Adolescents’ Declining Motivation to Learn Science: Inevitable or Not?
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Abstract: There is a growing awareness that science education should center not just on knowledge acquisition but developing the foundation for lifelong learning. However, for intentional learning of science to occur in school, out of school, and after school, there needs to be a motivation to learn science. Prior research had shown that students’ motivation to learn science tends to decrease during adolescence [Anderman and Young [1994] Journal of Research in Science Teaching 31: 811–831; Lee and Anderson [1993] American Educational Research Journal 30: 585–610; Simpson and Oliver [1990] Science Education 74: 1–18]. This study compared 5th through 8th grade students’ self-reported goal orientations, engagement in science class, continuing motivation for science learning, and perceptions of their schools’ and parents’ goals emphases, in Israeli traditional and democratic schools. The results show that the aforementioned decline in adolescents’ motivation for science learning in school and out of school is not an inevitable developmental trend, since it is apparent only in traditional schools but not in democratic ones. The results suggest that the non-declining motivation of adolescents in democratic schools is not a result of home influence but rather is related to the school culture.

Keywords: motivation; school culture; adolescents

A growing body of research shows the importance of motivation in education (Schunk, Pintrich, & Meece, 2008). However, researchers in science education have studied motivation and other affective constructs much less than cognitive constructs (Koballa & Glynn, 2007). Several researchers have suggested that we turn our attention towards motivation more than we have done before (e.g., Pintrich, Marx, & Boyle, 1993).

The goal of this study was to explore, using the lens of achievement goal theory, age-related trends of Israeli students’ motivation for science learning in different school cultures. In particular, we investigated age-related trends of students’: (1) motivation in science class (goal orientations and classroom engagement), (2) continuing motivation for science learning (engagement in and rejection of science related extracurricular activities), and (3) perceptions of their parents’ and schools’ goals emphases for science learning.

Historically, science motivation research has adopted four perspectives of motivation: (1) behavioral (emphasizing concepts such as incentives and reinforcement); (2) humanistic (emphasizing students’ capacity for personal growth, their freedom to choose their destiny, and their desire to achieve and excel); (3) cognitive (emphasizing students’ goals, plans, expectations, and attributions); (4) social (emphasizing students identities and their interpersonal relationships in the community). Science education researchers adopted one or more of these perspective when studying motivation. For example, Simpson and Oliver (1990) adopted many of these perspectives, as the basis for a large multidimensional longitudinal study performed between 1979 and 1989. This study showed that the science curriculum and practices which were used at that time in schools in the USA “were not collectively producing students with positive feelings towards science” (p. 16).

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Other science education researchers have investigated students’ attitudes toward science and science learning (e.g., DeBacker & Nelson, 2000; Logan & Skamp, 2008; Singh, Granville, & Dika, 2002; Speering & Rennie, 1996; Yager & Penick, 1986) as well as other motivational constructs, such as students’ engagement in class (e.g., Anderman & Young, 1994; Blumenfeld & Meece, 1988; Lee & Anderson, 1993; Meece, Blumenfeld, & Hoyle, 1988), enrollment in science courses (e.g., Cavallo & Laubach, 2001; Milner, Ben-Zvi, & Hofstein, 1987; Shernoff & Hoogstra, 2001), and interest (e.g., Baram-Tsabari & Yarden, 2005; Logan & Skamp, 2008). Many of the studies revealed that students’ attitudes, interest, and motivation towards science learning decline throughout their years at school, especially during secondary school (for reviews, see Galton, 2009; Osborne, Simon, & Collins, 2003). These findings led some educators to speculate that “in some senses, school science education might do more harm than good!” (Osborne et al., 2003, p. 1060), inferring that the decline in students’ motivation for science learning might not be inevitable but rather connected to the way science is taught at schools.

The decline in students’ attitude and motivation towards learning have also been found in other subject areas, and it has been linked to changes in classroom environment (e.g., Anderman & Young, 1994; Eccles et al., 1993; Ferguson & Fraser, 1998; Midgley, Feldlaufer, & Eccles, 1989) and in instructional practices, such as less student-centered instruction, fewer classroom discussions and debates and more lecturing, copying notes and adhering to the text books (Logan & Skamp, 2008; Piburn & Baker, 1993; Simpson & Oliver, 1990; Speering & Rennie, 1996). Some of these studies also pointed out the possible influence of lesson pacing (whether topics were rushed or not), the variety of teaching strategies, the level of personal support, willingness to listen to the students’ voice and allow them to take control of their learning, and be involved in making choices about curriculum (for a review, see Osborne et al., 2003).

Achievement Goal Theory

Over the years, several theories have been developed that aim to define and explain the mechanism of students’ motivation in academic contexts. Achievement goal theory (Ames, 1992a) is probably the most widely used of these theories in the last two decades and the one we used to guide this study.

The key construct in achievement goal theory is the goal orientation, which refers to, in the context of academic behavior, why and how students engage in academic activities. Extensive research suggests that adopting different goal orientations is associated with different ways of engaging in schoolwork as well as with different emotional experiences in school (Schunk et al., 2008).

