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Improving the Science Process Skills of Science, Technology, Engineering Students through Personality-Based Approach

Leo Peter Dacumos[1]

[1]*Special Science Teacher IV, Philippine Science High School – Cordillera Administrative Region Campus*

Abstract

The study aimed to investigate the impact of the Personality-based Approach (PBA) on the integrated science process skills (SPS) of grade 7 Science, Technology, and Engineering (STE) students as compared to the conventional learning approach. A two-grouped quasi-experimental design with pretest and posttest was used in this study. This method consisted of two instructional groups (control group in conventional learning approach and experimental group in Personality-based Approach), and repeated testing (pretest and posttest) on students' science process skill competency level. Results showed Grade 7 students of Baguio City National Science High School have an overall performance exceeding average achievement. Individually, the experimental group who was given the personality-based approach (PBA) performed high with their science process skills while the control group which was given with the conventional approach had typical science process skill levels. When compared, the experimental group have better performance in the skills where students are to prepare research proposals than their counterpart in the control group. However, in terms of the experimentation process down to creating models, the two groups do not differ.

Keywords: personality-based approach, personality styles, science process skills, academic performance, differentiated instruction

Introduction

Science as a subject deals with almost everything in the environment (Supriyatman and Sukarno, 2014). It is a course that is mandated from junior to senior high school to equip students with knowledge about nature. Hence, students are expected to have the ability to observe, infer, predict, communicate, hypothesize, experiment and implement concepts towards the protection of natural resources. This, therefore, entails that the success of science learning is measured through the abovementioned abilities (Karamustafaoglu, 2011) which will collectively determine the students' level of Science Process Skills (SPS).

Scientific process skills (SPS) include skills that every individual could use in each step of his/her daily life by being scientifically literate and increasing the quality and standard of life by comprehending the nature of science (Aktamis and Ergin, 2008). Therefore, these skills affect the personal, social, and global lives of individuals. The SPS are a necessary tool to produce and use scientific information, to perform scientific research, and to solve problems – skills that Science, Technology, Engineering and Mathematics (STEM) students need before they go for higher sciences at the tertiary level.

According to Supriyatman and Sukarno (2014), learning science should provide the opportunity for students to develop science process skills (SPS). The educational system should provide learners with the opportunity to develop the science process skills to enable their creativity, which is essentially necessary to search for solutions (Aktamis and Ergin, 2008) to all kinds of problems that are encountered in daily life and to make new products, creating, therefore, future engineers, scientists, mathematics and health care force for the country. Many studies show that creativity can make their science education functional, and therefore, scientific information can be the basis for producing a valuable product instead of just amassing information.

However, deficiency of educational facilities (Salem al-amarat, 2011) and instructional materials (Ogbu, 2015), large class size (Eison, 2010), poor instruction (Eison, 2010), and non-differentiated instructional methodologies and curriculum (Weselby, 2014) are problems that threaten education process and students ability to develop their science process skills. The current educational system of the Philippines is filled with problems on classrooms shortage and scarce funding to provide for differentiated instructional materials required in each science classroom. These are pressing problems that impede teaching and learning to succeed. Due to these predicaments, the successful teaching process is encumbered and, in turn, achievement in learning is not met. Many students are not able to cope with these problems hence can result in their poor performance in achieving science process skills.

Differentiating instructional methodologies, curriculum and materials are ways to alleviate the problem abovementioned. Differentiated instruction "is the practice of modifying and adapting instruction, materials, content, student projects and products, and assessment to meet the learning needs of individual students (Tucker, 2011)." Differentiated instruction excites the brilliant student to uncover deeper layers of learning, while simultaneously structuring curriculum to support lower-level students or students with learning disabilities- both identified and unidentified, in turn, increasing their ability to master their science process skills.

It is without any doubt that intelligence, as proven by research, predicts the academic performance of students. However, various studies show that there are also non-cognitive factors that are responsible for students' academic performance.

