 4.a] understanding of the SPS, particularly observing, measuring and classifying were moderate among them. However, the process skills of inference & logical reasoning skills and identifying of variables were poor.

Table 4.a. Percentages of marks obtained by grade six students for different science process skills

| No | SP Skill | Question no | % of students gave correct answer for each question | total % for each skill |
|---|---|---|---|---|
| 1 | Observing | 02<br>06<br>14 | 64.2<br>35.4<br>21.8 | 50.9% |

| | | | | |
|---|---|---|---|---|
| | | 15 | 82.4 | |
| 2 | Measuring | 05<br>11 | 36.8<br>64.2 | 50.5% |
| 3 | Classifying | 03<br>10 | 59.1<br>45.8 | 52% |
| 4 | Inferences & logical reasoning | 04<br>07<br>08<br>12<br>13 | 43.5<br>16.7<br>25.8<br>35.1<br>35.8 | 31.38% |
| 5 | Identifying the variables | 09 | 45.8 | 45.8% |

*Grade seven:* Understanding the levels of different science process skills, which were subjected to examine under this study for grade seven were analyzed in a random sample of 200 (total sample was 3289). The Science process skills observing, measuring, classifying, identifying variables, inferences & logical reasoning, hypothesizing, and experimenting were considered in this and the results are in Table 4.b.

Table 4.b. Percentages of marks obtained by grade seven students for different science process skills

| No | SP Skill | Question no | % of students gave correct answer for each question | total % for each skill |
|---|---|---|---|---|
| 1 | Observing | Q 4<br>Q 6<br>Q 17<br>Q 19 | 52.9<br>27.4<br>87.1<br>26.9 | 48.6 |
| 2 | Measuring | Q 13 | 21.2 | 21.2 |
| 3 | Classifying | Q 8<br>Q 16<br>Q 18 | 52.9<br>35.1<br>31.3 | 39.8 |
| 4 | Inferences & logical reasoning | Q 2<br>Q 3<br>Q 5<br>Q 9<br>Q 15 | 44.7<br>26.4<br>32.7<br>31.3<br>60.1 | 41.6 |

| No | SP Skill | Question no | % of students gave correct answer for each question | total % for each skill |
|---|---|---|---|---|
| | | Q 20 | 54.3 | |
| 5 | Identifying of Variables | Q 12 | 31.8 | 31.8 |
| 6 | Hypothesizing | Q 7 | 54.8 | 54.8 |
| 7 | Experimenting | Q 10<br>Q 11<br>Q 14 | 48.1<br>17.8<br>35.6 | 33.8 |

According to Table 4.b, the level of understanding the SPS of hypothesizing was moderate. However, the science process skills of observing, measuring, classifying, Inferences & logical reasoning, experimenting and understanding of variables were poor.

The findings of the research objective 1 (level of understanding the SPS) revealed that the majority of the students in both grades, achieved a medium score category (36-79 marks) level of understanding of the science processing skills (68.8% and 67.2%).

This finding is consistent with the findings of the study reported by Delen and Kesercioglu (2012). They also found that the students in grade eight students of Turkey who participated in the study obtained around 50% of SPS.

Grade six students' achievements were moderate with a mean value of 54.4 and 81% of the students obtained more than the pass mark (35 mark) for the SPST paper. They were better than grade seven students. Moreover, the results show that grade six students had selected more correct answers for the question related to science process skills of observing, measuring, classifying, identifying variables, inferences & logical reasoning than that of grade seven students.

Grade seven students followed the old syllabus while sixth graders followed the new science syllabus, which has more practical oriented approach towards teaching science. Researchers (authors) are in the view that, teaching and learning activities used for grade seven students were traditional and it resulted less understanding levels of science process skills. In a study of Science Process Skills among Palestinian secondary school students (Zeidan & Jayosi, 2015) the researchers have found that traditional methods cannot develop the acquisition of science process skills.

*R.2 Results and discussion for objective 2; differences between the students' understanding level of SPS and school type/school functional groups/ medium of instruction/ and gender*

In order to measure these the mean values were compared either by using independent sample t tests or One Way ANOVA test appropriately.