The theory specifies two main goal orientations: mastery goals orientation and performance goals orientation. Mastery goals orientation refers to an individual’s purpose of developing competence, understanding and skills or achieving a sense of mastery (Ames, 1992a). Mastery goals orientation (referred to in this paper as mastery goals) has been related to a broad array of adaptive cognitive, emotional, and behavioral outcomes, such as self-efficacy (Kaplan & Maehr, 1999; Roeser, Midgley, & Urdan, 1996), effort and persistence (Elliot, McCregor, & Gable, 1999; Elliott & Dweck, 1988), preferences for challenges (Ames & Archer, 1988; Elliott & Dweck, 1988), interest and continuing motivation (Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Shernoff & Hoogstra, 2001), self-regulated learning (Pintrich, 2000), learning for understanding strategies (Elliot et al., 1999; Kaplan & Midgley, 1997), retention of information learned (Elliot & McGregor, 1999), depth of information processing (Graham & Golan, 1991), and transfer of problem-solving strategies (Bereby-Meyer & Kaplan, 2005).

In the field of science education, Patrick and Yoon (2004) found that increased conceptual understanding is related to mastery goals. As evidenced by this study and others (Anderman & Young, 1994; DeBacker & Nelson, 2000; Meece & Holt, 1993; Nolen & Haladyna, 1990; Tabak, Kaplan, & Deutsch, 2003), mastery goals in science learning has a positive relation with desired learning characteristics and therefore should be encouraged and fostered by parents, teachers, and schools.

Performance goals orientation (referred to in this paper as performance goals) refers to the purpose of demonstrating competence. Performance-oriented students are concerned with others’ perceptions of their competence and with their ability relative to others (Ames, 1992a; Nicholls, 1984). Elliot and Church (1997) suggested distinguishing between performance-approach and performance-avoidance goals. According to this distinction, when pursuing performance-approach goals, the student is focused on attaining favorable
judgments of competence, whereas when pursuing performance-avoidance goals the student is focused on avoiding unfavorable judgments of competence. Findings from studies that adopted this distinction support its prevalence among students and strongly suggest that performance-avoidance goals are associated with maladaptive patterns of engagement; the evidence regarding performance approach goals are not consistent (Kaplan & Maehr, 2007).

Achievement goal theory and its related research also highlight environmental characteristics that may foster the different orientations. It suggests that different educational environments are characterized by different goal structures which are the environmental emphases on different goals (Kaplan & Maehr, 2007; Mucherah, 2008). Previous studies showed that the perceived goals emphases of the learning environment are associated with students’ adoption of these goals (Anderman & Midgley, 1997; Roeser et al., 1996). It had been suggested that students’ perceptions of goals emphases may act as mediators between the environmental characteristics and students’ personal goal orientation (Meece, Herman, & McCombs, 2003; Nolen & Haladyna, 1990).

Classroom Engagement and Continuing Motivation

Classroom engagement is often used as an indicator of students’ motivation (Fredricks, Blumenfeld, & Paris, 2004). Meece et al. (1988) found that students who adopted mastery goals in science class reported more active cognitive engagement in class. In our study, classroom engagement refers to behavioral engagement, which is the involvement in learning and academic tasks that includes behaviors such as effort, persistence, concentration, attention, asking questions, and contributing to class discussion (Fredricks et al., 2004), as well as cognitive engagement, which is the psychological commitment directed toward the construction of knowledge and understanding.

When studying students’ motivation for science learning, one should also consider their continuing motivation, a term coined by Maehr (1976), who defined it as “the tendency to return to and continue working on tasks away from the instructional contexts in which they were initially introduced” (p. 443). Continuing motivation for science learning is expressed by re-engagement in science-related extra-curricular activities that are not the result of some external pressure or requirement, such as watching science-related TV programs, browsing science-related websites, going to science clubs, doing hands-on activities at home or with friends, looking at the science section in newspapers, etc. Maehr argued that continuing motivation is critical because in a world where life-long learning is crucial, education must not be something that is confined exclusively to schools. Furthermore, in the area of science education, one might also argue that it is the participation in the activity of doing science, rather than just mastery of science content, that nurtures the scientist (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; Pascarella, Walberg, Junker, & Heartel, 1981). Hence continuing motivation for science learning, which can be expressed as engagement in extra-curricular science related activities, may be viewed as a desired outcome of formal science education.

Despite its importance, surprisingly little research has focused on continuing motivation as an important educational outcome in science and in other domains. An exception is the work of Pascarella et al. (1981) who examined some classroom environment correlates of continuing motivation in science for early and late adolescents. Their findings indicate that the extent to which teachers, rather than students, controlled the learning environment was negatively associated with continuing motivation.

Parental Influences

Many studies have indicated that parents influence their children’s motivation for learning in science (e.g., Breakwell & Beardsell, 1992) and in other domains (e.g., Ames, 1992b; Grolnick & Ryan, 1989; Wentzel, 1998; Zimmerman, Bandura, & Martinez-Pons, 1992). According to Kamins and Dweck (1999), parental responses to task success or failure are related to students’ task engagement, persistence, and mastery oriented behavior. Students who are highly supported and encouraged by their parents tend to adopt mastery goals and to demonstrate more persistence and effort during difficult learning tasks (Hokoda & Fincham, 1995). The literature also shows positive relations between parental involvement in schooling and several motivational variables, including school engagement, intrinsic motivation, and mastery goals (Schunk et al., 2008). Friedel, Cortina, Turner, and Midgley (2007) found that 7th grade student perceptions of parents’ goals

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emphases were good predictors of students’ personal goal orientation in mathematics. Moreover, students’ personal goal orientations were more strongly related to those they perceived to be emphasized by parents than by teachers, particularly with respect to performance goals. Thus it is reasonable to hypothesize that perception of parents’ goals emphases will also influence students’ motivation and goal orientation in science learning.