Ciorbea and Pasarica (2013) discussed that personality is now an important consideration that affects students' academic performance. Performance of the students in science enhances when activities are specific to their type of personality, i.e. one who is introverted gets an activity that is geared towards autonomous learning while extroverted students perform better in collaborative activities. Previous research shows that a significant relationship between students' personality styles and their academic achievement exists (Dacumos, 2016). Jang et al (2016) concur with this finding indicating that academic achievement is significantly related to the student's personality style in sensing-intuition and judging-perceiving preferences. Furthermore, they say that knowing students personality styles will be helpful in the selection of appropriate teaching and learning strategies to provide better education. Finally, Al-Naggar et al (2015) found out that openness and conscientiousness personalities were found to be positively associated with academic performance.

Considering these findings, one can say that a way to differentiate instruction is by considering their personality styles. There is a close relationship between personality styles and students' academic achievement in science (Dacumos, 2016). Findings showed that students with introverted personalities perform better in the autonomous way of learning while extroverted students have better performance when activities are conducted in a group (Dacumos, 2016). It is, therefore, imperative that educators throughout the world should be inclined in differentiating the learners as to their personality style by dichotomizing the materials specialized for these varied psychological differences.

Many of the above studies only focused on determining the relationship between the academic performances of the students. These studies failed to demonstrate the effectiveness of differentiated instruction or assessment patterned according to the learners' personality styles.

This study aimed, therefore, to test whether using a differentiated formative assessment which is designed to the specific students' personality styles can improve their basic Science Process Skills. This approach is called the Personality-based Approach (PBA). This is an approach designed by the researcher as an offshoot of the previous research which determined the significant relationship between the personality styles of the students and their academic performance (Dacumos, 2016). Through this approach, STE learners are expected to be equipped with the basic science process skills (SPS) necessary for their knowledge and skill acquisition of higher sciences and scientific investigation.

Research Questions

The study aimed to investigate the impact of the Personality-Based Approach (PBA) on the integrated science process skills (SPS) of grade 7 science, technology, and engineering (STE) students as compared to the conventional learning approach. Specifically, this study answered the following:

1) What is the Integrated Science Process Skills competence level of STE students along with the following domains?

a. Use of Scientific Knowledge

b. Formulation of Scientific Question

c. Designing of Experiment

d. Communication of Scientific Procedures

e. Collection of Data

f. Creation of Visual Representation

g. Organization of Data

h. Analysis of Data

i. Use of Nominal Scientific Knowledge to Communicate Results

j. Use of Models to Explain Results

k. Use of Results to Answer Question

2) Is there a significant difference between the SPS competence level of the experimental and the control group along with the SPS domains?

3) What intervention can be proposed to increase the Science Process Skills (SPS) competence level of the Grade 7 STE students?

Scope and Delimitation

A sample of 124 grade 7 students randomly selected from Baguio City National Science High School participated in the study and were assigned to either the experimental or control group. This study limits its coverage on the grade 7 students under the Science, Technology, and Engineering (STE) program and undergoing the introductory research subject, i.e. Research 1. The main purpose of the study was to investigate the effectiveness of the proposed Personality-based Approach (PBA) in the improvement of the science process skills of the students compared to the conventional learning approach. This is proposed as it is found that the declining academic performance of the students may be due to their low achievement of the science process skills resulting from an undifferentiated and intelligence-focused curriculum. Pre-post test scores described the Science Process Skills (SPS) competence level of the students and were likewise used to compare the two groups, however for the sake of discussion, only the post-test was used to give a statistical inference on the significant difference between the two approaches.

Research Methodology

A two-grouped quasi-experimental design with pretest and posttest was used in this study. This method consisted of two instructional groups (control group in conventional learning approach and experimental group in Personality-based Approach), and repeated testing (pretest and posttest) on students' science process skill competency level.

Participants/Data Source

A sample of 124 grade 7 students from Baguio City National Science High School (BCNSHS) – Science, Technology, and Engineering (STE) program participated in the study. The sample was computed from the online sample size calculator developed by Raosoft Inc., and respondents were chosen via random selection. A personality-based Approach (PBA) was performed for the experimental group (n=62), while a conventional learning approach was employed for the control group (n=62). The sample from the experimental group was further distributed according to their personality styles, i.e. introverts and extroverts. Their personality styles profile were determined by the designated guidance counsellor using the Personality Style Inventory (PSI) by Hogan and Champagne (1980). This division allowed the researcher to implement formative activities in Research 1 specific for introverted and extroverted students, i.e. self-learning activities for the introverted students and collaborative activities for the extroverted students. In the selection of respondents for this study, the following criteria should be met: they are currently enrolled in the Research 1 subject and have basic knowledge of science courses.

