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# Grade 10 Indian Students' Academic Performance and Leisure Interest in Science Under Laboratory-Based and Textbook-Based Methods

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## Abstract

**Purpose:** The purpose of this quantitative comparative study was to determine whether there was a significant difference in the gain in academic performance and leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India. **Research design, data and methodology:** The researchers implemented, during June 2022, a quasi-experimental research design, using two conveniently-chosen groups of Grade 10 students from the target school: a group of 35 students was taught using laboratory-based method, while a group of 37 students was taught using the textbook-based method. For the data collection, the Students' Leisure Interest in Science Questionnaire and a Science academic performance test were both administered as pre-tests and post-tests. **Results:** There was no significant difference in the gain in either academic performance in Science or leisure interest in Science between Grade 10 students learning under laboratory-based and textbook-based methods; however, participants' academic performance in Science was numerically higher for those learning through laboratory-based method. **Conclusions:** The results indicate that the teaching method under which Grade 10 Indian students from the target school were learning Science appears to have no significant effect on their gain in either academic performance or leisure interest in Science.
Keywords: Science Education, Academic Performance, Leisure Interest, Teaching Methods, India.

**JEL Classification Code**: C12, I20, I21, N35

## 1. Introduction[13][14]

Science is an important subject in one's educational life, because it generates solutions for everyday life and helps us to answer the great mysteries of the universe. Science helps students to develop an understanding of the world, grounded on current scientific theories and it also contains practical inquiry activities such as laboratories and experiments (Das et al., 2017). Science is also very important in education worldwide, and particularly in India, where many renowned science institutions are located. However, even though Science is introduced as a distinct discipline in the upper secondary stage in India, with an emphasis on experiments, technology, and investigative projects, only approximately 38% of Indian secondary schools have an adequate science laboratory (Rajput & Srivastava, 2005). Moreover, the mostly used learning methods for teaching science in India are the laboratory-based and textbook-based methods.

Oyedeji (2000) determined that students taught science under the laboratory-based method academically perform higher than of those taught under the textbook-based method. Laboratory activities have been designed and are conducted to engage students individually, in small groups and in large-group demonstration, in observation, counting, measuring, experimenting, recording, investigating, testing, analyzing, creating, and testing hypotheses. The laboratory-based method also has been found to influence goal-orientated behavior in students; hence the method is very

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effective in improving student academic achievement (Slavin, 1996). Çelik (2018) described the laboratory-based method as the implementation of series of activity-based learning activities and practical work with the purpose of improving students' academic performance and interest toward science activities.

The textbook-based method is a teacher-based learning approach that focuses on telling, memorizing and recalling information, through which learners might be involved mostly in note-taking (Haghighi et al., 2006). Textbook-based method does not use activity-based learning to motivate students to solve real-world problems using applicable knowledge, because the instructor controls the transmission and sharing of knowledge, trying to maximize information delivery while saving time and effort. In the textbook-based method, students learn by memorization and recitation, and hence do not build critical thinking, problem-solving, or decision-making skills, which results in a low academic performance (Haghighi et al., 2006). As a result, students' interest in science may decrease (Fraser, 1981).

