RESEARCH REPORT

Attitudes towards Science Learning among 10th-Grade Students: A qualitative look

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The twenty-first century is characterized by multiple, frequent and remarkable scientific advancements, which have a major effect on the decisions that govern everyday life. It is therefore vital to give proper comprehensive scientific education to the population and provide it with the right tools for decision-making. This in turn requires that we foster a positive attitude among students towards science studies and encourage them to choose sciences as their major subjects. The following study examines 10th-grade high school students in an attempt to understand and document the influential factors underlying their attitudes towards science studies. The study is conducted through a qualitative research methodology, gathering data based on interviews. This methodology exposes the students’ feelings, views and beliefs, and explores the characteristics of the factors influencing students’ attitudes. Of these factors, we found the most significant for high school students to be interpersonal interaction between teacher and student, the relevance and authenticity of the topics being studied, and the diversity of the teaching methods. We therefore suggest that these three elements should be given particular emphasis by teachers and teacher educators.

Keywords: Attitudes; Biology education; High school; Learning environment; Qualitative research

Introduction

The era in which we live is characterized by frequent and meaningful changes in different scientific fields, which manifest themselves in all aspects of our life and influence daily decision-making processes on both individual and communal levels (an impact palpable, for instance, in our constantly changing approaches to such

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issues as vaccination, alternative energy use and diet). A broad scientific education for the entire population is therefore more vital today than ever. Paradoxically, science education research shows an alarming drop in youths’ interest in sciences, choice of science courses in school, and aspiration to careers in a scientific field (Osborne, Simon, & Collins, 2003). This negative attitude, as the ROSE Education Foundation’s data show, is particularly prevalent in developed countries (Sjøberg & Schreiner, 2005). Finding a way back into the ‘hearts’ and ‘minds’ of the students, requires that we document and examine their views and attitudes towards the learning process in school, since an unawareness of students’ attitudes may lead to poor and irrelevant learning experiences and the failed emergence of a meaningful learning process. To this end, the study reported here sought to document the views, needs, and expectations of 10th-grade students on the verge of choosing their course of final matriculation study, in order to acquire a full and profound picture of the factors that influence students’ attitudes towards science studies in school.

The study uses an interview-based, Multiple Case Narrative research methodology, which allows us to expose the students’ feelings, opinions, and beliefs, to study and delve into their attitudes and characterize the factors influencing their outlook on science studies. Until today, most studies of students’ attitude have employed a quantitative methodology, mostly questionnaires. From a social psychological perspective this methodology, while it can identify a problem, does not present its complexities and its essence, showing only ‘the tip of the iceberg’ (Osborne & Collins, 2001; Potter & Wetherall, 1987). As Osborne et al. (2003) point out, as much work as possible need to be done to identify those aspects of science teaching that make school science engaging for pupils and to qualitatively ‘fill in the blanks’ left by quantitative research.

In this context, research is required that stresses the students’ viewpoints and assesses their attitudes. The work that has thus far been done on the topic has not focused on this particular age group—a group especially worthy of notice because of the turning point on which they stand in determining their future education. The results of this study may therefore serve to increase present knowledge about students’ attitudes towards science studies and the factors influencing them, and to provide the information that ‘fills in’ this particular gap in our knowledge. Moreover, the study’s findings may assist in developing teaching strategies that will relevantly answer the students’ needs and improve their attitude towards science studies.

**Literature Review**

**What is Attitude?**

In approaching the attitudes and views of students towards science studies, we must understand what attitudes mean, how they develop, and how they impact the studying and decision-making process of students in relation to future science occupation. The word ‘attitudes’ is used in this study as a general term encompassing students’
orientation or relation (be it positive or negative) towards a particular object or event (in this case—the study of science). Based on the distinctions drawn by social psychologists Breckler (1984) and Millar and Tesser (1989), we further break down this comprehensive term into three sub-categories in which attitude can manifest—the affective, behavioral, and cognitive dimensions (or ABC model of attitudes). The cognitive element of attitude refers to the set of factors and rational arguments that contribute to one’s relation towards an object—that is, the elements of one’s attitude that are based on what one knows (Eagly & Chaiken, 1998). For example, students who are positively inclined towards science studies because they believe these will lead them to a lucrative career in medicine are exhibiting an attitude influenced by cognitive concerns. The affective element, on the other hand relates not to the rational but to the emotional components of one’s relation towards an object. Reactions voiced in terms of attraction or repulsion, love or hate, enjoyment or displeasure, for instance, refer to the affective/emotional element of attitude.

The relation and interaction of these first two dimensions in forming attitudes has been the central focus of studies in this field. While Millar and Tesser (1989) proposed that one’s affective and cognitive aspects are often independent of each other, it nevertheless seems that the conscious and emotional aspects of attitude are not fully separate and have a complex interrelationship, though the motives inducing each are essentially different (Breckler, 1984; Osborne et al., 2003).

