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Students' Attitude towards Science in Lower Secondary Classes: Comparison across Regions

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Abstract

Science education is an area of interest for long and has gained a lot of attention from science educators. Keeping this in view, the current study explored the attitude of grade VI-VIII students towards science in the provinces of Sindh and Balochistan. This research study was conducted as part of a 5-year project titled 'USAID-LINKS to learning: Education Support to Pakistan' (USAID-EDLINKS). A 5-point rating scale, Science Attitude Scale (SAS) was adapted from previous research. SAS has 32 items arranged under five constructs: learning science in school, self-concept in science, science outside of school, future participation in science and importance of science. SAS was administered to 1458 students, from twelve randomly selected schools from the two provinces. The result exhibited positive students' attitude towards science, irrespective of province. However, comparison across regions favoured students from the province of Sindh as compared to their counterparts in Balochistan. A similar pattern was observed for all constructs except future participation in science, where both regions have exhibited a similar trend. The study concludes that students need to be engaged actively in science learning so that their positive attitude towards the discipline can be sustained and improved further as they grow older.

Key Words: Science education, Attitude, Science learning, Science practicals.

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Introduction

Attitude towards science has gained a lot of attention in the realm of science education especially from the perspective of teaching and learning. It has been noticed that students find science to be a very difficult and boring subject. The interest of the students declines as they move to the higher grades of education. Research shows that students manifest the highest level of a positive attitude towards science before the age of eleven which significantly declines over the middle school and high school years (Barmby, Kind & Jones, 2008; George, 2006; Simon, 2000). Students, particularly at the secondary level, perceive science irrelevant to life. They feel that advancement in science has generated social and environmental problems; science is difficult and is about things not people (Bennett, 2001). For these reasons many students do not want to continue studying science (Kind, Jones & Barmby, 2007).

While students' attitude towards science has been explored in other contexts there is a dearth of research in this important area in Pakistan. Keeping this gap in consideration, this study aimed to investigate students' attitude towards science in lower secondary schools in the provinces of Sindh and Balochistan. The focus of the study was three years of lower secondary schooling (VI–VIII) because students' science attitudes are shaped during these years. It was conducted as part of a 5-year project titled 'USAID-LINKS to Learning: Education Support to Pakistan (EDLINKS)' launched by the United States Agency for International Development (USAID). The project recruited schools from the two provinces of Pakistan including Sindh and Balochistan. This paper presents a part of the larger study by focusing on one of the research questions defined for the study: What are students' attitude towards science in the EDLINKS schools of Sindh and Balochistan?

Theoretical Framework

This section explains the theoretical underpinning, the study is based on. Defining Attitude and Science Attitude: Attitude is a hypothetical trait hold by an individual for something. Attitude themselves are evaluative judgments formed by the person (Aijzen, 2001). Evaluation and subsequent decision depends upon personal knowledge, feelings and experiences. Generally, attitudes once established remain stable. However, this trait is open to change and development (Reid, 2006). Social psychologists have defined attitude as a combination of emotional or affective components (liking or disliking), a cognitive component (beliefs) and a behavioural component (tendencies to act towards these items in various ways) (Child, 2007; Reid, 2006; Baron, 2001). Attitude is a multidimensional construct and different researchers have studied various aspects of attitude depending upon the aim of the study. The common areas which have been used across studies as attitude constructs are: experience, interest, feeling, motivation, enjoyment, usefulness and self-concepts (Lim,

Tso & Lin, 2009; Barmby, Kind & Jones, 2008; Kind, Jones & Barmby, 2007; Jones, Howe & Rua, 2000).

Although educationists and psychologists have tried to define the parameters of attitude towards science, different interpretations have been made for this term. That is why, many studies have focused on different parameters of 'attitude' (Osborn & Simon, 2003). Bennet (2001) has elaborated on different research studies to explain the nature of these terms. Some studies focus on physical science, some on school science and some on science outside the school. Because of the complexities attached, science educators have defined attitude towards science in different ways. Ramsden's (1998) definition of science attitude comprises cognitive, emotional and action components, which leads to develop a particular behaviour. Kind, et al (2007) have defined attitude as the feeling that one has on the basis of knowledge and belief about an object, where science is an object, therefore attitude is towards science. Both the definitions are based on three broad components of attitude including cognition, affect, and behaviour (Child, 2007; Baron, 2001). Interlinks between the components could be interpreted as; a person has knowledge and beliefs and develops feelings about an object. As a result, knowledge and beliefs may lead to certain actions (Barmby, et al, 2008).