Most of the Science teachers at St. Joseph High School, India, follow the textbook-based method, which is a teacher-centered one. Even though there are science laboratories in the school to perform experiments and practical science lessons, teachers mostly use the textbook-based method. This is in line with a report from the Indian National Science Academy (INSA, 2001), which states that the exploratory method of learning science (i.e., employing keen and careful observation, asking questions, challenging the answers, and making generalizations and discoveries) has not yet been adopted by the formal system of Indian science education. The textbook-based method is used highly throughout the school, which can be an issue in triggering students' academic performance and leisure interest in science (Fraser, 1981; Klopfer, 1971; Slavin, 1996). The laboratory-based method allows students to gather first-hand learning experience by performing various experiments on their own, which has been found to be very effective in improving students' academic performance (Slavin, 1996). Obanya (2014) stated that the average recall rate of learning by lecture-based approaches such as the textbook-based method is 5%, whereas that of practice by doing, such as the laboratory-based method, is approximately 75%. Moreover, the researchers have observed that Grade 10 students who learn science at St. Joseph High School, India, by performing experiments in laboratory seems to be more involved and engaged in science-related activities, which is an indicator or having a high level of interest in science (Fraser, 1981; Zandstra, 2012). Moreover, the researchers have also observed that Grade 10 students at the target school who learn science under the laboratory-based method seem to have a better Science academic performance than the one of those students who are learning science through the textbook-based method. This is in line with Yadav and Mishra (2013), who reported that students taught science by using laboratory-based method academically performed better than those who used the textbook-based method. Through the use of the laboratory-based method, learners are able to participate in the educational process through demonstrating by doing, as well as by collaborating, associating and contributing with peers, contrarily to the textbook-based method, and hence students' interest in science, cognitive skills, understanding of nature through science, curiosity, and problem-solving skills in science are improved, resulting in a better academic performance (Fallows & Ahmet, 1999; McGrath & MacEwan, 2011).

Another issue that is worth raising regarding Grade 10 students at the target school is their Science academic performance. The results revealed that, for the last five years, the mean academic performance in science was 70%, which is less than the 85% in Mathematics, and even lower than other subjects like English, Computer Science, and Social Science. The researchers believe that learning Science through a student-centered approach such as the laboratory-based method would make the science learning process more efficient and productive. Therefore, in order to compare students' academic performance and leisure interest in science under the two learning methods (i.e., laboratory-based method and textbook-based method), the current study was conducted on two conveniently-chosen Grade 10 classes at the target school in the Science program.

## 2. Research Objectives

The following were the specific research objectives addressed in this study.

5. To determine the levels of academic performance in Science of Grade 10 students before and after learni ng through laboratory-based method at St. Joseph H igh School, Barhalganj, India.
6. To determine levels of academic performance in Sci ence of Grade 10 students before and after learning t hrough textbook-based method at St. Joseph High S chool, Barhalganj, India.
7. To determine the levels of leisure interest in Science of Grade 10 students before and after learning throu

gh laboratory-based method at St. Joseph High School, Barhalganj, India.

8. To determine the levels of leisure of interest in Science of Grade 10 students before and after learning through textbook-based method at St. Joseph High School, Barhalganj, India.
9. To determine if there is a significant difference in the gain in academic performance in Science between Grade 10 students learning under laboratory-based method and those learning under textbook-based method at St. Joseph High School, Barhalganj, India.
10. To determine if there is a significant difference in the gain in leisure interest in Science between Grade 10 students learning under laboratory-based method and those learning under textbook- based method at St. Joseph High School, Barhalganj, India

## 3. Theoretical Framework

This study was carried out on the basis of three major theories: the behaviorist theory, the constructivist theory, and Klopfer's (1971) attitude to science scheme classification.

### 3.1 Behaviorist Theory

The behaviorist theory, also known as behaviorism, is concerned with observable changes in behavior caused by repetition and practice (Pandey, 2017). According to the behaviorist theory, learning happens when a proper response is demonstrated in response to the presentation of a specific environmental stimulus (Ertmer & Newby, 2013). The behaviorist method can still be used to memorize facts, recall steps, comprehend rules, and make generalizations (Ertmer & Newby, 2013).

### 3.2 Constructivist Theory

The constructivist theory is based on the assumption that, in order for learners to grasp and transfer knowledge effectively, the information must be presented in a way that allows them to interact with its real-world relevance and application. Constructivists believe that learning is a one-of-a-kind thing performed by a one-of-a-kind being (Booth, 2011). This means that teachers' lesson plans, teaching styles, and content would be adjusted to meet children's ability, developmental stage, or interest (Matthews, 2003).

### 3.3 Klopfer's (1971) Attitude to Science Scheme Classification

This theoretical classification is comprised of six major affective behaviors related to science education: manifestation of favorable attitudes toward science and scientists; acceptance of scientific inquiry as a way of thought; adoption of scientific attitudes; enjoyment of science learning experiences; development of interest in science and science-related activities; and development of interest in pursuing a career in science. Based on Klopfer's (1971) classification, Fraser (1981) devised the Test of Science-Related Attitudes (TOSRA) to measure secondary students' attitudes toward science and science-related issues. The TOSRA's subscale "leisure interest in science" belongs to the category of "development of interest in science and science-related activities" in Klopfer's (1971) classification.