The third, behavioral element of attitude refers to the way one tends to actually behave towards an object. This more pragmatic element does not necessarily result from one’s cognitive or emotional attitude, meaning that there can be a disparity between one’s declared attitude and one’s behavior. Despite this possibility, however, knowing one’s attitude nevertheless allows for the prediction of one’s behavior (Ajzen & Fishbein, 1980; Armitage & Conner, 1999; Crawley & Coe, 1990; Shrigley, 1990). Ajzen and Fishbein (1980) formulated a theory describing the interaction between attitude, purpose, and behavior—the theory of reasoned action (TRA). According to TRA (Ajzen & Fishbein, 1980), the degree of conation involved in choosing a certain behavior is influenced by the intensity of the attitudes, which in turn are influenced by the opinion and beliefs of the individual. Moreover, certain behaviors can lead to the creation of new opinions about a subject, and those can influence attitudes. The current study is based on the TRA, and we assume that attitudes can predict behavior, the relevant behavioral element being science studies strategies, efforts spent in science studies, the choice of scientific courses in school, and the tendency to choose scientific occupations in the future. TRA proposes that the generation of experiences that give students opportunities for new ‘behavior’ can lead to the creation of new attitudes (i.e., positive/negative experiences generate positive/negative attitudes). Based on this correlation, we believe that an understanding of students’ attitudes towards science studies in school can be used to identify those experiences in science studies that relate positively to the students’ needs, and use this knowledge in turn to bring about more positive attitudes towards science studies.
Factors Influencing Attitudes towards Science Studies

Of the various factors that research has identified as pertinent in students’ attitudes towards science (see e.g., George, 2000; Tuan, Chin, & Shich, 2005), we will be focusing on only three—‘the perception of the science teacher’, ‘the value of science studies’, and ‘enjoyment of science studies’. Our choice of these particular foci was influenced by the fact that they constitute an intersection between two primary considerations. First, they are attitudinal factors that are influenced by pedagogical concerns. Osborne and Dillon (2008) have claimed that any teaching and learning situation is constructed out of three components—curriculum, pedagogy, and assessment. Our decision to focus our efforts on aspects of attitude that pertain to pedagogy is in agreement with their further contention that, though both curriculum and pedagogy are increasingly failing to engage young people with the further study of science, the need to transform the pedagogy of school science is more fundamental than the need to make curricular changes. Our second consideration in choosing these three factors reflects Osborne et al.’s claim that ‘despite the recurrent message of the significance of teachers, and teacher styles, on attitudes towards science, so little research has been attempted to understand what makes for effective teaching of science in the eyes of the pupil’ (2003, p. 1069—our emphasis). The three factors we have chosen, in addition to their relation to issues in pedagogy, are also the most suited to our chosen methodology, which seeks to acquire detailed knowledge of the students’ point of view. These factors, we deemed, were topics upon which our interviews could provide particularly abundant or useful information.

The Perception of the Science Teacher

Studies concerning this issue show that teachers and their conduct in class are very meaningful in developing students’ attitude towards science studies, and influence the students’ behavior concerning science studies (George, 2000; Haladyna, Olsen, & Shaughnessy, 1982, 1983; Haladyna & Shaughnessy, 1982). Teachers can influence students’ attitudes for better or for worse, depending on the interaction between the students and their teachers. According to Meighan’s (1981) study, students perceive teachers as good when they are warm and have a personal relation towards their students, listening, being understanding and patient towards them, encouraging and supporting them. Ebenezer and Zoller (1993), who studied the perceptions and attitudes of 10th-grade students towards teaching and science studies, showed that students emphasized their teachers’ teaching method and stressed the teachers’ influence on their interest and understanding of sciences. Osborne and Collins (2001) found an overwhelming consensus among students that their interest in science class grew, thanks to teachers who taught in a ‘fun’ and entertaining way. By fun and entertaining, the students meant use of various methods to communicate the material and interactive lessons. Other studies showed that the students accentuate the teachers’ enthusiasm and way of simplifying the
subjects and speaking in a language clear to the students (George & Kaplan, 1998; Osborne & Collins, 2001). Moreover, it seems that the quality of teaching of the school science teacher not only affected the students’ satisfaction with the teacher, but was also the crucial factor in the decision to continue with science studies (Woolnough, 1994). Thus, it can be gathered that if a teacher’s conduct answers the students’ needs, it will bring about a more positive attitude towards science studies.

Value of Science Studies

Studies conducted in the 1980s examining students’ views on the importance of science studies indicated that middle and high school students show a positive attitude towards the necessity and benefit of science studies (Yager & Yager, 1985). However, more recent studies have shown that this interest in the importance of science classes has severely decreased at these ages, most significantly in the transfer from middle to high school (Rani, 2003). Recent studies show a gap between the science subjects considered interesting and relevant by students and those taught in high school (Baram-Tsabari & Yarden, 2009; Kwick, Halpin, Reiter, Hoeffler, & Schwartz-Bloom, 2007). In addition, Osborne and Collins’ study (2001) showed that though the students might have agreed about the importance of science, they referred to science studies in terms of a career—an instrumental value rather than a personal interest (Osborne & Collins, 2001).

Enjoyment of Science Studies

There is a vast amount of literature examining the degree to which students enjoy science class, based on the assumption that enjoyment, interest and satisfaction are indicators of positive educational experience. Those studies view enjoyment in science class as an expression of an inner motivation and positive attitudes of students towards science studies (Rani, 2003; Ryan & Deci, 2000). Furthermore, studies concerning this issue show that there is a close connection between enjoyment, interest and the students’ attitude (Bennett, 2001; Haussler, 1987; Zembylas, 2005).