School Culture

‘‘. . . Schools differ in the way they go about their business. At the root of these differences are the existence of and stress on certain goals, purposes, and values: What is worth doing and why’’ (Maehr & Anderman, 1993, p. 595). These school-wide characteristics have been named ‘‘school culture’’; it has been suggested that they may play a central role in fostering or de-emphasizing students’ mastery goals, beyond the influence of a certain teacher (Kaplan & Maehr, 1997; Maehr & Midgley, 1991). As phrased by Maehr and Anderman (1993, p. 596): ‘‘After all, why should students adopt a mastery goal if they know that what really counts in school is getting high grades?’’ Only few studies have investigated students’ perceptions of school’s goals emphases. One that did was conducted by Roeser et al. (1996) which found that perceived school goals emphases, in middle school, were related to students’ personal goal orientations. Hence, a more complete investigation of the factors which affect students’ motivation to learn science should not only consider the science teacher and the science classroom, but also school culture and students’ perceptions of it. This study explored the association between Israeli schools’ cultures and their students’ motivation to learn science and engage in science-related activities, in and out of school, by comparing between students in democratic and traditional schools.

Democratic Schools

More than 200 schools around the world are identified as ‘‘democratic schools’’ (Bennis & Graves, 2008). In Israel there are about 25 schools identified by the Institute for Democratic Education as ‘‘democratic schools,’’ and new ones are established each year (‘‘Alternative Education Resource Organization (AERO) Website, 2008b). There is no exact definition or requirement for a school to be considered democratic (Bennis & Graves, 2008; Ram, 2006), but most of them share some common characteristics: (1) they are managed by shared decision-making among the students and staff, (2) students can choose which subjects to learn and in general, what to do with their time, (3) there are usually no required classes, and (4) the staff supports students by offering facilitation according to students’ interest and needs (‘‘Alternative Education Resource Organization (AERO) Website, 2008a). These characteristics all apply, in differing degrees, to the democratic schools that participated in this study.

Students’ autonomy is a guiding principle in democratic education. Students’ autonomy refers to the amount of freedom a student has to determine his or her own behavior. Especially important in fostering autonomy is the absence of external rewards, controls, and pressures. Most of the components of autonomy support in education have been thoroughly studied by researchers interested in intrinsic motivation and the reward structures that undermine it (for a review, see Deci & Ryan, 2002). Their studies have shown that autonomy support enhances students’ intrinsic motivation (Deci, Ryan, & Williams, 1996; Deci, Vallerand, Pelletier, & Ryan, 1991; Lepper & Greene, 1975). Students’ autonomy has been found to be positively associated with their classroom engagement (Assor, Kaplan, & Roth, 2002; Skinner & Belmont, 1993), mastery goals orientations (Ames, 1992a; Maehr & Midgley, 1991; Patrick, Anderman, Ryan, Edelin, & Midgley, 2001) and continuing motivation (Pascarella et al., 1981).

Zanzuri (1997) investigated one Israeli democratic high school and found that students in that school were more intrinsically motivated to learn than students in a traditional high school, and that this intrinsic motivation was related to students’ perception of the democratic atmosphere at school, including teachers’ respect for their students, their interest in their students’ desires, the scarcity of punishment, and the degree to which students were partners in managing classroom activities. However she did not examine the motivation for science learning, nor did she relate to changes in motivation as students matured.

Science learning in Israeli democratic and traditional schools. It is difficult to characterize science learning and teaching in Israeli democratic schools in terms of curriculum, activities, and teachers’ practices,
as the variation between the schools is great. On the other hand, the science curriculum used in traditional schools in Israel is quite uniform and is largely dictated by the Ministry of Education. Teachers in traditional schools have little autonomy in choosing what to teach and which materials to use, and teaching is becoming more and more aimed at succeeding on standardized tests. Although democratic schools are public schools and supervised by the ministry, they enjoy much greater autonomy which leads to greater diversity. For example, some democratic schools draw on the same pre-specified science curriculum as do traditional schools, while others democratic schools change their curriculum each year and give the teacher complete freedom in choosing what to teach. In general, science classes in both types of schools (in the elementary and middle school grades) deal with a range of science topics, mainly in biology, chemistry and physics. The number of weekly hours of science in democratic schools ranges from 2 to 6, depending largely on students’ choice. Traditional schools typically provide 3–4 hours a week, depending on the school and grade.

There are, however, a few common characteristics to most science classes in democratic schools, including the ones that participated in this study: students’ in democratic schools are free to choose whether or not to learn science, and if they choose to learn science they may often choose the number of science courses. This means that they may also choose with which teacher to learn (if there is more than one science teacher), what subject to learn and for how many hours. Science teachers in most democratic schools seldom use textbooks and usually there are no tests. Instead, the teachers have great autonomy in designing their teaching to match their students’ needs and desires and they use qualitative evaluation methods. Science classes in many democratic schools are aged mixed, usually in the range of 2–3 grade levels, and the number of students in each class is usually smaller than in traditional schools.