## 4. Conceptual Framework

Figure 1 depicts the conceptual framework of the study. The Science teaching method (with two attributes: laboratory-based method and textbook-based method) served as the independent variable, while the participants' academic performance and the leisure interest in Science served as the dependent variables.

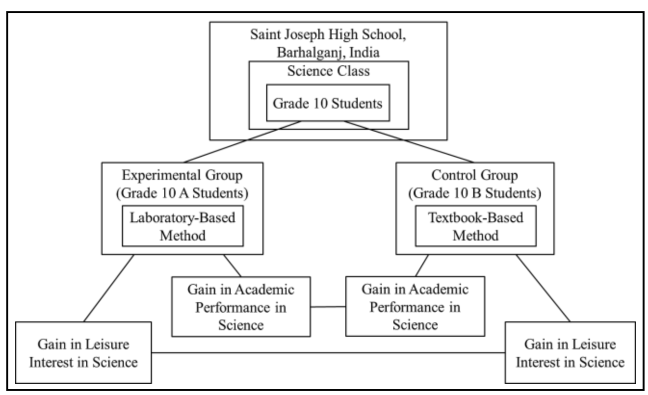


**Figure 1:** Conceptual Framework for the Current Study

## 5. Literature Review

In this section, some previous studies related to the research variables addressed in this study are reviewed and summarized.

Olubu (2015) conducted a study to determine the influence of laboratory learning environment on students' performance in secondary school. The study's population included all 690 Senior Secondary School III (SSS III) science students from all public secondary schools in Ondo State, Nigeria. From performing multiple regression to analyze the collected data, it was found that there was a significant relationship between the five dimensions of the laboratory learning environment and student performance. It was recommended that the government provide secondary schools with resources, teaching materials, models, equipment, and adequate laboratories for the teaching and learning of Science in order to improve teaching and learning.

Yadav and Mishra (2013) conducted a study to compare the effects of laboratory approach on the development of science process skills and academic achievement in university students. The sample for this study consisted of 81 university students enrolled in the General Physics Laboratory-I course at Devi Ahilya Vishwavidyalaya, a State university in Indore, India. A total of 43 students taking this course were chosen as the experimental group, while 38 students were chosen as the control group. From the data analysis, it was found that the achievement of students learning using the laboratory approach was significantly higher than the traditional approach.

Zandstra (2012) conducted a study to examine the impact of an informal science program on students' science knowledge and interest on the students enrolled in 14 different Grade 11 science classes in three high schools at Texas, United States, who participated in this project for six years. A sample of 122 Grade 11 students were administered a modified version of the Test of Science-Related Attitudes (TOSRA), in order to assess their scientific knowledge and interest in science. The findings revealed a weak but significant and positive correlation between students' attendance (in total number of hours) and science interest at program elements (i.e., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, communicating findings, mathematics workshops and summer camp) and their science knowledge. The participants' level of academic performance in Science was found to be very good, and their level of leisure interest in science was found to be moderate. Moreover, Grade 11 students who had higher attendance at the program elements were found to have a higher level of science interest than students with lower attendance. Leisure interest in science was found to be not significantly correlated to attendance at any of the program elements. However, science academic performance (knowledge) was found to be significantly, positively and weakly correlated to attendance at science-related program elements.

