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The Status of Science and Technology Relative to Other School Subjects. Results of a Study Conducted on Primary and Secondary School Students in Quebec

Abdelkrim Hasni
Université de Sherbrooke, CANADA
Patrice Potvin
Université du Québec à Montréal, CANADA
Vincent Belletête
Université de Sherbrooke, CANADA

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ABSTRACT
In recent decades, many studies have examined students' interest in science and technology (S&T) at school. However, few investigations have studied this interest in a manner that accounts for the status that students assign to this subject relative to other subjects in the curriculum. The main objective of this article is to conduct such an examination. To assess this issue, three dimensions have been considered: ease, relative preference, and relative importance. This study, which included 2,571 students, reveals that S&T occupies an intermediate position relative to other subjects, with only slight differences between boys and girls. However, there are important differences across school years: 1) S&T is perceived to be increasingly difficult as students' progress in their schooling; 2) relative preference for S&T decreases during the primary-secondary school transition but subsequently rises; and 3) the relative importance of S&T increases compared with all other subjects as students advance in their education. Significant correlations are observed between the latter two dimensions and students' intentions to pursue studies or careers in S&T.
Keywords: school subjects, interest in S&T, S&T careers, relative importance of S&T, relative preference of S&T.

INTRODUCTION

In recent decades, numerous studies have examined student relationships to science and technology (S&T) at school while taking into account notions of interest, motivation, and attitude (I/M/A) (Potvin & Hasni, 2014). This relationship serves as a potential predictor of student engagement in S&T courses and of their intentions to pursue studies or careers in

Correspondence: Abdelkrim Hasni, *CREAS, Université de Sherbrooke, 2500 boul. de l'Université, Sherbrooke (QC), J1K2R1, Canada.*
A.Hasni@USherbrooke.ca

State of the literature

- In recent decades, numerous studies have examined students' relationship to science and technology (S&T) at school through the constructs of interest, motivation and attitude.
- These studies described factors that influence these constructs, such as gender, grade level, teaching methods, participation in out-of-school cultural activities, etc.
- However, these studies analysed interest in S&T without comparing it to other subjects that make up the curriculum. Consequently, they do not allow to confirm, for example, whether the decline in interest by school year applies only to the S&T topics or whether it is merely the result of a general decline in student interest in school or in all subjects that compose the curricula.

Contribution of this paper to the literature

- In this article we present the results of a study that explored the relative status that students give to S&T in comparison to other school subjects: perception of ease, relative preference and relative importance.
- Although various studies that have specifically examined S&T show that student interest in this subject decreases as they grow older, our study shows that S&T increases in perceived importance in relation to all other curriculum subjects (taken one by one) and in perceived preference in relation to many other school subjects.
- Finally, the perception of ease of S&T does not appear to be correlated with students' intention to pursue studies in the field. However, this intention seems to be influenced by the relative importance and the relative preference that students give to different disciplines.

related fields (Ainley, Corrigan, & Richardson, 2005; Ainley, Hidi, & Berndorff, 2002; Bates, Galloway, Loptson, & Slaughter, 2011; Christidou, 2011; Krapp & Prenzel, 2011).

Many studies have described this relationship while examining S&T in general, its component disciplines (biology, chemistry, physics, etc.), or specific issues explored and teaching methods used in the classroom (e.g., Baram-Tsabari, Sethi, & Yarden, 2010; Bates et al., 2011; Christidou, 2011; Haussler & Hauffman, 1987, 2002; Jocz, Zhai, & Tan, 2014; Jones, Howe, & Rua, 2000; Murphy, Ambusaidi, & Beggs, 2006; Murphy & Beggs, 2003; Swarat, Ortony, & Revelle, 2012). These studies and resulting literature reviews (Christidou, 2011; Krapp & Prenzel, 2011; Potvin & Hasni, 2014; Renninger & Hidi, 2011; Ruthven, 2011; Schraw & Lehman, 2001) have led many researchers and organizations (Commission européenne, 2008; OECD, 2008; Ourisson, 2002; Porchet, 2002) to speak of student 'disinterest' (or decrease in I/M/A) in S&T and in related careers:

1) Most studies show that student interest (I/M/A) in S&T decreases as students advance to higher grade levels. This has been found to be the case, for instance, in studies performed in the U.K. (Barmby, Kind, & Jones, 2008; Bennett & Hogarth, 2009; Owen, Dickson, Stanisstreet, & Boyes, 2008; Pell & Jarvis, 2001), the U.S.A. (Alexander, Johnson, & Kelley, 2012; Sorge, 2007; George, 2006), Turkey (Cavas, 2011;

Kirikkaya, 2011), Israel (Vedder-Weiss & Fortus, 2011), and Hong Kong (Cheung, 2009).