Ebenezer and Zoller (1993) showed that 10th-graders see the method of science study as important to the consolidation of their enjoyment in science studies. In general, previous studies have shown that the teachers’ character, the atmosphere in class, and the relevance to real life that students find in study topics deeply affect their interest, their enjoyment, and thus their attitude towards science (Ebenezer & Zoller, 1993; Osborne & Collins, 2001). Therefore, because of the connection between the students’ enjoyment in science class and the attitudes formed, knowing the factors that create enjoyment in science class, from the students’ perspective, is important in understanding the factors influencing attitudes.
Methodology

The Research Goal and Questions

This study has two primary goals. First, it aims to present and examine the factors influencing students’ attitudes towards science studies, and second it analyzes the interaction between these factors and the affective and cognitive elements of attitude. While a separate analysis of the behavioral element is not conducted here, we nevertheless proceed under the assumption suggested above, that the cognitive and affective elements may be used as indicators for predicting behavior.

Our analysis focuses on the three specific factors detailed above: ‘perception of the science teacher’, ‘value of science studies’, and ‘enjoyment of science studies’. These can be roughly translated into three central research questions. If our goal is to foster positive attitudes towards the study of science, we ask: (1) Who should teach? (i.e., what constitutes a ‘good’ teacher?); (2) What to teach? (i.e., what sort of material will students perceive as ‘valuable’?); and (3) How to teach? (i.e., what sort of classroom experience do students find enjoyable?).

The Research Approach

Exposing the feelings, opinions, and beliefs of students, understanding their attitude and recognizing its attributes requires access to the complexities, paradoxes, and context of different levels of the issue under observation. We therefore chose to conduct this study according to the interview-based qualitative-naturalistic approach. Naturalistic research aims at the imitation of ‘nature’s way’, trying to understand phenomena in specific contexts, the context of the ‘real’ world. The qualitative-naturalistic researcher aspires to avoid manipulating the studied phenomenon (Patton, 2002). Unlike quantitative researchers, who try to define reasons, predict and understand the rules of data, qualitative researchers try to illuminate, understand, and extrapolate conclusions between similar situations (Hoepfl, 1997).

We choose to use Multiple Case Narrative methodology, which allows for the collection of data from a large number of people within a single study. While this methodology is similar to the conventional-quantitative study in that its purpose is to collect data from multiple people, it nevertheless preserves its narrative-qualitative nature and produces narrative-qualitative findings (Shkedi, 2005). The duality of this approach (combining a relatively large population with a narrative-qualitative form) is what, according to Shkedi (2005), allows researchers to identify the presence of broad patterns recurring within a wide variety of case narratives.

In our study, the Multiple Case Narrative methodology provides us with a comprehensive view of the students’ world, as it emerges from their many individual stories. The students’ interviews reveal different angles of the phenomenon, combining to create a full, complex reality that reflects their overall point of view on science studies and the factors that create their attitudes. The interviews were held in the students’ natural environment (school), and conducted as a conversation, the goal of
which was to elicit and express their opinions and attitudes. The interview analysis then attempted to explain and present the interviews sensitively and as close to the original as possible. Finally, this study focused on the subjects’ authentic narrative, placing the students firmly in its center and examining reality from their point of view.

The Research Population

The research population consisted of 10th-grade biology students \( n = 61 \). All students studied the same curriculum, since Israel has a centralized education system. The biology syllabus for this age group centers around a curriculum entitled \textit{Human Biology}. After 10th-grade, students in Israel must choose to major in at least one scientific or non-scientific topic, which is evaluated in a national matriculation examination at the end of 11th-and 12th-grades. At this stage, the students must therefore examine their attitude towards different subjects in order to choose the right topic for them.

In choosing schools for our study, care was taken to ensure that urban and rural schools, boys and girls, would all be represented in similar proportions. The students were gathered from 11 schools, taken from every geographical district in Israel (six districts in all). The schools were chosen for their willingness to cooperate with the researchers. All students in the study learn biology, whether by choice or as part of their school curriculum (the final choice of study course is done at the end of 10th-grade in most schools). Most students (about 80%) were chosen randomly out of all those who agreed to be interviewed, the rest were chosen by their teachers.

The Research Tool

Interviews

This study used a personal, semi-structured interview, in which the sequence and structure of questions is predetermined and defined by protocol, but in which the interviewer has the flexibility to ask further questions and ask for clarification and examples, in order to better understand the interviewee’s opinions. Osborne et al. (2003) said that few studies examined attitude towards science studies using an interview alone. Though this tool has been criticized for generalizing, the wealth of data arising from the interviews gives a glimpse into the attitudes towards school science studies (Osborne et al., 2003).

The interviews were held at the students’ schools during class hours, the students being taken out one by one for an interview of 30–40 minutes. They took place in a quiet room and in a relaxed atmosphere, so that the students would feel free to share their opinions. Before presenting the questions, the interviewer introduced herself, and a short, informal conversation was held to help the students become accustomed to the situation and the interviewer. Then the students were told that during the half-hour interview, they would be asked about school and science class. They
were informed that the interview was anonymous, and its purpose was to learn about
the students’ opinions, and it was clarified that there are no right or wrong answers,
but it is important that they be honest and true. The students’ consent was then
obtained to record the interview.