Students' Attitude towards Science: Meta-analysis done by educationists reveals that a lot of research has been done on students' attitude towards science (Osborne, Driver & Simons, 1998; Osborne, Simons & Collins, 2003). Reid (2006) has identified four target areas as important features of attitude in science education: "the science subject itself as a discipline; the learning of the science subject; topics and themes covered in a particular course and the method of science" (p. 7). Nevertheless, much of the research has been done to find out attitude towards science as a discipline (Bennett, Rollnick, Green & White, 2001; Pell & Jarvis, 2001; Ramsden, 1998; Osborne et al, 1998).

Generally, science is perceived to be a difficult, boring and inaccessible subject (Osborne, et al, 1998; Simons, 2000). The other widely held perceptions among students are: science is irrelevant to human lives, responsible for social and environmental problems, difficult to understand, science is about things rather than people, science is for boys rather than girls and that scientists are generally odd people (Bennet, 2001; Ramsden, 1998). Literature also indicates that students exhibit positive attitude towards utility of science while their attitude towards science declines as they progress to the higher grades (George, 2006). It is argued that a negative attitude towards science has an adverse effect on students' engagement with science in the school. Furthermore, the negative attitude has been identified as one of the important factors which restrict students from continuing their career in science (Ramsden, 1998).

Measuring Students' Attitude towards Science: Over the last three decades the researchers have used various approaches to measure students' attitude towards science. Paper-and-pencil is one such widely used technique. Types of questions used in this technique were based on format similar to that developed by Osgood or Likert; rating questions and situational set questions (Reid, 2006). In most of the cases, attitudes have been measured through questionnaires consisting of Likert scale items (Simons, 2000). It is argued that these scales have inherent advantages and disadvantages. Researchers are expected to establish reliability and validity of their tools to gather useful information yet poor psychometric properties of these tools have been identified as a recurrent issue (Reid, 2006; Osborne & Reid, 2003; Ramsden, 1998; Munby, 1997; Gardner, 1996). Due to the poor psychometric properties of the attitude scales, results were generated which were difficult to interpret and unable to offer the precision required in understanding attitude development in science education (Reid, 2006; Gardner 1996). Therefore, a need was identified to develop statistically valid and reliable tools to measure attitude towards science (Munby, 1997; Gardner, 1996). Kind et al (2007) worked with the problem by developing an instrument - Science Attitude Scale (SAS) - for measuring students' attitude towards science. They have not only computed the internal consistency (Cronbach's Alpha) but have also explored unidimensionality (factor analysis). SAS was found to be an appropriate tool for the current study to explore students' attitude towards science. Figure 1 demonstrates the links between our working definition of attitude (beliefs and feeling towards an object), theoretical constructs and empirical categories (construct of SAS).

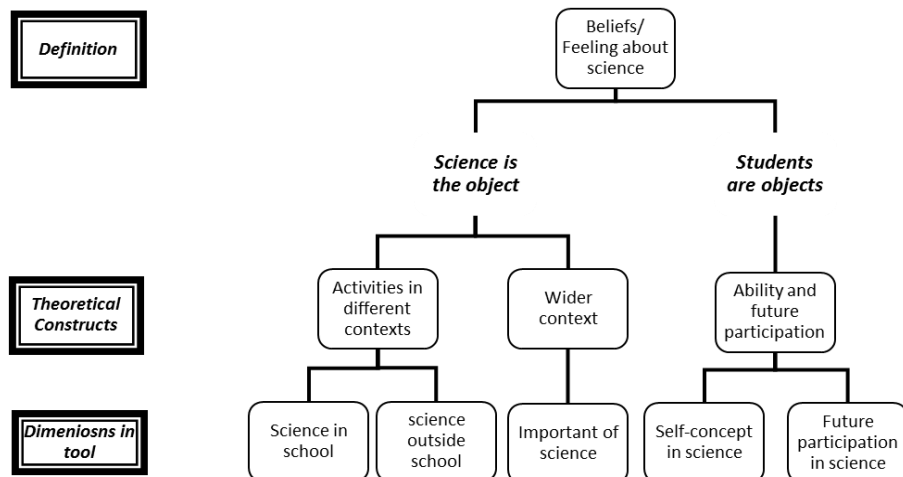


Figure 1: Interlinks among definition, theoretical constructs and dimensions in the tool

The two subscales learning science in school and science outside school focused on students' attitude towards science learning activities in different contexts. The construct presents meaningful objects (science) about which students would form beliefs. The subscale importance of science focused on students' beliefs in the value of science in a wider context. Self-concept in science and future participation in science were of a different nature because in these two constructs students were themselves a part of the attitude object (Kind et al, 2007).