2) Not all students who express considerable interest (I/M/A) in S&T intend to pursue studies or careers in related fields (OECD, 2006).
3) Differences are often found between girls and boys: While some studies show no significant differences according to gender (Krstovic, Brown, Chacko, & Trinh, 2008; Wang & Berlin, 2010; Zeyer & Wolf, 2010), a number of others show that girls exhibit less interest in S&T studies and in certain careers related to this field (e.g., Adesoji & Raimi, 2004; Badri, Al Mazroui, Al Rashedi, & Yang, 2016; Caleon & Subramaniam, 2008; Barmb et al., 2008; Desy, Peterson, & Brockman, 2011; van Griethuijsen, van Eijck, Haste, den Brok, Skinner, Mansour, BouJaoude, 2015). Other studies show that girls and boys express differing levels of interest in different subject areas: girls generally exhibit a stronger preference for life sciences than boys, while the opposite is observed for physics, chemistry, and technology (e.g., Baram-Tsabari & Yarden, 2011; Buccheri, Gurber, & Bruhwiler, 2011; Krapp & Prenzel, 2011).

As the above-cited studies and resulting syntheses show (Christidou, 2011; Krapp & Prenzel, 2011; Renninger & Hidi, 2011; Potvin & Hasni, 2014; Schraw & Lehman, 2001), such results are essentially based on studies of interest (I/M/A) that specifically address S&T issues (S&T in general, its component disciplines, its usefulness to life outside of school, related teaching methods, etc.) and are not based on those that compare S&T topics with other subjects. Consequently, these findings do not allow us to confirm, for example, whether the decline in interest by school year applies only to the subject of S&T or whether it is merely the result of a general decline in student interest in school or in all subjects that compose curricula.

To better understand student interest in S&T at school, it is necessary to conduct studies that ask the following questions: 'How high are students' interests in science compared with other subjects?' (Krapp & Prenzel, 2011, p. 40) or 'How popular is science compared to other subjects?' (Osborne, Simon, & Collins, 2003, p. 1056). In other words, it is important to consider the relative status of S&T (its status relative to that of other curriculum subjects). This is the central topic of the present article. In their literature review on student attitudes toward S&T, Osborne, Simon, and Collins (2003) underline that few studies have examined this issue. Recent syntheses of interest-focused research (Krapp & Prenzel, 2011; Potvin & Hasni, 2014) confirm this observation. The few studies that have examined the issue, despite being one-time studies, have examined questions that fall under two dimensions: degree of ease and order of preference.

Degree of ease

In their literature review, Osborne et al. (2003) find 'students' perception of science as a difficult subject as being a determinant of subject choice' (p. 1070). Krapp & Prenzel (2011) review shows that 'While the subjects physics and chemistry, which are considered to be

relatively difficult by the majority of students at the secondary level, are relatively unpopular and are rated as an interesting school subject comparatively seldom […], the subject of biology has much higher scores when it comes to ratings of popularity and interest' (p. 40). Findings reported in Osborne et al. (2003) reveal appear to highlight the same trend. Jones et al. (2000) show that 'more girls than boys perceived science as difficult to understand' (p. 186). Results obtained by Pell & Jarvis (2001) from studies on 800 primary school students reveal an evolution that occurs with age: 'there is a clear trend, common to both boys and girls, to rate science as less difficult and less demanding as they get older' (p. 857). Other studies (Jenkins & Nelson, 2005; Schreiner, 2006) have used specific items ('school science is a difficult subject') to study the degree of ease (or difficulty) relative to S&T, although without comparing it with other subjects.

Order of preference

In their literature review, Osborne et al.(2003) suggest that the relative popularity of S&T as indicated by its order of preference with respect to other subjects gives 'some indication of students' attitudes towards the subject' (p. 1055). The authors also argue that 'some measure of attitudes towards school science can be obtained by asking pupils to rank their liking of school subjects' (p. 1055). Studies described in this last synthesis indicate 'that physics and chemistry were two of the least popular subjects post-14 and that these were distanced in pupils' minds from biology' (p. 1055). Biology appears to be most strongly preferred alongside other subjects such as geography and history.