Darlington (2017) conducted a study to gain a deeper insight on students' interest in science. The study was conducted on 475 students, aged 14 to 16, in four secondary schools in England, who just began their General Certificate of Secondary Education (GCSE) studies. The participants were asked about what they thought the purpose of learning science was, how interested they were, and what they believed could pique their interest in science lessons The findings indicated that students in all schools agreed that learning from others and their perception of choice and control in learning increase their interest in science lessons, whereas students in all schools appeared to be ambivalent about the role of exploring science in increasing their science interest levels. Moreover, there was a significant, moderately strong and positive correlation between students' strength of agreement with being more interested if more effort is put into the lesson and their science interest level. Also, after administering the questionnaires, two classes were chosen for putting in place manageable interventions, focused on supporting the development of student interest in science, with practical work being a key component of science lessons enacted in the classroom. The quantitative data collected from students in Classes 1 and 2 showed that, even though there was a numerical increase in the students' overall level of interest in science for students in both classes, no significant impact on the students' interest in science was found as a result of the trialed interventions.

## 6. Methodology/Procedure

In this section, details on the study's population, sample and research instruments are provided.

### 6.1. Population and Sample

From the population, the researchers conveniently chose two Grade 10 classes: Grade 10 Class A (hereafter Grade 10 A), comprised of 35 students, and Grade 10 Class B (hereafter Grade 10 B), comprised of 37 students. These two classes were selected because the first author was teaching them Science at the target school by the time of conducting the study. Then, randomly, Grade 10 A was assigned to be the experimental group, while Grade 10 B was assigned to be the control group.

## 6.2. Research Instruments

This study was conducted based on the following research instruments: the Science academic performance test, and the Students' Leisure Interest in Science Questionnaire. Both instruments were administered as pre-test and post-test, in order to address this research's objectives and hypotheses.

### 6.2.1. Science Academic Performance Test

The researchers designed and administered the Science academic performance test to measure the level of academic performance in science held by the Grade 10 students at St. Joseph High School, Barhalganj, India, who participated in this study during the Term 2 of the academic year 2021-2022. This test was created to collect information on participants' academic performance in relation to the instructional content that was reinforced during the intervention period: Light-Reflection and Refraction, and Magnetic Effects and Electric Current. This content was included in Chapters 10 and 13 of the Grade 10 Science textbook used by the participants, developed by the National Council of Educational Research and Training (NCERT).

The Science academic performance test consisted of 30 questions organized into three sections: Sections A, B and C.

- Section A. Questions 1 to 15, which were either multiple choice questions, very short answer type questions, or assertion-reason type questions, worth 1 mark each. Answers to these questions should be given in one word, sentence, or choice.
- Section B. Questions 16 to 25 were short answer type questions, worth 2 marks each. Answers to these questions should not exceed 60 words.
- Section C. Questions 26 to 30, which were long answer type questions, worth 2.5 marks each. Answers should not exceed 90 words.

The scores from this test were interpreted as follows, using a continuum from 0 to 30: failure (0-14); satisfactory (15-19); good (20-23); very good (24-27); excellent (28-30).

Regarding the test content validity, it was reviewed and confirmed by the head of the Science department and three Science teachers from the target school, after the test was designed. All the reviewers had at least 10 years of experience in teaching Science at high school level in India.

Regarding the test reliability, the questions comprising the test were shuffled between the pre-test and post-test administrations, in order to minimize participant recall and avoid possible memorized answers. Also, the test questions had the same format and structure that the target school have been using for many years, so it can be assumed that this test structure is considered reliable by the target school.

### 6.2.2. Students' Leisure Interest in Science Questionnaire

The SLISQ had 10 items (see Appendix 1), adopted from the "Leisure Interest in Science" subscale of the Test of Science-Related Attitudes (TOSRA; Fraser, 1981). Five of the items were positively worded (i.e., Items 1, 3, 5, 7, and 9), and five were negatively worded (i.e., Items 2, 4, 6, 8, and 10). The students were asked to express their degree of agreement to each item statement using a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The mean scores obtained from averaging the Likert scale ratings of all items were interpreted using a continuum from 1.00 (very low leisure interest in science) to 5.00 (very high leisure interest in science).

Regarding the validity of this test, the "Leisure Interest in Science" subscale, as well as the remaining TOSRA subscales, were pilot tested and validated using samples of students at all four junior high school grades (Years 7-10) in Australia (Fraser, 1981).

