ENHANCING SINOS AND SBPaLP USING STS APPROACH IN TEACHING ROTATIONAL AND CIRCULAR MOTION

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ABSTRACT
Researches in Physics education have identified students’ attitudes and beliefs as contributors to higher gains in learning (Mistades, 2011). Educators must therefore rethink the goals for Science instruction such that both students and those who teach Science must focus on the NOS itself—rather than its facts and principles (McComas, 1998). This study investigates the efficacy of using the STS approach in teaching rotational and circular motion in enhancing SINOS and SBPaLP. Senior high school students belonging to an intact class were the participants of the study. The study utilized the following instruments to gather data pertinent to the main problem: SINOS and CLASS questionnaires, structured interviews, reflection logs, and implementing teacher’s daily journal entries. Analyses of the data gathered involved the use of the SINOS constructs adapted from Chen, et.al (2013) and Attitudes towards Science constructs adapted from Adams, et.al (2004). The results reveal that students have enhanced ideas about the nature of Science as manifested in the significant improvements in how they view the Theory-ladenness NOS and scientists. Students were also able to identify intelligence, passion, hardwork, and patience as other characteristics of scientists. Furthermore, the use of the STS approach is strongly associated with how students established real-world connections and personal interest in physics and learning physics evidenced by the students’ array of Expert-like views. The significant enhancement and improvement of SINOS and SBPaLP reveal the efficacy of using the STS approach in teaching rotational and circular motion.

Field of Research: Science education; attitudes towards science; learning physics

1. Introduction
Physics appears to be complicated for most students. The reason why high school students find Physics difficult is because, they have to deal with different representations such as experiments, formulas, calculations, graphs, and conceptual explanations at the same time (Angell, et. al, 2004). The students are faced with the difficult task of transforming the varied representations they encounter in Physics into something more relatable. Physics is often taught in a vague manner making it more difficult for the students to understand what is being taught (Adeymo, 2010). This perennial problem transcends through all levels in the educational system. Educational psychologists, like Albert Bandura and Robert Yager, argued that students’ views and attitudes about a course can greatly influence the understanding and learning of that particular course. According to Mistades (2011), research in Physics education has identified students’ attitudes and beliefs as contributors to higher gains in learning. Given this, if the students’ belief in Physics continue to appear in such ways that it’s hard, difficult and complicated, this kind of point of view will have its drawbacks with regards to the learning of the students. This will also have an effect in determining the success of the students regarding the subject matter. Growing evidence suggests that students who possess positive attitudes toward science will perform better academically. Russell and Hollander (1975), who created the Biology Attitude Scale—a tool designed specifically to measure students’ attitudes toward Biology—support this claim. The important consequence of instruction is a positive change in the student's attitude toward the subject, and the importance of focusing on
attitudes by stating that there usually exists a positive correlation between attitudes and achievement (Russell & Hollander, 1975).

Looking in the Philippine setting, Physics education seems to show appalling classroom situations. A research conducted by Orleans (2007) suggested that some unfavorable implications hinder the effective Physics teaching in the Philippine secondary schools. The number of relatively large Physics classes implies that there must be at least two qualified physics teachers per high school, and that a considerably large collection of instructional materials is needed to effect meaningful student learning. This large number signifies that much burden is placed on the teacher to facilitate learning, and less teacher time is allotted to monitor student learning advancement. Despite this unfavorable condition, however, physics teachers do not receive necessary professional help from colleagues and science supervisors. Moreover, an inventory of instructional materials confirms that Philippine secondary school Physics teaching is textbook-based. This scenario implies that students are not exposed to varied modes of learning or classroom learning is not maximized. Classroom teaching is not supported by quality instructional materials because of their scarcity in the classrooms. Hence, learning effectiveness is dependent on teachers’ knowledge proficiency and teaching skills. Looking at this, one can say that the attitude of Filipino learners towards Physics is something that is manifested by the lack of motivation and other needless attitudes inside the classroom.