The interview questions were concrete, designed to elicit the attributes of the
central factors influencing attitudes, but we took care to avoid questions that may
lead the students to a single answer, and the questions were worded so that the
students would feel free to express their feelings and opinions. The questions were
based on a pilot study, consisting of a few case narratives, suggested as a means of
helping researchers plan their study (Shkedi, 2005) and on the existing theoretical
knowledge from the literature on attitudes towards science studies, emphasizing
avoiding judgment. The interviewer tried to avoid judgmental reactions and use of
terms that could influence the students’ answers, unless the terms were brought up
by the students.

**Interview Questions**

The interview included 12 questions:

1. What do you do in your free time?
2. How do you feel about your science teachers in school? What is a good science
teacher?
3. How do you feel about science subjects at your school?
4. Which extended course have you decided to take? Why? What do you want to
be when you grow up?
5. What do you think of science studies/teaching method at school? The way they
teach science? Give an example.
6. Why, if at all, should science be studied? Why does it matter? Give an example
of a science subject you feel is important to learn.
7. How should a science class proceed in order to be interesting?
8. What do science classes look like in your school? Do they inspire interest?
Curiosity? Enjoyment?
9. What influences your enjoyment/lack of enjoyment of science class? Give an
example.
10. In your opinion, what makes science class/material difficult?
11. Some claim that only those who want to become scientists should study science
in school, what do you think of this statement?
12. Is there a science subject you would like to study and have not been exposed
to?

**The Data Processing**

The data processing was done according to the qualitative research method, through
category building and continuous interaction between conceptual perspective and
the data arising from the field. The qualitative-naturalistic research method requires the development of a cyclic study sequence (Spradley, 1979). This study was therefore done in circles—the study questions and categories were continuously re-evaluated as the data were processed.

After a primary read-through of 20 interviews, categories expressing the central attributes of attitudes, as conveyed by the students, were built. Each category was named in order to find similarities and differences between students’ different attitudes. Each interview was first processed by categories separately, so as not to force the first interviews’ categorization on the next interviews. Next, links and relations were found between categories and, according to these relations, we built a ‘category tree’ with a number of categories and sub-categories. Some of the categories were grouped by wider themed names. The graphic presentation of categories with a ‘category tree’ allowed a view of all relations and hierarchies between categories. The categories were then united under one main category, which directly addressed the study question, after which the theoretical explanation was constructed, based on field data and literature on science attitudes. Representative quotes from the students were filled into a category tree.

Though our information-gathering purposes in using Multiple Case narrative research strategy were primarily qualitative, the large number of participating students allowed numerical trends in the students’ answers to be studied—the number of students relating to each attribute (sub-category) was counted. This data allow another point of view of the phenomenon thanks to the distribution among the students. Many times, one student referred to a number of attributes, which were in different sub-categories (so the sum of students for all attributes was larger than the number of students in the study).

The following steps were taken to ensure the trustworthiness of our results. First, the drafting of a comprehensive final report, including contextual information, proper quotations from informants and an explicit conceptual discussion, so other researchers can also review the database evidence. Second, the analysis process was fully documented and preserved, and third, the final report offered and maintained a chain of evidence. Finally, the analysis of the different categories was carried out by the researcher and her advisor separately and simultaneously. At the end of each stage, the advisor was consulted, to strengthen the reliability of the results. An examination of the categories revealed an agreement of over 80% between the two mappings. The 20% that did not agree were remapped until agreement was achieved.

**Results**

The findings were arranged in three main categories according to the influential factors of attitude selected for focus in this study: (1) perception of the science teacher, (2) value of science studies, and (3) enjoyment of science studies. They are further divided into sub-categories based on the principal elements within them that arose in the interviews.
Who Should Teach?—Perception of the science teacher

In general, throughout the interviews, the students referred to the teacher’s key role in the learning process and their attitude towards science studies. One boy claimed, for instance, that ‘A teacher can make any course interesting and varied—any course’. The teacher’s influence upon students’ attitude towards a course can manifest negatively as well, as another boy claimed, ‘I don’t like to study science in class, I don’t like our teacher … The subjects are interesting, but the way she teaches is boring’. To describe the students’ perception of their science teacher, we have divided this factor into two sub-categories: Attributes of a good teacher and Science teaching method (see Figures 1 and 3).

Sub-Category # 1: Attributes of a good teacher

In order to learn of what students view as good teachers, who can positively influence the class atmosphere and the students’ attitude, we asked students what they viewed as important qualities in a teacher. Students’ answers focused mainly on professional and emotional attributes (see Figure 1). Though we must note that professional and emotional attributes are two inseparable parts of a whole, and that treating them as

[Diagram: Categorization for the sub-category—Attributes of a good teacher]

Figure 1. Categorization for the sub-category—Attributes of a good teacher
two separate sub-categories is inaccurate, it is nevertheless interesting that emotional characteristics were central to the students’ descriptions. Eighty-three percent of the students referred to the teacher’s emotional attributes, 57% referred to professional attributes (see Figure 2), and many students referred to both.