Regarding the reliability of this test, a reliability analysis was carried out for it, and the SLISQ administrations before and after the intervention were found both to be reliable (see Table 1). The Cronbach's alphas reported by previous studies employing the "Leisure Interest in Science" subscale (Fraser, 1981) ranged from .83 (by Zandstra [2012], on a sample of 122 American Grade 11 students) to .89 (by Fraser [1981], on samples of Australian students from Year 7 to Year 10; see Table 1).

**Table 1:** Reliability Coefficients of the SLISQ, Reported by Previous Studies and the Current Study

| Previous study | | Current study | |
|---|---|---|---|
| **Fraser (1981)** | **Zandstra (2012)** | **Before the intervention** | **After the intervention** |
| .85 ~ .89 | .83 | .71 | .74 |

## 7. Research Findings

The research findings obtained from the data collection and analysis follows, presented by research objective. For the data analysis, negatively worded items were reverse coded, in order to average them with the positively worded ones, and maintain consistent scale direction for all items.

### 7.1. Findings From Research Objective 1

Regarding to Research Objective 1, the following findings were obtained.

- The overall level of Grade 10 students' academic pe rformance before learning through laboratory-based method was good, *M* = 21.29, *SD* = 3.68.
- The overall level of Grade 10 students' academic pe rformance after learning through laboratory-based m ethod was very good, *M* = 23.46, *SD* = 2.32.

### 7.2. Findings From Research Objective 2

Regarding to Research Objective 2, the following findings were obtained.

- The overall level of Grade 10 students' academic pe rformance before learning through textbook-based m ethod was good, *M* = 20.14, *SD* = 3.41.
- The overall level of Grade 10 students' academic pe rformance after learning through textbook-based me thod was good, *M* = 20.78, *SD* = 3.62.

### 7.3. Findings From Research Objective 3

Regarding to Research Objective 3, the following findings were obtained.

- The level of leisure interest in science held by Grade 10 students in the experimental group before learnin g under the laboratory-based method was moderate, *M* = 3.13, *SD* = 1.06.
- The level of leisure interest in science held by Grade 10 students in the experimental group after learning under the laboratory-based method was moderate, *M* = 3.34, *SD* = 1.14.

### 7.4. Findings From Research Objective 4

Regarding to Research Objective 4, the following findings were obtained.

- The level of leisure interest in science held by Grade 10 students in the control group before learning und er the textbook-based method was moderate, *M* = 3. 05, *SD* = 1.23.
- The level of leisure interest in science held by Grade 10 students in the control group after learning under the textbook-based method was moderate, *M* = 3.12, *SD* = 1.18.

### 7.5. Findings From Research Objective 5

Regarding to Research Objective 5, the following findings were obtained from performing an independent samples *t*-test to compare the overall gains in academic performance in Science subject, from the pre-test to the post-test, between the experimental and control groups.

- No significant difference was found in the gain in academic performance in science between Grade 10 students at St. Joseph High School, Barhalganj, India, learning under laboratory-based method (*M* = 2.17, *SD* = 3.71) and those learning under textbook-based method (*M* = 0.65, *SD* = 4.71) at St. Joseph High School, Barhalganj, India; $t(70) = 1.52$, $p = .134$.

### 7.6. Findings From Research Objective 6

Regarding to Research Objective 6, the following findings were obtained from performing an independent samples *t*-test to compare the overall gains in leisure interest in science, from the pre-test to the post-test, between the experimental and control groups.

- No significant difference was found in the gain in academic performance in science between Grade 10 students at St. Joseph High School, Barhalganj, India, learning under laboratory-based method (*M* = 0.21, *SD* = 0.58) and those learning under textbook-based method (*M* = 0.07, *SD* = 0.43) at St. Joseph High School, Barhalganj, India; $t(70) = 1.18$, $p = .240$.

## 8. Discussion

In this section, a discussion of the research findings from the current study is provided, by relating such findings with the ones reported by previous research studies.