Data Gathering Procedure and Instruments

The variables in this research consisted of independent and dependent variables (Table 1). The personality-based Learning Approach (PBA) and conventional learning approach are the independent variable (X) for the study. The dependent variable (Y) is the level of science process skill of the grade 7 STE students.

To collect the data, Science Process Skill Inventory (SPSI) was used. The SPSI was developed by Arnold and Bourdeau (2009) to "measure the ability to practice the full cycle of steps in the scientific inquiry process. The inventory measures science process skills, not science content knowledge." Hence, this inventory is appropriate for measurement in scientific investigation that requires scientific skills while not focusing much on the science content. To secure permission for the use of this inventory, an e-mail was sent to Dr Mary Arnold of the College of Public Health and Human Sciences, Oregon State University on September 03, 2017. A response e-mail from Dr Arnold approving the request on the use of the SPSI was received on September 05, 2017.

Table 1. Variables of the Research

Sample	Treatment	Post-test
Experimental Group	X1	Y
Control Group	X2	Y

where Y: Post-test (Science Process Skill competency level after treatment)
X1: Treatment by using Personality-based Approach (PBA)
X2: Treatment by using Conventional Learning Approach

Psychometric testing for the SPSI: the Cronbach's Alpha calculated pre-program/post-program with middle schools students attending a two-week residential summer science camp in 2007 and 2008 at Oregon State University (n=106) revealed coefficients of .84 and .94, respectively. Split-half reliability (Spearman-Brown) was .93. Kaplan and Saccuz (1993) argue that instruments with a reliability coefficient of at least 0.7 are accepted as reliable in research.

The inventory consists of eleven items, each representing a different skill in the science inquiry process. Youth are prompted to respond to each statement using a 4-point Likert scale indicating how often they practice each of the items when doing science: Never (1), sometimes (2), usually (3), and always (4). Recommended scoring of the SPSI is the calculation of a composite science process skills score. This is calculated by summing the individual ratings for each item and getting its mean. The score (rating) range for the composite score is 11-44.

The SPSI measuring the basic SPS level of the students was given to both experimental and control groups before the treatment as a pre-test formatted in an online sharing platform for easy collection of data. Both groups were given varied teaching strategies in the implementation of the lesson in Research 1. The experimental group were given a formative assessment that adopted the Personality-based Approach (PBA) which the researcher personally designed to cater to the specific assessment requirement of students with varied personality styles. Introverted students received self-learning design formative assessments while extroverted students were formatively assessed with the cooperative-learning design of the assessment tool.

On the other hand, the control group received undifferentiated formative assessment tools in the implementation of topics in Genetics.

After the implementation, the basic Science Process Skills Inventory (SPSI) was used to assess the SPS level of the students and was recorded as a post-test. However, in the discussion of results, only the post-test results were used to assess the extent of effectiveness of the PBA vs the conventional approach which was given to the experimental and control groups, respectively.

To describe the SPS competence level of the grade 7 STE students on their science process skills, the following score and its interpretation were used is given in Table 2.

Table 2. SPS Mean and Interpretation on SPS competence level

Range	Interpretation (SPS Competence Level)
3.40 – 4.00	Excellent
2.80 – 3.39	Above Average
2.20 – 2.79	Average
1.60 – 2.19	Below Average
1.00 – 1.59	Very Poor

Data Analysis

Shapiro-Wilk test was used to test the normality of distribution of the respondents for the SPS scores of both the experimental and control groups. Tests revealed a *p*-value lower than the set alpha level at 0.05 ($p_{value} < \alpha_{0.05}$), indicating a skewed population. This means that the scores of the sample significantly deviate from the normal distribution, hence the use of alternative non-parametric tests to check on the significant difference between the control and experimental group. Mann-Whitney U-test was used to compare the scores of the experimental and control group. All tests were done at the 0.05 level of significance, and rejection was observed when the *p*-value is lower than the set level of significance.