**Emotional attributes.** Refers to interpersonal relations between the teacher and students, including all attributes of teacher–student relations brought up by students—personal contact and consideration of the students’ needs, equal treatment of students, mutual teacher–student respect, using humor in class, empowering students’ self-efficacy and encouraging excellence, inciting students’ interest in the subject matter and teacher’s enthusiasm for the subject (see Figure 1). This affective element as a whole is an important attribute the students seek in their teachers, most particularly in terms of personal contact and consideration of students’ needs, to which 62% of the students referred (see Figure 2). Students seem to yearn for personal attention from their teachers; a boy told us that a good teacher ‘connects personally with each student and learns from them. Tries to get to know each personally, not just completes his duties but does more’. Moreover, students show that the personal touch they need expresses itself outside the class as well. As one girl said:

A good teacher sits with you after class, helps you. Gives a personal touch, if you don’t understand, explains again. A teacher who flashes through the material and doesn’t explain to those who don’t understand—he’s not a good teacher.
The students we interviewed said that they recognized the conflict between the teacher’s need to create a pleasant atmosphere, to emphasize the human and personal connection, and the simultaneous need to be strict. A girl told us:

We teenagers love teachers who are ‘cool’ and fun. But those teachers, though you love them—you allow yourself to behave as you wish in class. A good teacher teaches well and in a fun way, is with the students and is inseparable from them. In our school there is a distinction between good professional teachers, and teachers who are ‘cool’ with students. A good teacher can combine.

Another girl said:

There are teachers I love and connect to them and their classes, and some I don’t. A good teacher is strict but can be considerate and understanding; A teacher who listens to students and does not teach without acknowledging the students.

An additional aspect the students’ interviews indicate as important is the interest the teacher arouses in the subject matter, to which 34% of students referred (see Figure 2). For instance, a boy told us:

A science teacher should attract and interest students. Science isn’t interesting to everyone, so the teacher needs to arouse interest and curiosity, tie it to real life. Difficult themes should be connected to real life ... Excite the students, make them want to learn. Today, it’s very dry and stale.

Professional attributes. Are those attributes that show the teacher’s level of teaching expertise, context-wise and pedagogically. A good pedagogue’s attributes, as seen by the students, are those concerning scientific issues—fitting language and learning level to the students, control in class (discipline), and attention to students’ difficulties while learning. Of these three, the first was most prominent in the interviews, mentioned by 33% of students (see Figure 2). A girl said, ‘A bad teacher does not connect to the class, teaches in a manner unfitting to the students’ age and interests. Teaches what he thinks is true and easy and not how the students feel’.

The students present the ideal teacher as one who can combine professional and emotional aspects. A ‘good teacher’, the students claim, is a professional teacher, pedagogically and in terms of content, highly emotionally intelligent, who allows a connection with the students, and has a personal touch. Of the two, the students interviewed placed greater emphasis on the affective aspects, their answers indicating that a personal touch is the main attribute they seek.

Sub-Category # 2: Science teaching method

The teacher’s role is to teach, so while the attributes of a good teacher are important in themselves, these must ultimately express themselves within the teacher’s teaching method. The methods teachers use to teach science influence the students’ learning and enjoyment, and thus also their attitude towards the subject. The two main aspects raised by the students about science teaching methods are repetition and the importance of variety and creativity in teaching (see Figure 3).
Variety and creativity in teaching. Refers to the use of a variety of teaching methods and teaching aids to illustrate subjects, connecting study subjects to different life issues to create interest, understanding the studied material, and stepping outside routine. Most of the interviewed students treated variety and creativity as inseparable parts of teaching, 44% of them said that variety in teaching is significant in creating interest in class (see Figure 4). The students noted the importance of peer teaching and discussions, contests and games, movies, presentations, models and field trips, and, most particularly, of conducting experiments. A girl said:

Experiments make material more tangible, you do the experiment and see results, actually see things, not just what the teacher says. It’s more appealing, it’s easier to learn. Kids who have difficulty listening and concentrating—in experiments they need to be active. Experiments excite everyone. Even after the experiment, it’s more fun to listen, it’s better to start a new subject with an experiment and only then the teacher explains. After you experimented, you saw the whole process, you’re more connected to the material and it’s more interesting to listen. In subjects that can be experimented, the more the better.

When asked to describe science class in their school, most students reported monotonous teaching methods lacking in variety. The ruling teaching method was traditional teaching, lecture-based, in which the teacher stands center, in front of the students, and teaches a planned and structured unit of material. Most students said this lessened their enjoyment and interest in learning. A boy told us that, ‘She (the teacher) stands in the center and talks and talks, doesn’t show anything to make it tangible—no presentation or picture, nothing. What could be interesting in that?’ The students are not active in class and their role is to listen to the teacher, which makes the students disinterested and bored; as another boy said, ‘In school, the teacher lectures and it’s boring, we fall asleep in class from boredom’.

Figure 3. Categorization for the category—Science teaching method
A similar number of students, 38%, emphasized variety in teaching as significant not only to interest and pleasure, but also to understanding the studied material (see Figure 4). One girl, for example, claimed that ‘If they showed models or had experiences, it would be more interesting and we’d understand better’. The contribution of variety to interest and understanding was usually tied to a material presentation of the subject. This girl’s sentiment arose often in the interviews: ‘All these aids help concentrate and really see things, not abstractly. Sometimes the teacher brings a tiny model, which no one can see, shows it a second, and returns it, so it won’t be broken, I guess’.

The importance of variety also arose in the context of a pleasant atmosphere in class (13% of students referred to it, see Figure 4). One girl said, ‘Experiments, movies, group work—all help and contribute since everyone studies and understands together. We do a lot of experiments alone and talk about it in a group. It’s better that way, and more fun—because you’re with your friends. So school isn’t a place where you learn alone—it makes the studying communal’.