2. Students’ Attitudes and Beliefs towards Learning Physics

Teachers and students alike agree that lack of motivation and interest is predicament to learning Physics (Haugan, et. al., 2008). Oakes and Lipton (2003) argue that student engagement and interest is sparked the moment they are allowed to pursue their innate drive to construct new meanings from the lessons taught and relate whatever they are learning to real-life contexts. As an effect, students pursue career options and programs that are more in line with their passion and interests. It is thereby imperative to look into means of motivating and inspiring students to take a personal interest in learning Physics. Students often have questions lingering such as “When am I ever going to use this?” or “How is this even relevant to real life?” However, some teachers ineffectively address these queries resulting to students’ disinterest. Teachers are faced with the difficult task to answer these questions in the most straightforward manner such that students realize ‘why’ and ‘how’ concepts in Physics pose relevance to real-life (Steven, 2009). According to Mistades (2011), research in Physics education has identified students’ attitudes and beliefs as contributors to higher gains in learning. Students’ beliefs and expectations play an important role during the course duration of the subject matter. When coming to the Physics classroom, students bring their attitudes, beliefs and assumptions about what will be taught, what skills will be required and what they will be expected to do (Redish, Saul, & Steinberg, 1998). A study conducted by Perkins et al. (2004) further suggested that students who come into a Physics course with more favourable beliefs are more likely to achieve higher learning gains. Accordingly, students’ beliefs can be a powerful predictor of the future action they will take. Bandura (1997) argued that the role of self-efficacy – the belief in one’s ability to perform – is that “people’s level of motivation, affective states, and actions are based more on what they believe than on what is objectively true” (Hoff & Mitchell, 2006). This statement of Bandura with regards to self-efficacy is supported by Çapri (2013). According to the results gathered, self-efficacy beliefs both in solving Physics problems and in learning Physics –coupled with feeling of efficacy and having positive attitudes towards the lesson— can be said to be effective for the success of university students in Physics lessons. This positive effect brought by the student’s self-efficacy beliefs in learning Physics includes lesser exposure to subject burnouts, which affects their academic success in Physics lessons positively.

Bajah (1998) explained that the position and negative attitudes of students themselves have been suggested as a contributory factor to misconceptions. If students have negative attitudes towards Science, they also do not like Physics courses and Physics teachers (Olusola and Rotimi, 2012).
According to educational psychologists, the attitude of the student plays an important role in his systematic and scientific training (Sharma and Trivedi, 2013). Negative attitude towards Physics lessons draw low rate of interest, expectation and success in Physics lessons (Böyük & Kaya, 2010). Moreover, Physics lessons being held in the classroom on the sole theoretical basis is one of the factors that influence attitude of the students toward these lessons in a negative manner. The author suggested that physical topics consisting of abstract concepts should be lectured in the students’ daily life, together with simulations, animations and other videos to keep the attention of the students alive. This is supported by a study which suggests that using new methods or strategies in teaching Science or Physics increases the attitude of the students (Abdulkarim & Raburu, 2013).

3. Learning About the Nature of Science

Many people view science as a body of rigid and unchangeable facts (O'Neill, 2011). The more serious problem is, science is ‘taught’ to students in this manner. Misconceptions concerning the nature of Science (NOS) are prevalent among high school and college students, and even among teacher (Lederman, 2007). Typically, NOS refers to the Epistemology and Sociology of Science, Science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development (Lederman, 1992). Moreover, Lederman and Zeidler (1987) defined NOS as the values and assumptions inherent to the development of scientific knowledge. The development of an adequate understanding of the nature of Science continues to be convincingly advocated as a desired outcome of Science instruction (American Association for the Advancement of Science, 1989; Hazen & Trefil, 1991; Rutherford Ahlgren, 1990).

It is important for students to develop an understanding of the enterprise of science as a whole—the wondering, investigating, questioning, data collecting and analyzing (NGSS, 2013). O'Neill (2011) explained that the process of questioning and critically examining our views and practices, testing them, and rejecting or revising them accordingly actually yields improvement. Moreover, changing our views in light of new information isn’t a sign of weakness or cause for embarrassment. He argued that it is because of this changed in our views that we have more advanced technologies than we had in the past. The process of critically examining and changing our views and positions lies at the heart of human progress (O'Neill, 2011).

McComas (1998) suggested that educators must rethink the goals for Science instruction. He argued that both students and those who teach Science must focus on the nature of Science itself—rather than just its facts and principles. Furthermore, school Science must give students an opportunity to experience Science and its processes, free of the legends, misconceptions and idealizations inherent in the myths about the nature of the scientific enterprise. “Only by clearing away the mist of half-truths and revealing Science in its full light, with knowledge of both its strengths and limitations, will all learners appreciate the true pageant of Science and be able to judge fairly its processes and products” (p. 16).