Methods

Study Goal

As mentioned before, a decline in students’ motivation to learn throughout adolescence has been repeatedly reported, and theorists have suggested that this decline may be related to school culture (Eccles et al., 1993; Maehr & Anderman, 1993; Midgley, Anderman, & Hicks, 1995; Urdan, Midgley, & Wood, 1995). The purpose of this study was to compare between students’ motivation (goal orientations and classroom engagement), continuing motivation (extra-curricular engagement and rejection), and perceived school and parents goals emphases, in democratic schools and in traditional schools, to help deepen the understanding of the relations between schools’ culture and adolescents’ declining motivation for science learning.

Sample

The participants in this study were 1181 Israeli-Jewish students from grades 5 to 8 from five democratic schools, six traditional elementary schools (1st to 6th grade) and six traditional middle schools (7th to 9th grade), all drawing on students from middle-high socio-economic backgrounds. The democratic schools in this sample are all intended to be K-12 schools. As their senior classes age, they add an additional grade. All these schools had reached 9th grade and some had already reached 12th grade. The number of democratic schools in the sample is smaller than the number of traditional schools as they are less prevalent in Israel and because of the unwillingness of some to participate. Table 1 presents the number of participants per grade per type of school.

Participation of schools was voluntary. In traditional schools, the principal or science teachers chose which classes would be sampled. In democratic schools all classes were sampled, including students who learn science as well as those who do not. Thus it is possible that in some cases the classes sampled in the traditional schools may have positively biased the traditional schools’ sample.

Classes in democratic schools are usually smaller than in traditional ones. The average number of participants per class in this study was 13.3 (6.2) in the democratic school, 29.1 (5.5) in the traditional elementary schools, and 26.7 (4.0) in the traditional middle schools. The number of weekly hours of science offered in both types of schools was between 3 and 4.
Measures

Students’ data were collected by anonymous questionnaires from December 2008 until May 2009. Instructions for completing the questionnaires were given to the students by the first author, who distributed the questionnaires, was present while students completed it, answered their questions, and collected the questionnaires from each student.

We assessed the following constructs by administering two Likert-type questionnaires (which probed other constructs as well, as part of a larger study).

**Personal Goal Orientations.** Students’ focus on developing competence (personal mastery goals), demonstrating competence (personal performance approach goals), and avoiding unfavorable judgments of competence (personal performance avoidance goals), in science class. In the democratic schools, these constructs were assessed only for students who learn science in school. Scales items were drawn from the Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 2000). The PALS have been used extensively, their validity and reliability have been reaffirmed in numerous studies across different contexts and they have been translated into Hebrew (Bereby-Meyer & Kaplan, 2005; Kaplan, Lichtinger, & Gorodetsky, 2009). Some modifications were made to adapt them to the purpose of this study, such as adding the word “science class” where appropriate and replacing the terms “grades” and “tests” with “achievements,” since grades and tests are often not given in democratic schools. The modified items were used for all participants, in both types of school.

**Classroom Engagement.** Students’ behavioral and cognitive engagement in science class. In the democratic schools, this construct was assessed only for students who learn science in school. The scale was adapted from Assor et al. (2002). In previous studies, students’ reports of their engagement in the classroom have been found to be significantly related to teachers’ reports of these same behaviors (Assor, Kaplan, Kanat-Maymon, & Roth, 2005; Skinner & Belmont, 1993). Hence, one may treat these self-reports as indicators of students’ actual engagement in class.

**Continuing Motivation.** Students’ engagement in and rejection of extra-curricular science related activities. These constructs were assessed for all students. The scales were developed for this current study and they are available in Table S1 as Online Supplementary Material. A series of self-report items describing different extra-curricular activities, such as watching science related TV programs, performing hands-on activities or reading about related issues, was developed and validated by using the cognitive pretesting procedure (Karabenick et al., 2007) with three students in grades 5–7. According to these interviews, items were revised and tested again with three other 5th and 7th grades students. The items were also validated with three science education researchers who are or were science teachers.

A factor analysis with exploratory varimax rotation that looked at the continuing motivation items revealed two factors with eigenvalues ranging from 3.45 to 3.56; one factor representing *extra-curricular engagement* with science related activities and another representing *extra-curricular rejection* or avoidance.

Table 1

<table>
<thead>
<tr>
<th>School Type</th>
<th>Grade</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Democratic</td>
<td>5th</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>6th</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>7th</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>8th</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>292</td>
</tr>
<tr>
<td>Traditional</td>
<td>5th</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>6th</td>
<td>201</td>
</tr>
<tr>
<td></td>
<td>7th</td>
<td>274</td>
</tr>
<tr>
<td></td>
<td>8th</td>
<td>194</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>889</td>
</tr>
</tbody>
</table>
of such activities (scales’ items are available in Table S1 as Online Supplementary Material). Every item loaded on the appropriate factor with loadings above 0.50. The factors extracted accounted for 54% of the variance. Cronbach alphas were 0.84, for engagement and 0.83 for rejection. These two factors were treated as distinct constructs.