Ethical Issues

Ethical measures were observed in the course of data collection. The researcher had a moral obligation to strictly consider the participants' rights who will be providing the knowledge of the study to be conducted (Streuber-Speziale & Carpenter, 2003).

A. Consent

Consent letters were sent to the parents of the students before the gathering of data. This informed them regarding the nature of the study and how much their involvement will be in the current study.

B. Confidentiality and Anonymity

Confidentiality means that no information that the participant divulges is made public or available to others for their consumption (Wiles, Crow, Heath & Charles, 2006). The anonymity of a person is protected by making it impossible to link aspects of data to a specific person. Confidentiality and anonymity were guaranteed by ensuring that data obtained were used in such a way that no other researchers nor readers know the source of the scores and other vital data that were provided. In this study, codes were used to properly arrange the scores that were obtained from the respondents.

C. The right to withdraw from the study

In this study, participants were informed that they may opt to withdraw from the study at any time if they wished to. This was done prior to their involvement or engagement in the study, before the experimentation proper (Oates, Kwiatkowski & Coulthard, 2009). This right was included in the consent letter that was sent to the chosen respondents.

D. Dissemination of Results

Results will be disseminated in the form of a report. This report will not expose the scores nor the weaknesses of the respondents but may recommend the implementation of the appropriate approach in improving their science process skills competence level.

The respondents were informed that the study may be submitted for possible publication in relevant journals in science education.

Results and Discussions

This part presents the gathered data, their analyses and interpretation. The results with their respective discussions are presented in two main parts. Part I concerns the Science Process Skills (SPS) level of Grade 7 Science, Technology, and Engineering (STE) students while part II describes the significant differences of these levels according to the learning approach applied to the groups.

Science Process Skills (SPS) Level of Grade 7 STE Students

The discussions that follow present the level of science process skills (SPS) of grade 7 STE students in terms of the key domains necessary for understanding their overall process skills.

Table 3. shows the mean of the 11 domains of science process skills distributed according to the approach given in teaching research. An overall average of 2.8636 was reported and is interpreted as above average. This means that Grade 7 students of Baguio City National Science High School have acquired enough skills to design and carry out experiments or in everyday life to find answers to questions. Furthermore, they use these skills that are used in daily lives to figure out everyday questions.

This implies that students require more training in terms of honing the skills that they will be using in orchestrating scientific investigations although sufficient skills have been acquired to perform scientific inquiry. Educations' emphasis on developing these skills to the Science, Technology, and Engineering (STE) students is important as it prepares the students into becoming future science and mathematics professionals, and by doing so, these science process skills should be taken as highly important. According to Zorlu and Zorlu (2017),
"because science process skills involve cognitive, intellectual, manual and social skills used to solve problems encountered in daily life that they are regarded as a tool which enables individuals to get the most out of their knowledge."

Table 3. Science Process Skills (SPS) Level of Grade 7 STE Students

SPS Domains	Control	Experimental
	x	x
1. Defining and Identifying Variables	2.5484	3.0161
2. Formulation of Scientific Question	2.7581	3.2419
3. Designing of Experiment	2.4677	2.8871
4. Communication of Scientific Procedure	2.3387	2.8065
5. Collection of Data	2.9194	2.9677
6. Organization of Data	2.5000	2.8871
7. Creation of Visual Representation	2.7258	3.3871
8. Analysis of Data	2.7903	3.0323
9. Conclusion/Problem Solving	3.2903	3.4516
10. Use of Models to Explain Results	2.5484	2.6935
11. Use of Nominal Scientific Knowledge to Communicate Results	2.8710	2.8710
Overall	**2.7053**	**3.0220**
Overall (for both groups)	**2.8636**	

Legend:

Range	***Interpretation***
3.40 – 4.00	*Excellent*
2.80 – 3.39	*Above Average*
2.20 – 2.79	*Average*
1.60 – 2.19	*Below Average*
1.00 – 1.59	*Very Poor*

Gultepe (2016) emphasized that one of the fundamental skills that science curricula should aim for the students to achieve is science process skills. Harlen (1999) cited by Gultepe (2016) underscored that the attainment of these skills is one of the most important goals of science education as these are the sets of skills used not only by science, and mathematics professionals but also by everyone, as they aim to be scientifically-literate. Students of science high schools have been cultivated by scientific literacy and science process skills through research classes. These two skills are hoped to develop the skills needed by students in the 21st century (Turiman, Omar, Daud and Osman, 2011). Hence, when scientific literacy and science process skills are considered by teachers and the curriculum to develop amongst science, technology, and engineering (STE) students, students will be guided with their career choices in the science and mathematics profession via the STE/STEM education.