4. Science, Technology, and Society (STS) as an Approach to Teaching Science

The National Science Teachers Association (2006), defines STS as the “teaching and learning of Science and technology in the context of human experience”. This reveals that STS is a prima as an approach to teaching and learning—opposed to a curriculum framework (Akcay & Yager, 2008). Inclusion of STS in teaching science is perceived to elicit more encouragement coming from the students. First is, students are encourage to demonstrate a more socially contextualized image of scientific knowledge. Second, students are able to make a careful study of the problematic associated in their construction, which will aid in better understanding the role of Science and technology, and the scientist. Third, students’ engagement in finding the solution of serious problems which mortgage the future of humanity, the destruction of the natural environment, polarization of rich and poor populations, diseases, nuclear arms, etc. Lastly, students are encourage
to succeed in transforming the teaching of Sciences into a fundamental element of our culture, in order to train critical and responsible citizens (Gagliardi and Giordan, 1986; Hlebbowist and Hudson, 1991 as cited by Akcay and Yager, 2008), not only for their professional efficiency, but also so that they can actively participate in social matters, contributing in this way to give meaning to studies made and favoring interest and positive attitudes. The nine essential features of the STS approach to teaching middle school Science are summarized in Figure 1 below.

<table>
<thead>
<tr>
<th>Nine Essential Features of the STS approach</th>
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<tbody>
<tr>
<td>1. Student identification of problems with local interest and impact</td>
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<td>2. The use of local resources (both human and material) to locate information that can be used in problem resolution</td>
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<td>3. The active involvement of students in seeking information that can be applied to solve real-life problems</td>
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<td>4. The extension of learning beyond the class period, the classroom, and the school</td>
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<tr>
<td>5. A view that Science content is more than concepts that exist for students to master for tests</td>
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<tr>
<td>6. An emphasis upon process skills that students can use in their own problem resolution</td>
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<tr>
<td>7. An emphasis upon career awareness—especially careers related to Science and technology</td>
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<tr>
<td>8. Identification of ways that Science and technology are likely to impact the future</td>
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<tr>
<td>9. Student autonomy in the learning process as individual issues are identified and approached</td>
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*Figure 1. The Nine Essential Features of the STS approach (Akcay and Yager, 2008).*

Yager (1991) and Brooks & Brooks (1999) explained that the STS effort is based on Constructivist Learning Theory that emphasizes learners’ prior knowledge and their own previous interpretations of nature. Moreover, Constructivist teaching requires a learner-oriented environment where the teacher acts as a guide and co-learner. STS uses the Constructivist perspective for learning and knowing where the emphasis is on current issues, local situations, and personal relevance. Furthermore, the issue-oriented STS approach significantly deemed to be more positive with regards to student’s attitudes concerning Science. The usual decrease in attitude following school study of Science as reported in several studies (Hueftle, Rakow, & Welch, 1983; National Assessment of Educational Progress, 1977; Yager, 1996) did not occur when students were involved with issues, which characterize the STS approach. In fact, the attitudes were significantly more positive than they were initially.

Akcay and Yager (2008) determined whether Science, Technology, and Society (STS) learning increases student concept mastery, general Science achievement, use of concepts in new situations, and attitudes toward Science in middle school classrooms—particularly in Chemistry and Physics. In another study by Akcay and Yager (2008), student learning outcomes in middle school Science classes were compared using STS approach and a typical textbook dominated approach. The study determined whether Science, Technology, and Society (STS) learning increases student concept mastery, general Science achievement, use of concepts in new situations, and attitudes toward Science in middle school classrooms—particularly in Chemistry and Physics. It was found that in general, students tend to be unfamiliar with the mutual relationships between Science, technology and the natural and social environments—in which they are immerse. This finding is parallel with that of Schibeci, (1986), Aikenhead, (1987 and 1988), Boyer and Tiberghien (1989) and Ryan (1990). More so, the absence of treatment of the STS relationships in the textbooks contributes to the decontextualized vision of Science that the students have. By making a detailed examination of the STS interactions in the Science classes, Akcay and Yager noted that the students were able to develop a more complete and contextualized image of Physics and Chemistry, as well as an increase of interest towards their study. In their data analysis, they found out that the students who didn’t take a course, in which the STS activities were established throughout the topics, weren’t capable of making a critical evaluation. The said students were asked to critically analyse the role played by
Physics or chemistry in the lives of men and women. The answers these students yield showed confusion in the majority of Science cases presented to them. Students in the STS section of middle school Science were notably more successful in generating ideas for use of Science concepts in new situations; using creativity skills, including questioning, proposing possible explanations; devising tests for the validity of the explanations generated; using community resources; conversing about Science at home and; taking actions in the community as a result of Science study.