*R.2.1 The difference between the students' understanding level of SPS and their school type*

In order to examine the above differences, independent samples t tests were done. First, the difference between students understanding levels of SPS and their school type (National school/ Provincial school) was tested separately for Grade six and seven students, following hypotheses were made;

$H_0$ = There is no significant difference of students' understanding of science process skills among the Grade six/seven students from National schools and the Grade six/seven students from Provincial schools

$H_1$ = There is a significant difference of students' understanding of science process skills among the Grade six/seven students from National school and the Grade six/seven students from Provincial schools

The results for grade six and seven are shown in Table 5.a and Table 5.b respectively.

Table 5.a. Independent t-test results related to school type and test marks of grade six students

| | School type | Number of students | Mean | Std. Deviation | t value | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Marks | National | 551 | 58.69 | 19.296 | 4.802 | 3181 | .000 |
| | Provincial | 2632 | 54.42 | 18.905 | | | |

Thus, according to Grade six students' data, the level of understanding of science process skills of national schools (58.69 ±19. 296) had significantly different from the level of understanding of science process skills of the students in the provincial schools (54.42±18.905). t (3181) = 4.802, p <0. 05.

Table 5.b. Independent t-test results related to school type and test marks of grade seven students

| | School type | Number of students | Mean | Std. Deviation | t value | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| Marks | National | 556 | 45.27 | 13.077 | 2.435 | 3282 | .015 |
| | Provincial | 2733 | 43.64 | 14.649 | | | |

According to Table 5.b, Grade seven students' data the level of understanding of science process skills of national schools (45.27±13.077) had significantly different from the level of understanding of science process skills of the students in the provincial schools (43.64±14.649), t (3287) = 2.43, p <0. 05.

According to the results for both grades, it is clear that the level of understanding of BSPS depends on school type. This finding supports the previous studies by Beaumont-Walters and Soyibo (2001).

*R.2.2 Difference between the students' understanding levels of SPS and their school functional groups (1AB, 1C and type 2)*

To see the differences between the understanding level of SPS and school functional groups for grade six/ seven students, One Way ANOVA tests were done for each grade, based on the following hypothesis;

$H_0$ = There is no mean difference of Grade six/seven students' levels of understanding of SPS, among the school functional groups (1AB, 1C and type 2)

$H_1$ = There is a mean difference of Grade six/seven students' levels of understanding of SPS, among the school functional groups (1AB, 1C and type 2)

Grade six:

**Table 6.a.** Mean marks for grade six students' understanding levels of SPS according to their school functional groups

| | Functional grade | Number of students | Mean | Std. Deviation |
|---|---|---|---|---|
| marks | 1AB | 1274 | 59.67 | 18.971 |
| | 1C | 805 | 52.17 | 17.585 |
| | type2 | 1104 | 52.13 | 19.122 |

**Table 6.b.** One-way Analysis of Variance (ANOVA) for grade six students' understanding levels of SPS according to their school functional groups

| Marks | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 43290.813 | 2 | 21645.406 | 62.005 | .000 |
| Within Groups | 1110113.959 | 3180 | 349.092 | | |
| Total | 1153404.772 | 3182 | | | |

**Table 6.c.** Post HOC analysis of grade six students' understanding levels of SPS according to their school functional groups

| **Multiple Comparisons** | | | | | | |
|---|---|---|---|---|---|---|
| Dependent Variable: marks<br>Tukey HSD | | | | | | |
| (I) functional grade | (J) functional grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | Lower Bound | Upper Bound |
| 1AB | 1C | 7.506* | .841 | .000 | 5.53 | 9.48 |
| | type2 | 7.542* | .768 | .000 | 5.74 | 9.34 |
| 1C | 1AB | -7.506* | .841 | .000 | -9.48 | -5.53 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | type2 | .037 | .866 | .999 | -1.99 | 2.07 |
| type2 | 1AB | -7.542* | .768 | .000 | -9.34 | -5.74 |
| | 1C | -.037 | .866 | .999 | -2.07 | 1.99 |
| *. The mean difference is significant at the 0.05 level. | | | | | | |

According to Table 6.a performance of students of 1AB schools was better than that of 1C and type 2 schools. There was a statistically significant difference between groups as determined by one-way ANOVA (F (2, 3180) = 62.005, p =.000). Furthermore, based on the multiple comparison (Table 6.c) a difference could find between the grade 6 students of 1AB and 1C schools as well as 1AB and Type 2. Moreover, there was no statistically significant difference between 1C and Type 2 schools (p=. 999).