It is also reported in the table that conclusion/problem solving was highest in both groups. This integrated science process skill is, without a doubt, the most important part of any scientific investigation as this part accomplishes the very goal of a scientific inquiry, i.e. to answer the question. This means the students have skills that allow them to take this final step in the scientific method. They have the skills to craft a conclusion as this gives a precise and direct answer to the very objectives of the study, emphasize the shortcomings of the research, and give suggestions for future study. Problem-solving, as another facet of this domain, has been found above-average alongside concluding skills. Many students of BCNSHS find the necessity to develop this skill as this skill provide them with the ability to look at situations from different points of perspective using critical and metacognitive skills.

This finding concurs with the study of Molefe, Stears, and Hobden (2016) which found that problem solving/critical thinking and interpreting (graphs and tables) have the highest overall ranking of SPS in terms of importance as perceived by the student teachers of South African teacher education institutions. Problem-solving particularly requires the development of critical thinking, both as part of life skills and as a concept of science education is enshrined by the Philippine education curricula. It is therefore justifiable that both kinds of research find problem-solving/conclusion as most important and hence highly developed amongst students. Problem-solving and concluding is a decision-making process that requires metacognition and critical thinking. Warnich and Meyer (2013) as cited by Molefe, Stears, and Hobden (2016) discussed that problem solving and critical thinking were ranked very highly for students "personal acquisition". When one has fully attained this science process skill, one does not only see a situation from a multitude of points of view but can think about an action plan and, in turn, determine the effectiveness of this set of actions in the resolution of the determined problem.

Designing of the experiment, and communication of scientific procedure were found to be least attained by students in the control group. This means students have not fully achieved the necessary skills on how to design an experiment in the sense that how the observations or measurements should be obtained to answer a query in a valid, efficient, and economical way. Furthermore, their inability to communicate this design is revealed to have not been completely attained as reported from the table.

Designing the experiment and communicating its layout, along with the plan for data analysis, are inseparable skills that students must develop to give comprehensive inferences of observations and measurements obtained from the experiment. According to Shalabh (n.d.), an experiment that is properly designed while taking note of the question will yield valid data, and its proper analysis will provide valid statistical inferences. Hanson (n.d.) further emphasized that a "carefully" designed experiment will allow researchers to infer causation. Planning an experiment properly, indeed, is very important to ensure that the right type of data and sufficient sample size and power are available to answer the research questions of interest as clearly and efficiently as possible.

Likewise, science communication should be highly underscored as well. According to Mojer (2015), "science communication is part of a scientist's everyday life. Scientists must give talks, write papers and proposals, communicate with a variety of audiences, and educate others". It can be inferred therefore that in order to be successful, scientists and researchers, alike, should learn how to communicate not only their statistical inferences and implication from their conducted experiment but as early as during the proposal of their intended experimentation. Effective communication is a prerequisite skill to becoming a successful scientist. Mojer (2015) further asserts that "when scientists communicate more effectively, science thrives". The increasing development of science as it becomes more interdisciplinary requires its ability to be communicated across related disciplines that promote innovation and development.

On the other hand, the use of models to explain results was found to have rated very low in both groups. In science, a model is

> …representation of an idea, an object or even a process or a system that is used to describe and explain phenomena that cannot be experienced directly. Models are central to what scientists do, both in their research as well as when communicating their explanations. (Science Learning Hub, 2011)

This means students of BCNSHS have not fully developed their skills in coming up with a model generated from the data and results/findings of their conducted experiment. This may be due to the fact that developing models is one of the hardest skills to attain. According to CPD for teachers (2018), scientific theories and models are only valid as long as they can explain all of the available data, i.e. from both observations and measurements. Therefore, the strengths and limitations of the model must be evaluated as new data are obtained.