The treatment of the STS interactions contributes to the improvement of the image of Science (Solbes and Vilches, 1997). It [STS] increases the interest of the students in the subject not only by its motivating character, but also overall because it helps to show a more contextualized image of the Science disciplines. The inclusion of STS interactions during instruction deem to be important in the forming of future citizens of a society that is penetrated more and more by science and technology. This later on cascades to the adoption of a responsible attitude founded in pressing scientific and technological development.

5. Theoretical Framework

![Figure 2. Theoretical framework of the study.](image)

The study focused on enhancing SINOS and SBPaLP using the STS approach in teaching rotational and circular motion. More specifically, the study examines the following questions:

1) What are the prior SINOS and views of physics and learning physics?
2) What are the changes (if any) in SINOS and SBPaLP after using the STS approach in teaching rotational and circular motion?

6. Methodology

6.1 Sample and data collection method

The participants of the research were forty-five (45) Fourth Year students enrolled at a laboratory school. Data were gathered through observation and journal logs, evaluations, survey questions, and one-on-one interviews. The study was conducted in a period of three (3) weeks. Before the use of the STS approach in teaching, the researcher assessed prior SINOS and SBPaLP using the SINOS and CLASS questionnaires respectively. Also, the students were interviewed to obtain qualitative responses. During the implementation of the lesson using the STS approach, the implementing teacher kept a daily journal to record significant highlights of the day’s session. On the other hand, the cooperating teacher accomplished observation logs to examine how SBPaLP developed/enhanced during the conduct of the lesson. At the end of the lesson, the students were again made to answer the SINOS and CLASS questionnaires. In addition, reflection logs were given to students to obtain qualitative data pertinent to post-intervention SINOS and SBPaLP.

This study made use of a mixed-method research design. With this, both quantitative and qualitative data were obtained. Qualitative data as evident in the students’ responses in the SINOS and CLASS questionnaires were analysed using descriptive statistics. Also, Adams, et. al (2004) proposed a manner by which students’ responses could be coded as Expert-like or Novice-like. An Excel scoring sheet for CLASS, which is provided together with the survey, was utilized in data analysis. The results of the quantitative analyses were triangulated with qualitative data obtained from interviews and reflection logs. In addition, empirical analysis of the qualitative data was enriched using the implementing teacher’s daily journal and the cooperating teacher’s observation logs.
6.2 Instrumentation
Assessment of Students’ Ideas about the Nature of Science (SINOS) was done using pre-posttest of SINOS Questionnaire adopted from Chen, et. al (2013). On the other hand, Students’ Beliefs on Physics and Learning Physics (SBPaLP) was described using the Colorado Learning Attitudes towards Science Survey (CLASS) Questionnaire adopted from Adams, et. al (2004). Structured interviews, reflection logs, cooperating teacher’s observation logs, and implementing teacher’s daily journal entries were used to further enrich data analysis.

7. Findings & Discussion
7.1 Students’ Ideas about the Nature of Science (SINOS) – Science and Scientists
The researchers selected four from the seven constructs described by Chen, et. al. (2013) to interpret qualitative data obtained from structured interviews, reflection logs, and daily journaling of the implementing teacher. These constructs include: (1) Theory-ladenness; (2) Tentativeness; (3) Durability; and (4) Coherence and Objectivity. The aforementioned guided the reporting and interpretation results and discussion of implications on how students perceive the nature of Science.

Structured interviews were conducted to gauge the students’ initial ideas about the nature of science prior to integration of STS approach in teaching the concept of rotational and circular motion. Analyses of the interview transcripts reveal that Theory-ladenness and Durability were the most recurring themes from students’ responses. Both constructs were found to be 62.22% present in the responses made by the students. On the other hand, Coherence and Objectivity and Tentativeness have recorded 48.89% and 44.44% frequencies respectively. The abovementioned findings suggest that students evidenced pre-existing notions about the nature of science more specifically on the constructs of Theory-ladenness and Durability. With these, it could be said that the students have existing views that Science is a systemized body of knowledge that are drawn from the observations and evidences gathered. Prior to the use of the STS approach in teaching, students were [already] familiar with the scientific method.