Grade seven:

**Table 7.a.** Mean marks for grade seven students' understanding levels of SPS according to their school functional groups

| | Functional grade | Number of students | Mean | Std. Deviation |
|---|---|---|---|---|
| Marks | 1AB | 1264 | 45.37 | 14.917 |
| | 1C | 1061 | 43.15 | 14.455 |
| | type2 | 964 | 42.85 | 13.500 |

**Table 7.b.** One-way Analysis of Variance (ANOVA) for grade seven students' understanding levels of SPS according to their school functional groups

| Marks | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4405.403 | 2 | 2202.701 | 10.675 | .000 |
| Within Groups | 678019.590 | 3286 | 206.336 | | |
| Total | 682424.992 | 3288 | | | |

**Table 7.c.** Post HOC analysis of grade seven students' understanding levels of SPS according to their school functional groups

| **Multiple Comparisons** | | | | | |
|---|---|---|---|---|---|
| Dependent Variable: marks<br>Tukey HSD | | | | | |
| (I) functional grade | (J) functional | Mean | Std. Error | Sig. | 95% Confidence Interval |

| | grade | Difference (I-J) | | | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| 1AB | 1C | 2.224* | .598 | .001 | .82 | 3.63 |
| | type2 | 2.524* | .614 | .000 | 1.08 | 3.96 |
| 1C | 1AB | -2.224* | .598 | .001 | -3.63 | -.82 |
| | type2 | .300 | .639 | .885 | -1.20 | 1.80 |
| type2 | 1AB | -2.524* | .614 | .000 | -3.96 | -1.08 |
| | 1C | -.300 | .639 | .885 | -1.80 | 1.20 |
| *. The mean difference is significant at the 0.05 level. | | | | | | |

According to Table 7.a performance of students of 1AB schools for the test was better than that of 1C and type 2 schools. However, the performance levels of grade seven students were lower than that of grade six.

There was a statistically significant difference between groups as determined by one-way ANOVA (F (2, 3286) = 10.675, p =.000).

Furthermore, based on the multiple comparisons (Table 7.c) it was found that a difference could find between the grade seven students of 1AB and 1C schools as well as 1AB and Type 2. Moreover, there was no statistically significant difference between 1C and type 2 schools (p=. 885).

Schools, which belongs to functional group 1AB are the schools which have GCE A/L (grade 12-13) science stream classes. Therefore, the presence of more science teachers and science students in the school may influence a positive attitude towards science. Zeidan and Jayosi (2015) report a positive correlation between science process skills and attitudes toward science. Therefore, the authors think that the school environment with more science involvements resulted better understanding level of BSPS of students of 1AB schools.

*R.2.3 Differences between the students understanding level of SPS and medium of instruction/conduct?*

Similarly, one way ANOVA test was done for each grade, to examine whether there is a significant difference among the students' understanding level of SPS who follows three different types of medium of instruction (Sinhala, Tamil and English).

This was calculated for Grade six/seven students based on the following hypothesis;

$H_0$ = There is no a mean difference of Grade six/seven students' level of understanding of SPS among three different mediums of instruction

$H_1$ = There is a mean difference of Grade six/seven students' level of understanding of SPS among three different mediums of instruction

Grade six:

**Table 8.a.** Mean marks for grade six students' understanding levels of SPS according to the medium of instruction

| | Medium of instruction | Number of students | Mean | Std. Deviation |
|---|---|---|---|---|
| marks | Sinhala | 2002 | 58.68 | 19.461 |
| | Tamil | 990 | 49.36 | 16.698 |
| | English | 191 | 48.24 | 16.633 |

According to Table 8.a, performance of students who studied science in Sinhala medium have performed well when compared to Tamil and English medium. One-way ANOVA test was done in order to examine whether there is a relationship between the students' understanding level of SPS and medium of instruction.