**Perceived Parents Goals Emphases.** Students’ perceptions of their parents’ emphasis on developing competence (perceived parents mastery emphasis) and of demonstrating it (perceived parents performance emphasis), in science class. These constructs were assessed for all students. Scales’ items were also drawn from PALS (Midgley et al., 2000) and same modification were made as mentioned above.

**Perceived School Goals Emphases.** Students’ perceptions of their school’s emphasis on developing competence (perceived school mastery emphasis) and of demonstrating it (perceived school performance emphasis), in learning in general. These constructs were assessed for all students. The items in these scales were originally used by Midgley et al. (2000) as teachers’ scales, assessing teachers’ perceptions of their school’s goals emphases. Validation of these scales as students’ scales was performed by using the cognitive pretesting procedure (Karabenick et al., 2007) with six students in grades 5–8, of whom three go to traditional schools and three to democratic ones. One of the interviewed students had transferred from a democratic school to a traditional one and one had transferred from a traditional school to a democratic one. Items that were not clear to at least one of the interviewees were not included in the scale.

Examples of items from the different scales are available in Table S2 as Online Supplementary Material. In all scales, no distinction was made between the different science domains. The internal reliabilities of published scales that were adapted to this study were re-evaluated by calculating Cronbach’s alpha for each scale. Items that interfered with the reliability were deleted. The data for each construct were normally distributed. Table 2 presents the constructs assessed by the questionnaires, the number of items clustered in each construct, and Cronbach’s alpha for each construct.

**Analysis**

Linear regression was done to test grade driven trends and two-tailed t-tests were done to compare between democratic and traditional schools. A power analysis indicated that our sample was large enough to detect significant differences between the same grades at the two different types of schools and grade-dependent trends within each type of school, both at the \( \alpha = 0.05 \) level with a power of more than 95%.

**Results**

Tables 3 and 4 summarize the numerical results of the analyses. A decline in students’ personal mastery goals in traditional schools from 5th grade to 8th grade was identified. This decline was not found in democratic schools (see Figure 1). Notice that in 5th and 6th grade, no significant differences were found in students’ personal mastery goals between traditional schools and democratic schools, whereas in 7th and
8th grade students in democratic schools had significantly higher levels of personal mastery goals than their peers in traditional schools.

We hypothesized that these differences between democratic schools and traditional schools might result from biased sampling. After all, only students who choose to learn science do so in the democratic schools, while in traditional schools all students must participate in science classes. Surely there are many students in traditional schools who sit in science classes only because they have to, not because they wish to do so. Perhaps the responses of these students were masking the responses of the students who did have an interest in learning science? To eliminate this possible bias, we created a sub-sample of students from traditional schools, using only the data from students that chose 3, 4, or 5 (maybe, probably, certainly) on a scale of 1–5 to the following question: “If it was possible in my school to choose whether or not to learn science, I would choose to learn science.” Interestingly, about 60% of the students in the traditional schools chose these options, while approximately 60% of the respondents in the democratic schools chose to learn science. The result of this unbiased comparison also appears in Table 3 and in Figure 1. Despite this amendment, the negative trend in students’ personal mastery goals described before remained.

### Table 3
**Trends between 5th and 8th grade**

<table>
<thead>
<tr>
<th></th>
<th>Democratic Schools</th>
<th>Traditional Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B&lt;sub&gt;YX&lt;/sub&gt;</td>
<td>df</td>
</tr>
<tr>
<td>Personal mastery goals</td>
<td>0.07 149 1.24 0.22</td>
<td>–0.21 692 –6.53 ***</td>
</tr>
<tr>
<td>Personal mastery goals (unbiased)</td>
<td>0.07 149 1.24 0.22</td>
<td>–0.03 695 –0.7 0.48</td>
</tr>
<tr>
<td>Personal performance approach goals</td>
<td>–0.02 150 –0.3 0.77</td>
<td>–0.18 692 –5.97 ***</td>
</tr>
<tr>
<td>Personal performance avoidance goals</td>
<td>–0.06 149 –0.87 0.39</td>
<td>–0.20 748 –6.46 ***</td>
</tr>
<tr>
<td>Classroom engagement</td>
<td>0.03 150 0.43 0.67</td>
<td>–0.14 744 –5.06 ***</td>
</tr>
<tr>
<td>Engagement in extra-curricular activities</td>
<td>–0.01 245 –0.16 0.87</td>
<td>–0.20 748 –6.46 ***</td>
</tr>
<tr>
<td>Rejection of extra-curricular activities</td>
<td>0.01 241 0.23 0.82</td>
<td>–0.14 744 –5.06 ***</td>
</tr>
<tr>
<td>Perceived parents mastery emphasis</td>
<td>0.01 247 0.27 0.79</td>
<td>–0.14 744 –5.06 ***</td>
</tr>
<tr>
<td>Perceived parents performance emphasis</td>
<td>–0.01 249 –0.10 0.92</td>
<td>–0.06 746 1.62 0.11</td>
</tr>
<tr>
<td>Perceived school mastery emphasis</td>
<td>–0.03 270 –0.78 0.44</td>
<td>–0.21 703 –7.74 ***</td>
</tr>
<tr>
<td>Perceived school performance emphasis</td>
<td>–0.11 272 –2.47 *</td>
<td>0.02 700 0.77 0.44</td>
</tr>
</tbody>
</table>

*p < 0.05.