Table 1 reflects the ratings of the students in the SINOS questionnaire after using the STS approach in teaching rotational and circular motion. It could be gleaned in Table 1 that the students had mostly positive ratings pertinent to all constructs. The construct of Durability had the highest student ratings while the construct of Coherence and Objectivity had the lowest ratings.

<table>
<thead>
<tr>
<th>CONSTRUCTS</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory-ladenness</td>
<td>Positive</td>
</tr>
<tr>
<td>Durability</td>
<td>Positive – Highly Positive</td>
</tr>
<tr>
<td>Coherence and Objectivity</td>
<td>Slightly negative – Neutral – Positive</td>
</tr>
<tr>
<td>Tentativeness</td>
<td>Positive</td>
</tr>
<tr>
<td>Creativity and Imagination</td>
<td>Positive</td>
</tr>
<tr>
<td>Science for Boys</td>
<td>Positive</td>
</tr>
<tr>
<td>Science for Girls</td>
<td>Positive</td>
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</table>

Students’ responses in the SINOS questionnaire are consistent with the structured interviews and reflection logs. Students were able to provide meaningful descriptions of Science and scientists as shown in Table 2. The emerging themes in the students’ reflection logs pertinent to Science and scientists are hard work, passion, intelligence, and patience.

Table 2. Students ideas of science and scientists after the use of STS approach in class.
Students’ Ideas about Science
- Science is everywhere
- Science is way of life
- Science is ever changing
- Science is dynamic

Students’ Ideas about Scientists
- Scientists are creative
- Science and art can mix.
- There is no gender bias in science.
  Scientists can be either male or female.

7.2 Students’ Beliefs on Physics and Learning Physics

Prior to the use of the STS approach in the conduct of the lesson, interviews were done to find out how students view physics. The responses were analysed using the following constructs: 1) Real World Connection; 2) Personal Interest; 3) Conceptual Connection; 4) Applied Conceptual Understanding; 5) Problem Solving General; 6) Problem Solving Confidence; and 7) Problem Solving Sophistication. This study utilized the STS approach to build more positively influence students’ views on learning physics. Analyses of the qualitative data (structured interviews, reflection logs, daily journal of implementing teacher) made use of seven (7) constructs to describe how students view learning physics. These constructs include a) real-world connection; b) personal interest; c) sense making/effort; d) applied conceptual understanding; e) problem solving sophistication; f) problem solving confidence; and g) problem solving general.

Results of the analyses of the students’ responses in the interviews reveal that some students have naive conceptions about Physics and learning Physics. Despite the identified prior notion of real-world connection from among a few students, it is asserted that majority of the students (prior to the use of STS approach) predominantly have traditional notions and contexts of learning Physics. It could be deduced that students are still acquainted with the traditional lecture-discussion approach used by most of their teachers. It is worthy to note that some students were not very interested to participate such that an active approach to learning is something new for them. Personal Interest of the students will lead to the better understanding of the students because it will first hook the students’ interest on a specific topic. The studies and research carried out have shown the fact that students acknowledge the importance of natural Sciences for life and career but have also pointed out a significant drop in their interest in the study of these subjects (Stephan, 2010). Before using the STS approach, most students would say that they do not associate the things they experience outside of school with the things they have learned in Physics. But there are a few students who do relate Physics in the situation happening around them.

Table 3. Overview of students’ responses in the CLASS questionnaire.

<table>
<thead>
<tr>
<th>CONSTRUCTS</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Interest</td>
<td>3 items Expert-like</td>
</tr>
<tr>
<td>Real World Connection</td>
<td>Most items Expert-like</td>
</tr>
<tr>
<td>Problem Solving General</td>
<td>3 items Expert-like</td>
</tr>
<tr>
<td>Problem Solving Sophistication</td>
<td>1 item Expert-like</td>
</tr>
<tr>
<td>Conceptual Understanding</td>
<td>Expert and Novice</td>
</tr>
<tr>
<td>Applied Conceptual Understanding</td>
<td>Expert and Novice</td>
</tr>
<tr>
<td>Sense Making/Effort</td>
<td>3 items Expert-like</td>
</tr>
</tbody>
</table>

Overall, the results of the CLASS survey questionnaire seen in Table 3 shows consistency with the responses of students in the reflection logs summarized in Table 4 in terms of the most frequently occurring constructs and least recurring constructs. Also, the results of implementing teacher’s journal entries and observation log book enriched the discussion of the data gathered.