**Table 8.b.** One-way Analysis of Variance (ANOVA) for grade six students' understanding levels of SPS according to their medium of instruction/conduct

| marks | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 67211.444 | 2 | 33605.722 | 98.386 | .000 |
| Within Groups | 1086193.328 | 3180 | 341.570 | | |
| Total | 1153404.772 | 3182 | | | |

**Table 8.c.** Post HOC analysis of grade six students' understanding levels of SPS according to their medium of instruction/conduct

| **Multiple Comparisons** | | | | | | |
|---|---|---|---|---|---|---|
| Dependent Variable: marks<br>Tukey HSD | | | | | | |
| (I) Medium | (J) Medium | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | Lower Bound | Upper Bound |
| Sinhala | Tamil | 9.316* | .718 | .000 | 7.63 | 11.00 |
| | English | 10.440* | 1.400 | .000 | 7.16 | 13.72 |
| Tamil | Sinhala | -9.316* | .718 | .000 | -11.00 | -7.63 |
| | English | 1.124 | 1.461 | .722 | -2.30 | 4.55 |

| | | | | | | |
|---|---|---|---|---|---|---|
| English | Sinhala | -10.440* | 1.400 | .000 | -13.72 | -7.16 |
| | Tamil | -1.124 | 1.461 | .722 | -4.55 | 2.30 |
| *. The mean difference is significant at the 0.05 level. | | | | | | |

According to the results of grade six students, as shown in the above Table 8.b, there is a statistically significant difference among the Grade six student groups of different medium of instruction as determined by one-way ANOVA (F (2, 3180) = 98.386, p = .000). Furthermore, based on the multiple comparisons (Table 8.c) it was found that a difference could find between the grade six student groups who follow medium of instruction of Sinhala and English and also medium of instruction of Sinhala and Tamil. Moreover, there was no statistically significant difference between English and Tamil mediums (p=. 722).

Grade seven:

**Table 9.a.** Mean marks for grade seven students' understanding levels of SPS according to the medium of instruction

| | Medium of instruction | Number of students | Mean | Std. Deviation |
|---|---|---|---|---|
| marks | Sinhala | 2075 | 44.44 | 14.856 |
| | Tamil | 963 | 43.07 | 13.785 |
| | English | 251 | 42.85 | 12.702 |

According to Table 9.a, performance of students based on the medium of instruction varies. However, the performance levels of grade seven students were lower than that of grade six in all three mediums.

**Table 9.b.** One-way Analysis of Variance for grade seven students' understanding levels of SPS according to their medium of instruction/conduct

| marks | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 1538.980 | 2 | 769.490 | 3.714 | .024 |
| Within Groups | 680886.013 | 3286 | 207.208 | | |
| Total | 682424.992 | 3288 | | | |

**Table 9.c.** Post HOC analysis of grade seven students' understanding levels of SPS according to their medium of instruction/conduct

| **Multiple Comparisons** |
|---|
| Dependent Variable: marks |
| Tukey HSD |

| (I) Medium | (J) Medium | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Sinhala | Tamil | 1.368* | .561 | .039 | .05 | 2.68 |
| | English | 1.588 | .962 | .225 | -.67 | 3.84 |
| Tamil | Sinhala | -1.368* | .561 | .039 | -2.68 | -.05 |
| | English | .220 | 1.020 | .975 | -2.17 | 2.61 |
| English | Sinhala | -1.588 | .962 | .225 | -3.84 | .67 |
| | Tamil | -.220 | 1.020 | .975 | -2.61 | 2.17 |
| *. The mean difference is significant at the 0.05 level. | | | | | | |

According to the results of grade seven students, as shown in the above Tables (Table 9.b &9.c), there is a statistically significant difference among the student groups who follow different medium of instruction as determined by one-way ANOVA (F (2, 3286) = 3.714, p = .024). Furthermore, based on the multiple comparisons (Table 9.c) it was found that the differences could found between the grade seven student groups who follow medium of instruction of Sinhala and Tamil. Moreover, there was no statistically significant difference between Sinhala and English (p=. 225) as well as English and Tamil (p=. 975)

*R.2.4 The difference between the students understanding level of SPS and their gender*

In order to see the difference an Independent sample t-test was done for both graders, based on the following hypothesis;