***p < 0.001.

8th grade students in democratic schools had significantly higher levels of personal mastery goals than their peers in traditional schools.

### Table 4
**Motivational differences between students in democratic and traditional schools, per grade**

<table>
<thead>
<tr>
<th></th>
<th>5th Grade</th>
<th>6th Grade</th>
<th>7th Grade</th>
<th>8th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>df</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td>Personal mastery goals</td>
<td>1.07 188</td>
<td>0.29 234 0.22</td>
<td>–3.13 52 **</td>
<td>–4.9 77 ***</td>
</tr>
<tr>
<td>Personal performance approach goals</td>
<td>4.89 43</td>
<td>3.07 110 **</td>
<td>2.49 237 *</td>
<td>5.4 89 ***</td>
</tr>
<tr>
<td>Personal performance avoidance goals</td>
<td>3.9 188</td>
<td>5.04 234 **</td>
<td>4.83 235 ***</td>
<td>4.84 67 ***</td>
</tr>
<tr>
<td>Classroom engagement</td>
<td>2.16 30</td>
<td>–1.43 234 0.16</td>
<td>–1.74 236 0.08</td>
<td>–1.70 179 0.09</td>
</tr>
<tr>
<td>Engagement in extra-curricular activities</td>
<td>2.89 233</td>
<td>0.48 229 0.64</td>
<td>–0.24 313 0.81</td>
<td>–1.55 213 0.12</td>
</tr>
<tr>
<td>Rejection of extra-curricular activities</td>
<td>–0.23 229</td>
<td>1.39 228 0.17</td>
<td>2.14 312 *</td>
<td>3.22 212 **</td>
</tr>
<tr>
<td>Perceived parents mastery emphasis</td>
<td>3.75 232</td>
<td>2.79 234 **</td>
<td>2.2 306 *</td>
<td>–0.89 213 0.37</td>
</tr>
<tr>
<td>Perceived parents performance emphasis</td>
<td>3.61 233</td>
<td>6.08 183 ***</td>
<td>7.13 309 ***</td>
<td>3.68 214 ***</td>
</tr>
<tr>
<td>Perceived school mastery emphasis</td>
<td>0.32 230</td>
<td>0.75 252 **</td>
<td>–4.06 270 ***</td>
<td>–4.63 133 ***</td>
</tr>
<tr>
<td>Perceived school performance emphasis</td>
<td>6.4 228</td>
<td>10.84 271 ***</td>
<td>12.83 128 ***</td>
<td>9.11 197 ***</td>
</tr>
</tbody>
</table>

*p < 0.05.

**p < 0.01.

***p < 0.001.
We also found significantly higher personal performance approach and performance avoidance goals in the traditional schools than in the democratic schools for all grades, with little or no significant trends over the years (see Figure 2).

Analysis of classroom engagement patterns revealed a similar pattern as for personal mastery goals: a significant decline with age in traditional schools and no significant trend in democratic ones (see Figure 3). Notice that 5th graders in traditional schools reported significantly higher levels of classroom engagement in comparison with their peers in democratic schools, while in 6th, 7th, and 8th grades they reported insignificantly lower levels than democratic schools students.

Figure 3 also shows students’ engagement in and rejection of extra-curricular science related activities. Students in democratic schools showed no significant change in their behavior across the years. However, in traditional schools, extra-curricular engagement decreased with age while rejection increased. Again, notice that 5th graders in traditional schools reported significantly higher levels of extra-curricular engagement in comparison with their peers in democratic schools, while in 6th, 7th, and 8th grades no significant differences were found. On the other hand, there was no significant difference between the two types of schools in their 5th and 6th graders’ rejection, while at 7th and 8th grades, students in traditional schools reported significantly higher levels of rejection than students in democratic schools.

Surprisingly, we found that students in grades 5–7 in democratic schools perceived their parents as emphasizing mastery goals for science learning significantly less than students in traditional schools (see Figure 4). In traditional schools, students’ perception of their parents’ emphasis on mastery goals declined through grades, whereas in democratic schools no significant trend was found. At 8th grade, there was no difference between students’ perceptions of their parents’ mastery goals emphasis in both school types.

Students in democratic schools also perceived their parents as emphasizing performance goals less than the students in traditional schools, at all grades tested, with no significant grade-related trends in both types of school (see Figure 4).

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In contrast to perceptions of parents’ emphases, students in democratic schools perceived their schools as having a greater emphasis on mastery goals at all grades but 5th, and a smaller emphasis on performance goals at all grades, than students in traditional schools (see Figure 5). Students’ perception of their schools’ mastery goals emphasis declined in traditional schools as they got older, especially after the transition to middle school, while in democratic schools no significant trend was found. Just the opposite was detected in students’ perceptions of their schools’ performance goals emphasis: a significant decline in democratic schools, and no significant trend in traditional ones.

Table 5 offers a summary of all the findings presented above.

Discussion

Past studies showed that students’ motivation to learn science declines during their adolescence years (e.g., Anderman & Young, 1994; Simpson & Oliver, 1990). These troubling findings are once again supported by the results of our study, showing a decline in students’ motivation to learn science from 5th to 8th grade in Israeli traditional schools. This decline was apparent in students’ motivation for school science learning (personal mastery goals and classroom engagement) as well as in their continuing motivation (engagement in and rejection of extra-curricular science related activities). Not only do these students get less and less engaged in science learning at school, they also get less engaged in science-related activities out of school and even worse—they develop resentment to science-related activities (extra-curricular rejection). This kind of resentment can lower the chances of them becoming lifelong science learners.