Table 4. Summary of students’ responses in the reflection logs.
Students’ ideas about Physics | Students’ ideas about learning Physics
---|---
- Highly relates to daily life. | - Learning physics is about establishing real-world connections
- It concerns different world phenomena | - “Fun and exciting”, “very interesting”, “really enjoyable”, “very amazing” and “worth the time”.
- It involves formulas and computations to better reflect concepts | - Learning physics is not all about memorizing and computations
- It is an elaborate explanation of things | |

As seen in Figure 3, the students’ engagement inside the classroom improved from the Day 1 until the last day of observation. It could be noticed that students’ engagement in diverse self-selected or self-paced activities and as well as that of engagement in science process skills had been the highest. On the other hand, students’ engagement in general classroom behaviors had the lowest rating at the end of the implementation. However, it could noticed that this construct still have shown significant improvement in student engagement from Day 1 to the last day of implementation. This finding is consistent with the positive results obtained from the CLASS survey questionnaire. The use of the STS approach may have influenced the positive views of students with respect to physics and learning physics. STS means starting with students, their questions, using resources available to work for their resolution, and wherever possible, advancing to the stage of taking actual actions individually and in groups to resolve actual issues. STS approach is expected to increase general interest and understanding of science. It is also expected to fill a critical void in the traditional curriculum (Harms and Yager, 1993).

![Figure 3](image)

**Figure 3.** Student Engagement Elicited from the Cooperating Teacher’s Observation Logs.

### 7.3 Implications

One important aspect of NOS is social and cultural embeddedness, which emphasizes the human aspects of Science, and the concept that Science is personally constructed and culturally bound explanations of the natural world (Stanley & Brickhouse, 1994). In addition, Chan and Tanner (2006) argue that student’s beliefs regarding Science are enforced early in their development. Although, these beliefs must be consistently persuaded in the classroom. As reflected in the interviews and reflection logs, most of cited personal experiences in different scientific encounters. This suggests that students have acquired and/or enhanced correct views on the nature of science. The pre-existing beliefs may have been positive influenced by the increased exposure to science using the STS approach to teaching.

Science educators have promoted a variety of justifications for teaching about the nature of Science. Matthews (1997) argued that the nature of Science is inherent to many critical issues in Science education. Others have related teaching about the nature of science to increased student interest (Lederman, 1999; Meyling, 1997), as well as developing awareness of the impacts of Science in
society (Driver, Leach, Millar, & Scott, 1996). The importance of knowing the nature of Science is one of the key to success in order for the students to make the best out of their Science courses. Teachers were hold responsible in molding these beliefs with regards to the nature of science—so they should also be knowledgeable about NOS. A change in classroom instruction is one of the proven ways to improve students’ conceptions about NOS. Hands-on activity in physics guided by Scientific-inquiry approach in teaching is deemed to be effective in order to correct wrong misconceptions about NOS. Moreover, this kind of intervention enhances the higher-order thinking skills of the students and as well as increasing the interest of the student in the subject matter.

Analysis of students’ ideas about scientists shows that STS approach implemented in the class may have enhanced students’ pre-existing ideas about scientists. This existing knowledge is mostly stereotypical and influenced by media, their parents, and the public (Chambers, 1983). They [students] also see pictures of scientists most of whom are all men, are all white, and have strange/weird behaviours. The strong correlation between attitude toward Science and achievement indicate little difference between girls and boys. Also, more positive attitudes are necessary for girls to enable them to achieve high scores (Weingburgh, 1995; Jarvis & Pell, 2005). Student-directed questions further serve to define problems, potential solutions, and actions need to resolve them. STS approach enables students to see/do Science in the same way that scientists do. This makes Science more meaningful, exciting, and appropriate for most students. The main goal of the STS approach is to achieve scientific literacy for all. It creates student-centered environments where students improve on their own ideas, raise questions, and undertake investigations. The STS approach starts with real world issues, and problems that related to students lives. (Yager, 2010).