Research Design

A cross-sectional survey was used to collect data about students' attitude towards science at one point in time (Fraenkel & Wallen, 2006; Gorard, 2003). The strategy helped to get useful information in the available time from a relatively bigger group (Robson, 2002; May, 2003). A multi-stage cluster sampling was employed to select districts, schools and students. Of the 22 EDLINKS target districts, 6 were randomly chosen from Sindh (n=3) and Balochistan (n=3). From within these districts, 12 lower-secondary schools were selected randomly to equally represent both regions. Altogether, 1458 students were recruited from the sample schools in Sindh (n=633) and Balochistan (n=825). The focus of the study was lower secondary classes; therefore VI, VII and VIII grades were selected from each school.

Assessment Tool: Students Attitude Scale (SAS)

This study adapted the Science Attitude Scale (SAS) developed for western context (Kind et al, 2007). The original tool has 37 items organized under six dimensions (i.e. learning science in school, practical work in science, science outside school, self-concept in science, future participation in science, importance of science). A 5-point scale (1 = strongly disagree to 5 = strongly agree) is defined for each item. The format of the tool was retained. However, changes were made in the content to address some contextual needs. In doing so, one of the dimensions of attitude - practical work in science - was excluded from SAS because science practicals are usually not conducted at lower secondary level in government schools. Furthermore, keeping in mind the rural context two items related to science clubs and science museum were also deleted. Table 1 presents a summary of adapted version of SAS which contains 32 items.

Table 1: Summary of Science Attitude Scale (SAS)

S. No	Sub-scale	Example of an item	No of items
1.	Learning Science in School (LSS)	We learn interesting things in science lessons	06
2.	Self-Concept in Science (SCS)	Science is one of my best subjects	07
3.	Science Outside School (SOS)	I like to do science experiments at home	08
4.	Future Participation in Science (FPS)	I would like to study more science in the future	05
5.	Importance of Science (IS)	Science and technology are important for society	06

Establishing Validity of SAS

In order to establish content validity of the items, the adapted SAS was reviewed by eleven subject specialists from government and private institutes. The group included teachers from the rural / urban schools and colleges, and teacher educators from professional development organisations like Bureau of Curriculum (BOC), Provincial Institute for Teacher Education (PITE) and Science Association of Pakistan (SAP). The purpose of the review was to establish whether the measurement scale covers the appropriate content to measure attitude towards science in Pakistani context. The reviewers were asked to make judgments according to their understanding of the definition of the items in the scale (Robson, 2002; Mertens, 1998; Carmines & Zeller, 1994; Mueller, 1986). These subject specialists reviewed the tool with reference to the contextual relevancy, clarity of language, and appropriateness of content to grade level. They individually rated each item on a five point rating scale (1 = completely irrelevant; 5 = completely relevant). Reviewers were also requested to suggest additions or deletions in the tool.

Overall, SAS was rated high ($M=3.88$) by the reviewers i.e. items are appropriate for measuring attitude in the rural context of Pakistan. Majority of the items fell between ‘excellent’ (i.e. 17; 54.8 %) and ‘good’ category (i.e. 10 items; 32.2%). Only four items (12.9%) were rated below three (i.e. rated as weak items). Reviewers suggested reconsidering items related to TV, scientific books and newspapers, which might not be available in the rural context. Although this suggestion was relevant, still these items were retained for the main study in light of reflections shared by rural teachers during pilot. They provided relevant examples showing that science related programmes are aired and published on local channels and local newspapers, respectively. For such items, an additional option ‘not available’ was added as sixth

option along with five points in the rating scale to avoid ‘forced opinion’. Reviewers also suggested adding an item related to farming as a majority of the rural population depends on agriculture. Therefore, one item ‘I like to use scientific knowledge in farming’ was added to SAS. An option of ‘not available’ was also added for this item. Final version of SAS was translated in Urdu and Sindhi to make it more user-friendly by minimizing the language related issues.