### 8.1. Academic Performance in Science

Regardless of the treatment under which the Grade 10 students from the target school were learning, the overall level of academic performance in Science before and after either treatment was found to be good. Therefore, the demonstration of understanding of the information learned in the Science class of Grade 10 students before and after learning through either of the methods at St. Joseph High School, Barhalganj, India, was consistently good. In other words, before and after learning through either of the methods, there was no statistical difference improvement in the overall level of academic performance in Science in the target group of Grade 10 students at St. Joseph High School, Barhalganj, India, although a slight numerical increase was noticed. This is not in line with the results reported by Olubu (2015) and Mulinge (2017), who found that teaching science using a laboratory learning environment had a significant effect on secondary school students' academic performance Also, Yadav and Mishra (2013) reached to the same conclusion on a sample of Indian university students enrolled in the General Physics Laboratory-I course. The reason why the results of the current study are different to those reported by previous ones might be the level of attendance and participation at science-related program elements (e.g., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, and communicating findings) by the participants, which have been reported to be significantly, positively and weakly correlated to science academic performance of English Grade 11 students (Zandstra, 2012).

In the case of Zandstra (2012), she conducted her study after the participants were involved in a science project for six years, and still found a weak correlation between science academic performance and attendance at science-related program elements. Therefore, a longer period of intervention might be needed in order to be able to appreciate a significant effect of laboratory-based activities on the students' academic performance in Science.

### 8.2. Leisure Interest in Science

In a similar fashion to that of the academic performance in Science, the results of the current study revealed that, regardless of the treatment under which the Grade 10 students from the target school were learning, the overall level of leisure interest in science before and after either treatment was found to be moderate. Therefore, the level of concern or psychological involvement to which Grade 10 students at St. Joseph High School, Barhalganj, India, engage and spend time in science-related activities in their leisure time, before and after learning through either of the methods, was consistently moderate. In other words, before and after learning through either of the methods, there was no statistical difference improvement in the overall level of participants' leisure interest in Science at the target school, even though a slightly larger increased was observed in the gain in leisure interest in science for the students under the laboratory-based method. The reason for these results could be rooted on the nature of the effort put into the laboratory-based activities and textbook-based activities by the participants (Darlington, 2017). According to Darlington (2017), there is a significant, moderately strong and positive correlation between a students' effort put into the science lesson and their science interest level. Thus, it is possible that the level of effort put into the activities under both approaches was not that different, and then no significant effect was seen on the participants' leisure interest in science.

Another reason for the current results can be the level of attendance and participation in science program elements (i.e., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, and communicating findings) while learning under laboratory-based method. According to Zandstra (2012), there is a significant and positive correlation between students the attendance in science program elements (e.g., science theater, hands-on exhibits, science experiments and projects, field trips, developing hypotheses, making observations, organizing data, communicating findings) and the level of science interest that high school students exhibit.

## 9. Recommendations

Based on the findings of this study, the following recommendations are provided for teachers, students, school administrators and future researchers.

### 9.1. Recommendations for Teachers

In order to contribute with improvement of the students' academic performance and leisure in interest in Science, the researchers suggest that the teachers can modify their teaching and shift from a textbook-based method to a more laboratory-based one, by including instructional elements such as those indicated in the items on the SLISQ that received the lowest overall mean score from participants. Therefore, the researchers would like to suggest to the teachers to create learning environments that are more engaging in their Science classes, by incorporating more laboratory activities or work, which may ultimately boost students' academic performance and leisure interest in science (e.g., Mulinge, 2017; Yadav & Mishra, 2013; Zandstra, 2012). Teachers can achieve this by including instructional activities that require students to read books, newspapers or web articles about science, do experiments and laboratory work instead of using only the textbook in Science class, or asking students to listen to radio programs or web podcasts about science in their leisure time or as homework, in order to increase their level of leisure interest in science, which may have a positive impact on their academic performance in Science (Yadav & Mishra, 2013; Zandstra, 2012).

## 9.2. Recommendations for Students

Despite no statistical difference in the gain in Science academic performance was found after the intervention, a slight numerical increase occurred for both groups, being the most noticeable one the numerical increase in gain in Science academic performance for the group learning under laboratory-based method. Therefore, in order for students to raise their academic performance in Science from good to very good or excellent, the researchers suggest that students should try to engage in science using experiments and the laboratory approach for a long term, especially outside the classroom, during their leisure time.