The decline in students’ motivation for science learning has been linked to the transfer from elementary school to middle school (Braud, 2009; Braunda & Drivera, 2005; Galton, 2009; Logan & Skamp, 2008; Neathery, 1997; Speering & Rennie, 1996; Yager & Penick, 1986). Our results also indicate such a decline as students transfer from elementary school to middle school. However, like other researchers have suggested (Pell & Jarvis, 2001; Tymms, Bolden, & Merrell, 2008), our results also show that in Israel, the decline starts earlier, in elementary school, as students climb from 5th to 6th grade (in Israel, middle schools start at 7th grade). It is possible that preparing for middle school influences students’ motivation in the last
elementary grade, but at the same time it is possible that the trend of decline starts earlier, maybe even at 1st grade. Yager and Penick (1986) concluded their investigation of students’ attitudes towards science in 3rd to 11th grade by claiming: “The more years our students enrol in science courses, the less they like it. Obviously, if one of our goals is for students to enjoy science and feel successful at it, we should quit teaching science in third grade. Or perhaps we should try teaching it differently” (p. 360). It is worth mentioning that according to our results the decline in students’ motivation (personal mastery goals, classroom engagement, and continuing motivation) levels out as students move from 7th to 8th grade. Of course this does not mean that it does not change later, as students transit to high school.

In contrast to all the studies mentioned in this paper, we did not find any decline in students’ science motivation, among students in democratic schools. In democratic schools, the levels of personal mastery goals, classroom engagement and continuing motivation seem to stay more or less stable throughout the years of early adolescence. Thus, as inferred before by others (Osborne et al., 2003; Yager & Penick, 1986) but not demonstrated, it appears that the decline in motivation and continuing motivation for science learning is indeed not an inevitable developmental trend.

Figure 3. Classroom engagement, extra-curricular engagement, and extra-curricular rejection of science activities, in 5th through 8th grade in traditional and democratic schools. Error bars represent standard errors (±1 SE).
Our findings present motivational profiles which change differently with age in the two types of schools. In traditional schools, the typical 5th grader is relatively highly performance oriented and highly engaged in science learning in school and out of school, in comparison to his 5th grader peer in the democratic school. By 8th grade this student will typically be relatively low mastery oriented, highly performance oriented and highly rejecting extra-curricular science activities, in comparison to his 8th grader peer in a democratic school.

The higher engagement found in traditional schools’ 5th graders in comparison to democratic schools, implies that democratic schools do not simply promote pre-existing motivation. It seems that the differing trends in students’ motivation and the differences found in 8th grade are driven more by the differing school environments than home environments. Supporting this claim are the findings that democratic schools’ students actually perceive their schools as emphasizing mastery goals more than traditional schools’ students do (in all but 5th grade), and that democratic schools’ students perceive their parents as having lower mastery goals emphases than traditional schools’ students do (in all grades but 8th grade). This finding does not match previous findings which suggested that parental influence might be stronger than school-context influence (Friedel et al., 2007). However, previous findings regarding the relation between parental emphases and students motivation seldom focused on age differences. Maehr (1991) found that the combined effect of family and school on students’ motivation changes with age. Young students are relatively more influenced by their parents whereas older students are relatively more influenced by their school. Thus it is possible that traditional schools’ 5th graders’ higher engagement is related to their perception of higher parent’s mastery goals emphasis.

Unlike the findings regarding mastery goals, performance goals, while higher in all grades in traditional schools than in democratic schools, remained relatively constant with time, in both types of schools, except for a very small decline in performance avoidance goals in traditional schools. This finding contradicts previous studies, which found higher levels of performance goals in middle than in elementary

*Figure 4.* Perceived parents mastery and performance emphases in 5th through 8th grade in traditional and democratic schools. Error bars represent standard errors (± 1 SE).
Figure 5. Perceived school mastery and performance emphases, in 5th through 8th grade in traditional and democratic schools. Error bars represent standard errors (±1 SE).

Table 5
Summary of results

<table>
<thead>
<tr>
<th>Grade/School Type</th>
<th>Variables With Significant School Type-Related Differences</th>
<th>Variables With Significant Age-Related Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5th</td>
<td>6th</td>
</tr>
<tr>
<td>Personal mastery goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal performance approach goals</td>
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<td>Personal performance avoidance goals</td>
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<td>Classroom engagement</td>
<td>T*</td>
<td></td>
</tr>
<tr>
<td>Engagement in extra-curricular activities</td>
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<td></td>
</tr>
<tr>
<td>Rejection of extra-curricular activities</td>
<td></td>
<td>T*</td>
</tr>
<tr>
<td>Perceived parents mastery emphasis</td>
<td>T***</td>
<td>T***</td>
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<tr>
<td>Perceived parents performance emphasis</td>
<td>T***</td>
<td>T***</td>
</tr>
<tr>
<td>Perceived school mastery emphasis</td>
<td>T***</td>
<td>T***</td>
</tr>
<tr>
<td>Perceived school performance emphasis</td>
<td>T***</td>
<td>T***</td>
</tr>
</tbody>
</table>

T = higher mean value in traditional schools; D = higher mean value in democratic schools; N = negative trend; P = positive trend.