A final element notable in the students’ interviews is the importance of repetition in teaching. Eighteen percent of the students said that repeating the studied material several times is a good way to implement the new knowledge and induce understanding (see Figure 4).

To conclude, the students interviewed see a diverse teaching method and the use of different representative aids as the main attribute of a good science class, not just in terms of pleasure and interest, but in terms of understanding and remembering.
the material. Variety, then, is a main factor influencing the cognitive and affective aspects of students’ attitude towards different science fields.

What to Teach?—The value of science studies

Understanding the goals of students’ science studies and the importance of scientific knowledge to them is essential to an analysis of the cognitive element of attitudes. To learn how students view the importance of science studies, we asked them why, if at all, does one need to learn science? Are the science subjects learned important to them? Do only those who want to work in science need to learn science?

This category has three sub-categories (see Figure 5). **Instrumental value** refers to the use-value of scientific knowledge gained at school. This value measures knowledge that is relevant and useful in everyday life, contributing to problem-solving ability, general education, and the development of a future career. **Essential value** refers to the study of science in order to develop scientific thinking, and to a thirst for knowledge born of genuine interest. This value measures scientific knowledge necessary for understanding everyday phenomena and acquiring the thinking skills needed for this wisdom. **No value** refers to the students’ belief that science subjects are irrelevant and insignificant for them, meaning that the study subjects, as they see them, are not connected to their world.

![Diagram of the value of science studies](image)

**Figure 5. Categorization for the category—The value of science studies**
Sub-Category #1: Instrumental value

Thirty-one percent of the students viewed the scientific knowledge acquired at school as practical knowledge necessary for every citizen (see Figure 6). A boy said, ‘[Science knowledge] is also social, it’s funny to see someone who doesn’t understand why when you throw a ball, it returns to the floor. I think it’s important to learn the basic laws’. The students also pointed out that this type of knowledge appears everywhere in everyday life, in conversation with others, on television, newspapers, etc. A girl noted:

Now when I hear about a disease on the street, I know what it is. Like when I watch TV and they talk about symptoms, I start to think what we learned about it. Like we learned about the heart and heart diseases, and when there’s talk about it, I know what cholesterol is, where it comes from.

Other students (20% of those interviewed), referred to scientific knowledge gained at school as a useful knowledge for solving real-life problems (see Figure 6). Many students referred to subjects concerning disease, medications and environmental issues. Some students referred to global problems, environmental and social issues, and presented scientific knowledge as vital for understanding and solving those problems. This girl, for instance, explained the following in reference to the importance of scientific knowledge in solving environmental dilemmas, ‘By understanding people’s
influence, we can preserve the good things in nature. Science studies are important for everyone, so they can influence their environment … Science explains how things work and how to fix them’. Several students talked about everyday problems and the solutions scientific knowledge provides, problems that arising mostly from the human body and its function. One boy, for instance, said:

You know life cannot exist without water, food, and oxygen. So you don’t go to sleep with a stove on and window closed, you understand it can finish the oxygen in the room, so you avoid doing it. Or when you go hiking, you arrange for water because you understand its importance.

Surprisingly, only 18% of the students talked about the importance of school science studies in terms of preparation for professional life—useful knowledge for higher education or future career (see Figure 6). On the other hand, 46% of them referred to this attribute—knowledge to prepare for finals and career, as school’s main purpose (see Figure 6). As one boy pointed out, ‘Science subjects at school open doors to other professions in the future, a lot of professions are science-related’. Some students claimed that science studies were important only for those who would work in science fields in the future, since those who would not, do not need to learn science in school, as explained by this student who claimed that ‘If someone doesn’t work in science fields when he’s grown up, he doesn’t need to learn science in school. Like, if I didn’t want to be a veterinarian, I wouldn’t care about biology’.

Sub-Category #2: Essential value

This subcategory includes attributes relating to the importance of evolving scientific thinking skills, interest and curiousity. It seems in this context that science subjects in everyday life are an important factor in arousing the students’ interest and curiousity, and these are central motivators for acquiring relevant ‘real life’ knowledge. Forty-sevent percent of the students spoke of the important connection between their interest and curiousity and the relevance of the subject matter to everyday life (see Figure 6). In a typical example, this boy said:

There are interesting things that are important to know. These are the basics of this world. Before everything, we need to know what this leaf that we see is and why we breathe oxygen. I think it’s important to experience and learn science at a high level because these are the most important subjects in the modern world. It helps me in everyday life to understand things and processes in animals and plants. I’m interested in knowing why my head hurts when I don’t drink, what body heat is, the immune system.

Most of the examples cited by the students as subjects they find interesting and relevant to real life were biology and human body related, specifically to disease. The illnesses the students had been exposed to personally were especially interesting to them. A girl told us:

If you are ill, you should know what you have and why you hurt … like we learned about the immune system and I had mononucleosis that hurts the immune system. The
teacher explained that a big illness like mono causes weakness all over the body and the immune system is weakened. Now every little thing I didn’t use to feel becomes a disease. So what you learn is life-related.

Only 13% of the students spoke of unique thinking skills in science fields acquired because of science studies in school (see Figure 6). One girl said, ‘Science thinking can help in life in general, even in un-science related subjects. Realistic thinking—thinking that demands solutions and rational explanations, not thinking there are fairies’.