Lastly, attitudes towards Science and scientists influence views of Science, future career awareness, and classroom participation. Students who have positive attitudes show increased attention to classroom instruction and participate more in Science activities (Germann, 1988; Jarvis & Pell, 2005).

Erinosho (2013) asserts that the perception of students of Physics as a difficult subject is the reason that students develop declining interest. Most of the students have shown disinterest in Physics and they tend to do other things during the period. Most of the negative statements from the students were about Physics being difficult because they feel overwhelmed when formulas are presented to them. Checkley (2005) implied that Physics requires educators to move away from the traditional pencil and paper method of instruction and towards engaging lessons. Borghi, De Ambrosis, Lamberti and Mascheretti (2005) described the “balance of hands on activity and traditional assessment is called teaching-learning sequence (TLS) and students learning Physics through TLS achieve a higher level of understanding compared to those who undergo traditional instruction” (p.271). With the implementation of a STS-integrated approach, the students became engaged during the activities and it piqued their interest. Each members of the group gave their inputs during planning and explaining. Erinosho (2013), expressed that by providing concrete and positive experiences and with the support of instructional strategies will enhance student interest and learning. The students changed their views about Physics based on the reflection logs after shifting the lessons from traditional to STS-integrated approach. Most of the statements from the interviews were mostly positive. This reveals changes in students’ beliefs after using the STS approach.

There are implications that arise from the study on how the students perceived Physics. First, the interest of students depends on how the lessons are presented to the class and what instructional strategies are used. Traditional type of instruction hinders the full understanding of the concept because it doesn’t engage the student. Students find it more meaningful if different activities in connection with the lessons are given to them. Second, the students see Physics as a difficult subject because the focus was more on the Mathematical aspect rather than the application and understanding part based on the qualitative data gathered from the interviews and reflection logs. The students tend to label Physics as a boring subject or as “another Math class”. Through the
implementation of STS-approach in teaching Physics, the students are given learning experiences that would be helpful in understanding it. STS education provides the students with a real-world connection between the classroom and society. It helps the students practise identifying potential problems, collect data with regard to the problem, consider alternative solutions and the consequences of a particular decision (Yager 1990).

The findings in the study are consistent with the works of Al-Mhi (1993), Al-Nemer (1991), Al-Rafi’i (1998), Bybee and Bonnstetter (1987), Chi Lun (1995), Fadhli (2000), Rhoton’s (1990), and Rubba (1989) which asserts the inclusion and implementation of STS in science curriculum. These studies indicate that the overall inclusion of STS issues and activities in Science curriculum was low, students need to understand STS, the major constraints in teaching the STS themes include lack of STS curricular materials and many scientific topics related to STS should be included in science curriculum. Students immersed in authentic learning activities cultivate the kinds of “portable skills” that newcomers to any discipline have the most difficulty acquiring on their own (Lombardi, 2007). Apparently, the STS approach provides more experiences with the application of concepts as a part of the regular classroom experiences and with the extension of science study and involvement with activities beyond the classroom and the textbook. Another advantage of the issue-oriented STS approach was the significantly more positive student attitudes concerning science. The STS approach seems to offer exciting possibilities for middle schools and teachers interested in the affective domain and the development of more positive attitudes about science. (Yager & Akcay, 2008).

8. Conclusion and Future Recommendation
The staple for 21st century Science education is aiming towards Science literacy, which can be achieved by Science instruction going beyond simply teaching science as a body of knowledge (Bell, 2009). An adequate understanding of nature of Science (NOS) is an important component of scientific literacy that has been widely agreed upon by scientists, science educators, and science education organizations (Abd-El-Khalick, Bell, & Lederman, 1998). Going beyond the traditional approach in Science instruction and implementing STS approach is one of the favourable interventions in developing students’ views on the nature of Science. The use of the STS approach in teaching rotational and circular motion to students elicited positive views on NOS, physics, and learning physics. This is evidenced by the positive student ratings in the SINOS and CLASS questionnaires as well as the responses of students in the reflection logs, cooperating teacher’s observation logs, and implementing teacher’s daily journal entries. Further researchers are recommended to look into examining beliefs and attitudes as other variables. Also, the comparison of SINOS across year levels can be looked into.

References