Before and after the intervention, the items on the questionnaire that received the lowest overall mean score from participants learning under laboratory-based method were Items 4 ("I dislike reading books about science during my holidays"), 5 ("I would like to do science experiments at home"), 8 ("Listening to talk about science on the radio or the internet would be boring"), and 10 ("I dislike reading newspapers or web articles about science"). Before and after the intervention, participants learning under textbook-based method gave the lowest scores on the SLISQ to Items 2 ("I get bored when watching science programs on TV at home"), 3 ("I would like to be given a science book or a piece of scientific equipment as a present"), 4 ("I dislike reading books about science during my holidays"), and 10 ("I dislike reading newspapers or web articles about science").

From these results, the researchers suggest that students under both experimental conditions should engage in the behaviors stated in the SLISQ items with lowest mean scores, and then try to read books, newspapers or web articles on science, do science experiments, or listen to radio programs or web podcasts about science in their free time, in order to increase their level of leisure interest in science.

## 9.3. Recommendations for School Administrators

The school administrators should encourage and prepare the teachers at the target school to use more laboratory activities or work in their Science classes. For that purpose, school administrators could organize training and professional development sessions for teachers to get them prepared to implement laboratory-based instructional methods in the Science classroom, as a complement of using the textbook. The administrators should encourage teachers to implement laboratory-based activities and environment in their Science classrooms, so that students are not restricted to teacher-centered methods all the time.

## 9.4. Recommendations for Future Researchers

For future researchers interested in examining students' academic performance and leisure interest in science through laboratory-based and traditional teacher-centered approaches such as the textbook-based method, the researchers suggest them to conduct studies on different types of schools and on a wider range of grade levels (i.e., cross-sectional studies), in order to obtain more generalizable results, and then be able to identify and characterize trends, across both grade levels and different types of schools, regarding the behavior of the variables addressed in this study.

Moreover, future researchers may consider conducting longitudinal studies to extend the results from the current study, and in so doing, it will be possible to investigate the change, development or the course over time of the variables addressed in this study.

Furthermore, in terms of the research variables considered in the present study, it was found that the teaching method under which Grade 10 students from the target school were learning Science appeared to have no significant effect on their gain in academic performance and leisure interest in science. Some previous studies (e.g., Zandstra, 2012) were carried out during an entire school year, while others (e.g., Yadav & Mishra, 2013) were completed in a duration of 10 days and found significant difference in academic performance and leisure interest in science between the experimental and control groups. Since the current study was conducted in four weeks, the researchers suggest that future researchers may consider to conduct the intervention for a longer period of time, in order to verify whether using either laboratory-based or textbook-based method has a significant effect on secondary school students' gain in academic performance and leisure interest in science.

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# Appendixes

**Appendix 1:** Items in the Leisure Interest in Science Questionnaire

| Items | Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|---|
| 1. I would like to belong to a science club. | 1 | 2 | 3 | 4 | 5 |
| 2. I get bored when watching science programs on TV at home. | 1 | 2 | 3 | 4 | 5 |
| 3. I would like to be given a science b ook or a piece of scientific equipme nt as a present. | 1 | 2 | 3 | 4 | 5 |
| 4. I dislike reading books about scienc e during my holidays. | 1 | 2 | 3 | 4 | 5 |
| 5. I would like to do science experime nts at home. | 1 | 2 | 3 | 4 | 5 |
| 6. Talking to friends about science aft er school would be boring. | 1 | 2 | 3 | 4 | 5 |
| 7. I would enjoy having a job in a scie nce laboratory during my school ho lidays. | 1 | 2 | 3 | 4 | 5 |
| 8. Listening to talk about science on t he radio or the internet would be bo ring | 1 | 2 | 3 | 4 | 5 |
| 9. I would enjoy visiting a science mu seum at the weekend. | 1 | 2 | 3 | 4 | 5 |
| 10. I dislike reading newspaper or web articles about science. | 1 | 2 | 3 | 4 | 5 |