Scientists will often test out theories by carefully designing and carrying out experiments. If new data appear that do not fit the theory, then the theory may need to be modified and updated. It will then have to be tested out again to confirm the result. The data collected must be both repeatable and reliable. Sometimes it takes a while for other scientists to accept these new models. This implies, therefore, the need for teachers to improve their strategy in increasing the ability of the students to generate a model out of their data to explain the answers to the objective of their study as this does not only pertains to yield to a model that can easily be modified, but a model that is can be used to explain a phenomenon, and be adept to changes when modifications are necessary.

The difference in the SPS Level between Experimental and Control Group

The following discussions display the difference in the levels of the integrated science process skills (SPS) between the experimental, who was given the personality-based learning approach, and the control group, with the conventional learning approach, along with the specific domains.

Table 4. presents the associated *p*-values in the assessment of the significance of the differences in the science process skills (SPS) levels of the 11 specific domains between the experimental and control group using the Mann-Whitney U test of significance.

Mann-Whitney U test of significance reveals that six (6) domains, namely, “use of scientific knowledge”, “formulation of scientific question”, “designing of experiment”, “communication of scientific procedure”, “creation of visual representation”, and “organization of data” have *p*-values lower than the alpha level set at 0.05 ($p_{value} < \alpha_{0.05}$). This rejects the null hypothesis which states that there is no significant difference between the experimental and control groups along with these six domains of the integrated science process skills (SPS). This indicates that in these domains, the experimental group who was given the personality-based learning approach have significantly improved these skills as compared to their counterpart in the control group which were given a conventional learning approach.

Table 4. Associated p-values in the Assessment of the Significance of the Differences in the Science Process Skills (SPS) Levels of the following Domains between Experimental and Control Group

SPS Domains	*p*-value	Decision
Use of Scientific Knowledge	<0.001**	**Significant**
Formulation of Scientific Question	<0.001**	**Significant**
Designing of Experiment	0.002**	**Significant**
Communication of Scientific Procedure	<0.001**	**Significant**
Collection of Data	0.636	Not Significant
Creation of Visual Representation	<0.001**	**Significant**
Organization of Data	0.003**	**Significant**
Analysis of Data	0.059	Not Significant
Use of Nominal Scientific Knowledge to Communicate Results	0.977	Not Significant
Use of Models to Explain Results	0.271	Not Significant
Use of Results to Answer Question	0.189	Not Significant

*** significant at 0.01 level*

This implies that along with these domains, students when grouped according to their personality can improve significantly these skills to become researchers or students capable of scientific inquiry. It is more effective that students are dichotomized as to introversion and extroversion and that activities are specific to these personality styles. It should be remembered that introversion received activities which are basically self-learning or autonomous learning while those classified as extroversion were given with collaborative learning activities.

This gives a substantiation with the previous study conducted by the researcher that correlation exists between the personality styles of the students and their academic performance (Dacumos, 2015). While the former study correlates the cognitive aspect of learning science, i.e. their academic performance in science, the former study proves that considering the personality styles, as an additional consideration to holistically address the unique needs of the students, is likewise important in enhancing the skills of the students especially in the field of scientific inquiry and investigation. Furthermore, this proves that considering personality styles is as important as considering learning styles, and cognitive types of the students in planning for instructional strategies.

It is thus important for teachers to consider this facet of the learners to properly assist their individualized needs. According to Kennedy and Herring (2016), "information concerning the influence of personality on learning and teaching styles is important for industrial/organizational training programs just as it is in the educational classroom". Many kinds of research have already proved that people have an innate personality, unchangeable by time. Therefore, when information regarding personality styles is considered, this facilitates teachers and educators to properly and determinedly select the necessary type in approaching different situations such as selecting the proper educational teaching strategy that they will incorporate in their classroom instruction.