Establishing Reliability of SAS

Researchers usually aim at reliability co-efficient greater than 0.70, though lower values are accepted as well. A well-constructed scale, however, may have reliability co-efficient of 0.80 to 0.90 (Field, 2005; Black, 1999; Mertens, 1998). The SAS was found to be reasonably reliable in the western context with internal consistency greater than the threshold value of 0.70 (Kind et al. 2007). However, there was a risk of irrelevance to our context. Therefore, reliability of the adapted tool was also explored for Pakistani context. Cronbach’s alpha for five dimensions ranged between 0.53 (Learning Science in School) and 0.74 (Future Participation in Science) with an alpha value of 0.85 for the total score. Evidently, alpha for one construct (learning science in school) was lower than those found for the rest of the constructs and total score. However, keeping in consideration the importance of this dimension it was retained for the final analysis.

In each province, a team of trained research assistants along with lead researchers administered SAS. Direct administration method was used where children were made to sit in examination set-up (Fraenkel & Wallen, 2003). After explaining the scale format each statement were read to respondents. They were encouraged to select responses according to their own feelings as the individual viewpoint was important.

Analysis and Results

Data collected through SAS was analyzed using Statistical Package for Social Sciences (SPSS 16.0). A database was developed beforehand to enter data at items level for individual participants. Negative statements were reversed. The subscale and total SAS scores were then computed from the raw data. The data obtained were explored using descriptive analysis (e.g. mean, range, standard deviation). In order to explore normality and homogeneity of the data, objective tests [i.e. skewness > 2 (standard error)] and Levene’s test) were carried out. The distribution was found to be skewed. Therefore, non-parametric version of t-test (i.e. Mann-Whitney) was employed to gauge the differences in attitude across two regions. The following section presents a summary of demographics and results of analysis.

Demographics

SAS was administered to 1458 students to represent Sindh (n=633; 43%) and Balochistan (n=825; 57%). This difference in number of children across regions is a function of class size which was consistently bigger in Balochistan than Sindh in all target grades with a more prominent difference for grade VI [$\chi^2(2) = 9.38, p < 0.05$]. Interestingly, girls were over-represented in this sample (n=822; 56%); however, the gender ratio across regions was not different. The mean age of the students for this sample was 12.8 years (SD = 1.55). On average, students in Balochistan (M=13.15; SD=1.60) were older than their counterpart in Sindh (M=12.47; SD = 1.35) and the difference was found to be significant [U = 177889.000, $p < 0.01$].

Students' Attitude towards Science: An Overview

The overall result, as shown in table 2, exhibits a positive (M = 3.99; SD = 0.50) students' attitude towards science. Similar patterns are observed at construct level, except for self-concept in science where students have shown slightly less positive attitude (M = 3.69; SD = 0.68) towards science. Students assigned highest score to importance of science (M = 4.31; SD = 0.56) which reflects their views about importance of science and technology for society in general and its role in solving problems in particular.

Table 2: Mean score for SAS total and five constructs

Constructs	Mean score	Standard Deviation
Learning Science in School (LSS)	4.08	0.62
Self-Concept in Science (SCS)	3.69	0.68
Science Outside School (SOS)	3.92	0.65
Future Participation in Science (FPS)	4.03	0.83
Importance of Science (IS)	4.31	0.56
Overall	3.99	0.50

Students' Attitude towards Science: Comparison across Two Regions

Figure 2 presents a comparative overview of students' attitude across two regions. Evidently, students from rural areas of Sindh have displayed more positive attitude (M=4.08; SD=0.51) towards science as compared to their counterparts in Balochistan (M=3.93; SD=0.48). The difference was found to be significant [U = 210991.5, $p < 0.001$] with a small effect size ($r=0.20$). A similar pattern was found for all constructs except future participation in science. What follows is an analytical description of results at construct level.