* p < 0.05.

** p < 0.01.

*** p < 0.001.

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schools (Anderman & Anderman, 1999; Anderman & Midgley, 1997; Meece, 1991). It is possible that these different results indicate differences between countries (the previous studies were done in the US, the present study in Israel), or changes that have developed over the last decade (the previous studies were done in the nineties). With high-stakes tests becoming a major influence in schools, including elementary schools, the focus on standardized evaluation may have led to an increase in performance goals at the elementary level.

Our findings suggest that traditional schools promote students’ performance approach and avoidance goals in comparison to democratic schools. However, it seems that this effect is combined with the influence of home environment, as students in traditional schools perceive both their schools and their parents as having a greater emphasis on performance goals than democratic schools’ students do. It is important to distinguish between performance approach and avoidance goals, as it is not yet clear whether performance approach goals promotes positive learning patterns but there is plenty of evidence showing that performance avoidance goals are associated with maladaptive patterns of learning (Kaplan & Maehr, 2007).

As stated by others (Braund, 2009; Braunda & Drivera, 2005; Galton, 2009; Logan & Skamp, 2008; Neathery, 1997; Osborne et al., 2003; Speering & Rennie, 1996; Yager & Penick, 1986), it appears that something happens to adolescents during their years at traditional schools, hindering their motivation for science learning, and causing it to decline. However, this decline is not inevitable, since apparently it does not exist in the democratic schools. Moreover, it appears that traditional schools promote students’ performance approach and avoidance goals in comparison to democratic schools. Zanzuri (1997) also found differences in students’ motivation (for school learning in general) between a democratic high school and a traditional one, which were related to the students’ perception of the democratic atmosphere in the school and in the classroom.

Just as there is great variation among traditional schools, all democratic schools are also not identical. However, there are certain core features that are common to almost all democratic schools and typically not found in traditional schools (Website AERO, 2008a). The most apparent difference between the two school systems is that in democratic schools, students are allowed to make more choices about their learning: they may choose what subjects they will learn, and to some extent, with whom and how much they will learn. Deci and Ryan (1985) pointed out that self-determination can foster motivation. Many other studies support the notion that students’ sense of autonomy and control over their academic activities promotes their motivation to engage in such activities (e.g., Assor et al., 2005; Deci & Ryan, 1987; Grolnick & Ryan, 1987; Patrick, Skinner, & Connell, 1993; Skinner & Belmont, 1993). Research in science education also stressed the advantages of providing opportunities for students to take control of their learning and be involved in making choices about curriculum, teaching, and learning strategies (e.g., Osborne et al., 2003; Pascarella et al., 1981; Piburn & Baker, 1993). However, several researchers have spoken about the challenges involved in giving children greater amounts of control and autonomy than they are developmentally prepared for (Ames, 1992a; Corno & Rohrkemper, 1985; Eccles et al., 1991). Giving young children too much freedom in decision making, without appropriate support, may be intimidating and yield counterproductive outcomes. This may explain why 5th grade students in democratic schools reported lower classroom and extra-curricular engagement than their peers in traditional schools. Perhaps the freedom adolescents have in democratic schools to choose what to learn enhances their motivation to learn science when they are mature enough to cope with this freedom, but decreases their motivation when they are still too young.

There are additional differences between democratic and traditional schools’ cultures, which may have influence on students’ motivation: (A) Democratic schools are usually K-12 schools (or they are growing, aiming to become K-12). Thus students can stay in the same school through all their schooling years. In traditional schools, however, students usually transfer at the end of 6th grade from a relatively small elementary school to a larger middle school; (B) Students in democratic schools usually have a personal mentor that supports their needs at school; (C) In democratic schools, classes are heterogeneous—there is no grouping according to ability; (D) Classes in many democratic schools are aged mixed, usually in the range of 2–3 age levels, and the number of students in each class is usually smaller than in traditional schools; (E) Students play a large role in managing the daily life in democratic schools; and (F) Teachers in democratic schools usually have much greater autonomy than in traditional schools, they seldom use tests and grades for evaluation and their relationships with their students tend to be less formal.
Which of these features, or which combination of them, is responsible for the different influence democratic schools have on adolescents’ motivation and continuing motivation to learn science? Previous investigations into students’ motivation and attitudes towards science related mainly to instruction practices, such as student-centered instruction, classroom discussions, variety in teaching, the pacing of lessons, and the availability of personal support (Logan & Skamp, 2008; Osborne et al., 2003; Simpson & Oliver, 1990; Speering & Rennie, 1996). Does the non-declining motivation for science learning in democratic schools’ result from instructional practices that differ from those used in traditional schools or does it result from organizational and other cultural differences? The answers to these questions are beyond the scope of this study and should be the subject for further study. Also required is a more careful examination of the relative influence schools and parents have on students’ science motivation at different ages. Future study may also look into gender differences and domain specific differences (e.g., biology vs. physics).

To summarize, this study indicates that adolescents’ declining motivation to learn science is not inevitable and offers new insights into ways to deal with this issue.

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