$H_0$ = There is no significant difference of students' understanding of science process skills between the male and female students of grade six/seven students

$H_1$ = There is a significant difference of students' understanding of science process skills between the male and female students of grade six/seven students

Grade six

Table 10.a. Independent t-test results related to gender and test marks of grade 6 students

| | Gender | N | Mean | Std. Deviation | t value | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| marks | male | 1379 | 53.77 | 19.175 | -2.141 | 2826 | .032 |
| | female | 1449 | 55.30 | 18.799 | | | |

According to the results (Table 10.a) grade six students' level of understanding of science process skills of male students (53.77±19.175) was

significantly different from the level of understanding of science process skills of the female students (55.30±18.799). t (2826) = -2.141, p <0. 05.

Grade 7:

Table 10.b. Independent t-test results related to gender and test marks of grade 7 students

| | Gender | N | Mean | Std. Deviation | t value | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| marks | male | 1642 | 43.64 | 14.145 | -1.101 | 3276 | .271 |
| | female | 1636 | 44.20 | 14.664 | | | |

Based on the results, grade seven students' level of understanding of science process skills of male students (43.64±14.145) had no significant difference from the level of understanding of science process skills of the female students in grade 7 (44.20±14.664). t (3276) = -1.101, p >0. 05.

## Conclusions

The aim of this study was to assess the understanding of SPS, among the grade six and seven students. The findings of the study revealed that the majority of the students in both grades, achieved a medium level of understanding of the science process skills. This finding supports the results of some previous studies, which showed that students did not achieve the highest level of acquisition of science process skills (Al-rabaani, 2014; Özgelen, 2012). Understanding level of SPS depends on the school type, school functional group, and medium of instruction for both grades six and seven, while gender too plays a similar role for sixth graders. However, no relationship was identified between the understanding level of SPS and gender for seventh grades. General trend and belief about the medium of instruction in Sri Lankan schools is that the students who learn in English medium perform better than the other students. But it is interesting to note that the understanding level of SPS is lower for the students who learn science in English medium than that of the other two mediums. Therefore, it is required to pay attention to change teaching methodology of science in enhancing the SPSs of English medium students as SPSs are important to acquire information about the world (Ostlund 1992).

As results of this study indicated, newly introduced science syllabus for six graders has a more practical oriented approach to teach and learn science. It provides room for students to develop an understanding of matter rather than forcing students to believe in something. This will enable students to practice and developed Science process skills, if the teachers provide a better learning environment for students with hands-on activities. To teach science effectively teachers should utilize SPS in their teaching process. Therefore, the authors think that, it needs to train teachers to build up a scientific attitude and significant skills to relate scientific concepts to their day to day life. Moreover, student examinations should be set up to test the above abilities rather than testing the memorized set of definitions.

Since the present study was limited to achievement test papers, future study should be expanded with a practical component to asses BSPS. In future,

further research should be carried out to study the effect of newly introduced science curriculum for sixth grade on understanding of BSPS.

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## Endnotes

- [1] The general education system in Sri Lanka provides 13 years of education in three cycles. Children from age 5-10 attend primary school (Grade 1-5), from age 11-14 junior secondary school (Grade 6-9), from age 15-16 senior secondary [for General Certificate Examination-Ordinary Level - GCE O/L (Grade 10-11)] and from age 17 -18 collegiate or GCE Advanced Level - A/L (Grade 12-13).

- [2] A National school in Sri Lanka is a school that is funded and administered by the Ministry of Education of the central government as opposed to Provincial schools run by the local provincial council. These schools provide secondary education (some including collegiate), with some providing primary education as well. Super grade urban National schools are capable of drawing enough financial resources, better equipped with modern learning resources, attract more students as well as more resources. But rural estate schools have unequal distribution of learning resources and less accessibility with less students.

| Functional Group | Description |
|---|---|
| 1AB | Schools having GCE A/L (grade 12-13) science stream classes |
| 1C | Schools having GCE A/L (grade 12-13) arts and/or commerce stream classes, but no science stream |
| Type 2 | Schools having classes only up to GCE O/L (grade 11) |
| Type 3 | Schools having classes only up to grade 5 or 8 |

## Disclosure statement

No potential conflict of interest was reported by the authors.

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