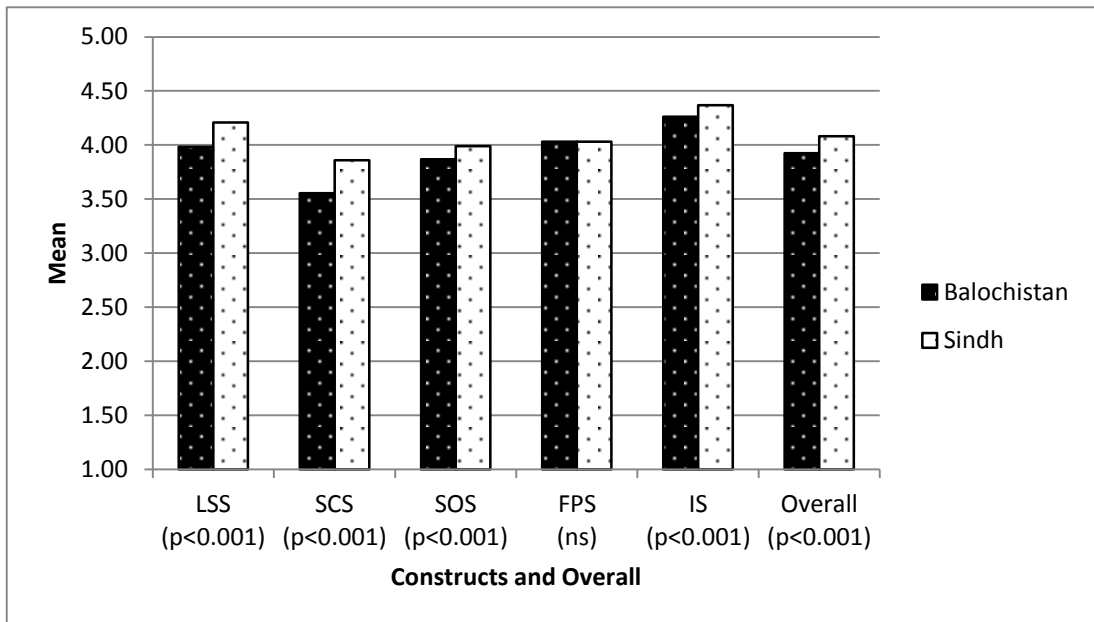


Figure 2: Students' attitude towards science-comparison across two regions

Learning Science in School

Students from Sindh have shown more positive attitude ($M = 4.12$; $SD = 0.61$) towards their engagement in learning of science in school as compared to their counterparts in Balochistan ($M = 3.98$; $SD = 0.62$). The difference was found to be significant [$U = 206206.00$; $p < 0.001$] with a small effect size ($r=0.18$). In other words, students in Sindh have found their science lessons exciting, engaging and better than the other subjects taught in school.

Self-Concept in Science

Similarly, students from Sindh have shown an edge ($M=3.86$; $SD=0.69$) on self-concept in science as compared to students in Balochistan ($M=3.55$; $SD=0.65$). The difference was found to be significant [$U = 191156.500$; $p < 0.001$] with a small effect size ($r=0.23$). It is important to note that the mean score of this sub-scale is lowest among all five sub scales. This indicates that students from both the provinces might find science difficult and feel helpless when doing science. This feeling is more prominent among students from Balochistan.

Science Outside School

The finding reveals that students from Sindh have claimed to be more oriented ($M=3.99$; $SD=0.65$) towards doing science outside school than students from

Balochistan ($M=3.87$; $SD=0.65$). The difference was found to be significant [$U = 230821.500$; $p < 0.001$] with a small effect size ($r=0.10$). In other words, students enjoy participating in various science-related activities (e.g. doing experiment at home, sharing knowledge with family) outside their schools. Furthermore, they use a variety of avenues (e.g. watching science-related TV programmes, reading science books and newspaper articles) to enhance their learning in science.

Future Participation in Science

Interestingly, students from both the provinces have shown equally high positive attitude ($M = 4.03$) towards their future participation in science with a slight dissimilarity in variation (Sindh $SD = 0.84$; Balochistan $SD = 0.82$). It is encouraging to note that students from both regions have shown inclination towards science-oriented career. More specifically, they want to contribute in the field of science as teachers or scientists.

Importance of Science

As mentioned earlier, students have shown their highest positive attitude towards importance of science. In this regards students from Sindh have shown slightly more positive attitude ($M=4.36$; $SD=0.55$) as compared to students from Balochistan ($M=4.26$; $SD=0.56$) with a significant difference [$U=227421.500$; $p < 0.001$] and small effect size ($r=0.10$). In general, students reported to believe in importance of science for society and its contribution in making lives easier and more comfortable. In a way, they have acknowledged the importance of science and technology for the society. This opinion was more strongly fostered by students in Sindh.