Sub-Category #3: No value

Fifteen percent of the students interviewed did not find science relevant to their life, and so found science subjects uninteresting (see Figure 6). One girl said:

I’ll tell you the truth, I used to love science—before high school. In high school it became something else, what do I care what happens in my body after I eat, I don’t care. I’m just not interested. I eat an apple for fun, I don’t care what happens to it in my body, what’s the inside of my body.

To summarize, the perception of the value of science studies arising from the interviews indicates that many students emphasize the connection between real life and science studies. This connection creates a positive attitude towards science studies among students and builds a positive attitude towards science class and science studies. Students who cannot find a connection between the subjects learned and everyday life do not understand the purpose of science and are not interested. Most of the students interviewed looked positively upon the importance of scientific knowledge gained at school. It is worth pointing out again here that the topic most recently covered by these students in their study of biology is the human body, which is naturally close to the children’s world, which may have impacted their significant interest in this as a contributing factor.

How to Teach?—Enjoyment of science studies

Deriving enjoyment from learning is an important factor, which positively influences the affective element of students’ attitude towards the subject learned. The students’ interviews show that different students viewed enjoyment in science class differently, some perceiving it as a relevant and important parameter for studying, and others viewing other factors as significant, and enjoyment as irrelevant and non-substantial to the learning process (see Figure 7).

Sub-Category #1: Enjoyment is a relevant parameter for learning

Most students thought pleasure was important in the learning process, motivating their learning and attitude towards the subject. The factors mentioned by the students as affecting pleasure were: atmosphere in class, interest, challenge, understanding the
material, study subject and teaching method. Of these, teaching method was especially prominent in the students’ descriptions, referred to by 29% of students (see Figure 8), who placed the most emphasis on variety in teaching method and active learning. The students’ concept of enjoyment in science studies was closely tied to interest, and many students used the words interchangeably. One boy said:

It all goes together. If there’s no interest and curiosity, there’s no enjoyment. In the science center, because the method is different, there are many experiments, presentations and models—they make the class interesting, and then there’s interest and enjoyment.

**Sub-Category #2: Enjoyment is an irrelevant parameter to learning**

Only 18% of students claimed that enjoyment is an unnecessary or irrelevant part of learning (see Figure 8). These students mostly maintained that they learned ‘because we must’ (60% of students in this sub-category). A girl told us, ‘School is
not fun, you go because you have to, because parents pressure you or think it will help in the future’.

It seems then, that students have different attitudes towards enjoyment in learning. Some students view enjoyment as a primary, necessary condition of an interesting and effective lesson, and some students envision two non-overlapping circles—one representing learning and the other enjoyment—which, to their mind, are not meant to meet.

**Discussion and Conclusions**

This study offers an opportunity for a comprehensive look at the way students perceive science studies. The students’ interviews allow us a glimpse of their world, and of the characteristic factors influencing their attitude towards science studies in school. The 10th-graders participating in this study are on the verge of an important academic decision, a decision that will influence their education and future profession. The information arising from the students’ descriptions and arguments, and from the categories found in the interview analysis, provides answers to three central questions:

1. **Who should teach?** What attributes do students associate with a good science teacher?
2. **What to teach?** What kinds of subjects do students find important?
3. **How to teach?** What study methods do students view as effective for them?
Who should Teach?

When asked to describe the image of a good teacher and present the main attributes of teachers they want to see in science class, students identified interpersonal teacher–student interaction and the teacher’s consideration of the student’s needs as central characteristics. Students aspire to and expect reciprocity between them and the teacher, based on personal acquaintance and contact, on the teacher’s awareness of each student’s strengths and weaknesses. The students stressed the importance of a teacher who knows the students, is attentive to their needs and questions in class and beyond, provides encourages their sense of self-efficacy, is patient with weaker students, stimulates a pleasant atmosphere and uses humor.

The importance of teachers’ affective attributes, and particularly of personal teacher–student relation, is in accordance with the findings of previous studies into students’ perception of the attributes of a ‘good teacher’, which indicated the importance to students of emotional interaction with their teacher (Meighan, 1981; Reichel & Arnon, 2009). It seems this need stems from teachers’ limited ability to provide their teaching with a ‘personal touch’, due to the ever increasing number of students per classroom. Moreover, teachers often teach in many classes at once, so superficial acquaintance is substituted for an in-depth and personal one, and close relations between teacher and student are impaired.

Many students also said that a good teacher and a positive atmosphere in class influence the way they view science class, a result that supports the argument raised by Haladyna et al., who claimed that teacher and atmosphere are central factors in forming and changing attitudes towards science (George, 2000; Haladyna & Shaughnessy, 1982; Haladyna et al., 1982, 1983). Since the interaction between teachers and students is created to a great degree by the teacher’s behavior in class, in order for this interaction to be successful, there must be harmony between the students’ and teachers’ expectations, and so teachers should embrace this finding and be aware of what their students expect. Advanced studies that raise the teachers’ awareness of this issue and supply them with practical tools for classroom behavior would be appropriate. In addition, since the number of students in a class and the number of classes taught by a teacher are high, and personal contact is nearly impossible, the number of students in a class, and the number of classes taught would need to be diminished if this conclusion is to be applied.

What to Teach?