Differentiated instruction is thus an important key towards the achievement of such science process skills. Tucker (2011) defines this as "the practice of modifying and adapting instruction, materials, content, student projects and products, and assessment to meet the learning needs of individual students". It is earlier cited that differentiated instruction excites the brilliant student to uncover deeper layers of learning, while simultaneously structuring curriculum to support lower-level students or students with learning disabilities- both identified and unidentified, in turn, increasing their ability to master their science process skills.

It can be deduced further that these learners have a significant increase in the science process skills along the "proposal part" of the science process skill, i.e. to use scientific knowledge, to formulate the question, and to design and communicate scientific experiment procedure. This part of research is best highlighted as research proposals are "informative and persuasive writing because they attempt to convince the reader to do something. The goal of the student is not only to persuade the reader to do what is being requested but also to make the reader believe that the solution is practical and appropriate." (Zouaoui, n.d.). This study successfully increased the skills of the students in terms of identifying the problem and planning for an experimental design to give resolution to this cited problem. The personality-based approach (PBA) is effective in improving the said skills of the students of Baguio City National Science High School.

To highlight, taking into consideration other facets of students is important in order to yield better performance. Ciorbea and Pasarica (2013) discussed that personality is now an important consideration that affects students' academic performance. Performance of the students in science enhances when activities are specific to their type of personality, i.e. one who is introverted gets an activity that is geared towards autonomous learning while extroverted students perform better in collaborative activities.

Research further shows that when comparing the other science process skills, namely, "collection of data", "analysis of data", "use of nominal scientific knowledge to communicate results", "use of models to explain results", and "use of results to answer the question" have *p*-values which are higher than the alpha level set at 0.05 using the Mann-Whitney U test ($p_{value} < \alpha_{0.05}$). This entails that the study failed to reject the null hypothesis which states that there is no significant difference in the SPS level between the experimental group and control group along these domains. This means that the personality-based approach (PBA) did not increase the SPS level of the students. Hence, the need to either improve the implementation of the said approach to better these science process skills.

While intelligence is proven to predict the academic performance of students. However, a multitude of studies shows the need to look at other non-cognitive factors that are responsible for this performance. This study successfully surfaced the importance of considering personality as a facet towards holistically addressing the individual needs of students.

Conclusions and Recommendations

Summary of Findings

Based on the findings, the following are therefore concluded: Individually, the experimental group who was given the personality-based approach (PBA) performed high with their science process skills while the control group which was given with the conventional approach have typical science process skill level.

When compared, the experimental group have better performance in the skills where students are to prepare research proposals than their counterpart in the control group. However, in terms of the experimentation process down to creating models, the two groups do not differ.

Recommendations

The researcher recommends the use of a personality-based approach (PBA) in classroom instruction in teaching the integrated science process skills to the STE students. Improvements on its implementation are recommended to be considered to address other domains of the science process skills especially in the experimentation part down to coming up with a model to answer the objectives of the research being advanced. Since this learning approach is found efficient in catering for the unique needs of learners, personality styles can be emphasized more in the curriculum. Lastly, a meta-analysis study can be conducted to investigate why some of the domains were not significantly increased by the proposed personality-based approach (PBA).

As an offshoot of the general findings of the present study, a learner's material called Personality Style-based Learner's Module (PSBLM) to differentiate research activities for the two personalities – introversion and extroversion was formulated, and in turn, improving the proficiency of Grade 7 students in Research 1. Previous research tells a correlation between the academic performance of the learners in Science and their type of personality, this suggests a differentiated approach in their way of understanding concepts. Introversion, being the quiet ones, prefer a type of autonomous learning while extroversion prefers interactive activities.

This module covers Science topics from the first quarter to fourth quarter for Grade 7 Research specifically on the students integrated science process skills. The module consists of differentiated formative activities aimed to provide the two types of learners (introversion and extroversion) specialized activities that will aid their understanding of the various Science and Research concepts. It should be remembered, however, that introversion-extroversion is a continuum and not a dichotomy. The aim of the module is not to totally divide the class according to their type of personality. One cannot simply dichotomize the class in half and put the introverts into a quiet setting and the extroverts into a more stimulating setting. Introduction to the concepts and summative assessments will still be unanimous for these two since the goal of the current study is to improve students' science process skills, and in effect improve their performance in a scientific investigation.

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