Discussion and Conclusion

This study aimed to explore lower secondary school students' attitude towards science in the EDLINKS schools of Sindh and Balochistan. Grade VI–VIII students ($n = 1458$), including both boys and girls, participated in this study. In general, students displayed a positive attitude towards science in the rural settings of Sindh and Balochistan. These results do not necessarily corroborate with findings of other research studies, where science is perceived to be a difficult, boring and inaccessible subject (Osborne et al. 1998; Simons, 2000). In the current study, students have acknowledged the importance of learning science in school, enjoy doing science outside of school, want to participate in science related activities in future and have realized the importance of science. Although, their self-concept in science is relatively low still the overall score for the construct remains at the higher end. That said, it is worth noting that students in Sindh have exhibited more positive attitude towards science as compared to their counterparts in Balochistan. Interestingly, the contexts are similar, all are EDLINKS intervention schools, follow the same curriculum, and students belong to

similar socioeconomic status yet there is a difference in their attitude towards science. How to interpret these findings?

It is worth recalling here that class size varied significantly across two regions with higher enrolment in Balochistan. Less positive attitude exhibited by students in Balochistan could be a manifestation of large class size. Research has found an inverse relationship between class size and students' learning outcomes (Blatchford, Basset, Goldstein & Martin, 2003; Pedder, 2006; Jeremy, Gerber, Ashilles & Boyd-Zoharias, 2001). Researchers have explained this relationship further by differentiating between pedagogical strategies used by the teachers in two types of classes. Arguably, teachers adapt strategies to handle large classes within available timeframe which has differential negative impact on quality and quantity of learning opportunities for different students (Pedder, 2006; Blatchford et al, 2003). Furthermore, they have found multiple effects of large classes effecting both teacher and students. In large classes there are large groups which teachers find difficult to manage. On the other hand, teachers in smaller classes can provide more support for learning with more teacher-student interaction (Blatchford et al, 2003). These interactive pedagogical strategies could have an implication for developing positive attitude towards the subject - science in this case. Perhaps, students view large class less favourable as compared to small class due to lack of teacher-student interaction which may have damaging impact on students' motivation. Therefore, students in small classes may develop more positive attitude towards subject. Based on this argument, it could be concluded that difference in students' attitude towards science across two regions might be a manifestation of class size.

This study has contributed to an important aspect of science education. Therefore, it has implications at different levels. This research generates some interesting findings for the curriculum designers at provincial and school level such that it retains or enhances students' attitude towards science as they promote to the higher grades. Having said that, it is imperative to arrange professional development programmes for elementary teachers to adopt more interactive methods of teaching science, make it more relevant to students' lives and society so that they see its value and importance. Attached to this is the availability and positive utilisation of resources which are very few in majority of rural schools. This implies that schools need to strive for provision of essential resources and encourage teachers to develop relevant material in order to enhance teaching.

Although, this research has generated important results, still there are some limitations attached to it. The data were collected through self-reported survey. The results of the study could have been benefitted by conducting in-depth interviews with students to understand contributing and inhibiting factors. Researchers have identified

many factors which may shape students' attitude towards science (George, 2006; Murphy & Beggs, 2003; Osborne, Simons & Collins, 2003). Examination of the contributing/inhibiting factors (i.e. role of teacher, school environment and home environment) was necessitated by the available time and resources. Furthermore, data on classroom practices would be helpful to explore possible linkages between pedagogical practices and students' attitude; nevertheless, it was beyond the scope of this study.

The study generates many opportunities for further research. A significant outcome of this research is a valid and reliable attitude tool (SAS) for Pakistani context. SAS can be used to replicate the study at national level. Furthermore, a correlational study can be carried out to explore associations between attitude towards the discipline and classroom practice. Data can also be collected on other possible factors (e.g. system of schools, role of teacher, school environment and home environment environment) which may influence students' attitude towards science. Suitable statistical models would help to isolate the effects of various factors on students' attitude. Those who are interested to take the same line of research can administer SAS on a large and more representative sample to generate more generalizable data.

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