As they have in previous studies (Glynn, Taasoobshiraz, & Brickman, 2009; Yager & Yager, 1985), most students in the study expressed positive attitudes towards the necessity and value of science studies, emphasizing the context and relevance of study topics to real life. This came up many times during the interviews, in answer to questions about interest, satisfaction, and pleasure. For students, understanding the value and importance of a task is vital to significant learning. If the students do not view the task as relevant, they are likely to use superficial strategies such as memorizing
The popular subjects referred to by the students in these studies as interesting and relevant are the mechanisms and treatment of disease, and environmental issues, which agrees with the findings of other studies that have discovered that high school students are interested in subjects of the human body, diseases, and environment (Baram-Tsabari & Yarden, 2009; Kwiek et al., 2007). It is important to note that the extent of the students’ interest in these topics is wholly disproportionate to the amount of attention they receive in school curricula a discrepancy worth addressing in the attempt to regain the sciences’ position in students’ favor.

In contrast to the results of Osborne and Collins’ study (2001), the students in this study did not find science’s instrumental role particularly important, but gave the instrumental and essential value of science studies equal weight. On the other hand, most students had trouble giving examples of subjects they studied in science class that were significant to them, which leads us to nevertheless question the degree to which they find their studies authentic and relevant. The examples students managed to find related once again to diseases and the environment—those subjects most interesting to the students.

It is worth noting that students who were negative towards science studies and claimed not to see their value were those who could not find a connection between the subjects studied in science class and their everyday life. This suggests that connecting science study subjects to the students’ real life through a narrative (story presented through a personal point of view) and relevant and current examples, and thus helping the knowledge and skills gained in science class to be meaningful and relevant to the student’s world, can help ensure that this knowledge becomes internalized and induces interest, satisfaction, and pleasure. It is therefore important that science teachers know of new developments in the science world through advanced training with experts from the field, and are able to relate this knowledge effectively to the students’ life, tying the relevant knowledge to the curriculum. Moreover, the study program and materials should be built to strengthen this connection. In this context, we must also consider that the sheer size of science curricula, especially in high schools, forces teachers to return to the traditional method of ‘dry’ and ‘compressed’ material, with no connection to the students’ life. These conclusions fit those of Osborne and Collins (2001), who emphasize the connection between content of science class to the general world as much as possible, in order to allow all students to study and be interested in science, not just those who aspire to work in the field.

**How to Teach?**

The need for creative teaching methods, varied study environments, and active learning arose over and over in the interviews, not just about teaching methods, but about understanding the importance of science studies, the students’ self-esteem, and their pleasure in science studies. The students mentioned experiments, peer learning, contests and riddles, movies, presentations and models, tours and discussions as
learning environments that contribute to interest and curiosity, understanding the material and motivating thinking, as well as creating a pleasant atmosphere in science class. It was emphasized that interest and curiosity in science class, created by a variety of teaching methods and means, are important not only for pleasure and a pleasant atmosphere, but also for meaningful learning and internalization of scientific subjects. This correlates with the literature by researchers who have said that variety in teaching methods is an important attribute influencing the students’ pleasure in science class and the students’ attitude towards science studies (Ebenezer & Zoller, 1993; George & Kaplan, 1998; Osborne & Collins, 2001).

It is important to note the apparent contrast between the students’ desires and their reality. Many of the students reported that their teachers fail to use varied teaching methods, and that most lessons are taught as a lecture in which the teacher stands in front of the students and teaches ‘dry’ material, and the student’s role is reduced to listening in class and preparing homework. It seems that lectures are the most prevalent teaching method because they allow one teacher to transfer a highly structured and planned body of knowledge to many students. As a result, students’ experiences in science learning are limited, experiences that are vital not only to the purposes stated above, but also, according to pedagogic psychologists (Bandura, 1977), to the students’ self-efficacy. The students interviewed described few opportunities, if any, in which they were allowed to execute assignments and assess their own science capabilities. It is therefore not surprising that the main evaluation index by which the students build self-esteem is exams.

It seems that the science studies conducted in many classes today are focused on passing information from the teacher to the students through a lecture, and as such do not answer the students’ needs, and damage their meaningful learning process. To remedy this, teachers must initiate various learning opportunities while actively involving the students in a learning process in which they have different experiences that present them with the versatility of the scientific world. A variety of assignments gives students an opportunity to evaluate their capabilities and find the most appropriate method for them in science studies. To avoid fixation on a single teaching method, teachers must be exposed to new methods through advanced teaching, which shows the teachers innovative teaching methods and means.

To summarize, the students interviewed in this study express a clear need for positive experiences in science class, and such experiences in the students’ eyes involve active learning through experiments, discussions, peer-learning, and field trips. It seems these experiences produce positive attitudes towards science studies and are vital for generating interest and pleasure in class, and assimilating study subjects and scientific thinking. Another prominent need expressed by students is the connection of study subjects to their life, citing relevance and authenticity as central influential factors in their attitude towards science studies in school. In the current reality, in which science takes center stage in culture and everyday life in the modern society, and scientific issues are inseparable from the dilemmas every citizen must face personally, familiarly and socially, there is great importance to fitting the curriculum and study method to the students’ needs so more students take an active role in
learning science and become educated citizens and full partners in decisions. This understanding of the students’ world, their opinions and the factors influencing their attitude, is vital to making science studies in school relevant and authentic for students, and must become an important and inseparable part in building and modeling science teaching policy.

References