In two of their studies, Colley, Comber, & Hargreaves (1994a, 1994b) focus on school subject preferences according to gender. In the first study, they show, among other things, that among students of 11-13 years of age, boys prefer physical education and science, while girls prefer English. In the second study, for students of 15-16 years of age, the authors find that girls show a definite preference for the arts while boys prefer mathematics, physical education, and science. A latter study, which focuses on updating research findings (Colley & Comber, 2003), suggests that student preferences have evolved: favourite subjects were found to be those that the authors referred to as 'practical subjects,' namely, art, drama, English, and technology. Among all of these studies, science seems to hold an intermediate position in terms of order of preference. The results of an interview-based qualitative study on 190 children (Hendley, Stables, & Stables, 1996) corroborate the above results. 'When asked which three subjects they liked best, science was ranked fifth out of 12 subjects' (Osborne et al., 2003, p. 1059).

Jovanovic & King (1998) assert that girls are less interested in S&T than boys are, as girls consider themselves to be more proficient at other subjects. This relationship between self-perception and preference across various subjects has also been studied by Hannover & Kessels (2004), who adopted a social psychology-based theoretical framework to examine four school subjects, namely, S&T, mathematics, and languages (German and English). According to these authors, student interest in S&T depends on '(a) the specific image this

subject domain has (in comparison to other domains) and (b) the image students of the relevant age group have of themselves or want to have of themselves' (p. 52). Their 'results showed that the better the match between self and favourite subject-prototype, the stronger were the subject preferences' (p. 51).

The above-mentioned studies provide information on student perceptions of the degree of ease of S&T and on their preferences for this subject. However, such studies are often based on a limited number of items (sometimes one item); many compare component disciplines of S&T (biology, physics, chemistry, etc.) rather than comparing S&T with other school subjects; a limited number of grade levels is covered, preventing a study of the evolution of student perceptions over a long period of time; and such studies do not consider the relationship between relative status levels and intentions to pursue S&T studies or careers. Our study complements previous research in several regards. 1) We do not ask students to rank subjects, for example, based on their order of preference (as has been done in most previous studies), but we instead ask students to compare S&T with each individual curriculum subject (see Methodology section); 2) We also include a third dimension that considers ease and preference levels, namely, the perceived importance of S&T relative to the other subjects; 3) We examine a large number of items, thus enabling a deeper analysis of relative status; 4) We study students of seven different school year levels (from the end of primary school to the end of secondary school), thus allowing us to monitor changes in relative status patterns over a long period; 5) Finally, we describe relationships between the relative status of S&T and student intentions to pursue studies or careers in related fields.

Order of importance

In addition to the two dimensions described above (ease and preference), we introduce a third dimension to describe the relative status of S&T: the level of importance students assign to this subject. This sociological dimension focuses on understanding curricular hierarchy effects on students: 'the relative "value" of subjects is determined by their official curriculum designation, creating a hierarchy of learning within which particular subjects are categorized as optional to the educational experience of young people' (Pitfield, 2013, p. 403).

The sociology of curricula, which became a field of study in the 1970s (Forquin, 1997) following the works of Bernstein (1971, 1997) and Young (1971, 1997), offers justification for the value of including this dimension (order of importance) in studies that focus on degrees of interest in S&T. This theoretical framework highlights possible effects of the stratification (hierarchy) of subjects on student academic choices and on student decisions to engage (or not) in their studies and in certain subject areas. For example, several studies on the Quebec context conducted with primary teachers and S&T secondary teachers (Hasni, Lenoir, Larose, & Squalli, 2012; Lenoir & Hasni, 2010) show that these teachers consider languages (French and English) and mathematics to be the most important subjects in student education and that these subjects should consequently be given significant consideration in

school. S&T teachers who took part in one of these recent studies ranked S&T fourth in importance after French (first language), mathematics, and English (second language), arguing that these three subjects are of use outside of school, are necessary for academic success (as their mastery is a precondition for success in other subjects), are fundamental to learning basic skills (reading, writing, and arithmetic), account for a larger portion of school schedules (a ministerial indication of their importance), etc. (Hasni et al., 2012). We thus raise the following questions: What about the student perspective? What degree of importance do students ascribe to S&T relative to other school subjects? Does this level of importance affect interest in S&T and, above all, the intention to pursue studies or careers in related fields? Considering the significant effect teachers and curricula have on students, it is necessary to consider the order of importance of school subjects within the context of studies when analysing the relationship between the relative status of S&T and student intentions to pursue studies or careers in related fields.

RESEARCH QUESTIONS

This article examines the following three research questions:

1) What relative status do students assign to S&T in terms of ease, order of preference, and order of importance relative to other school subjects?
2) How does this relative status vary according to gender and school year?
3) Is there a relationship between relative status levels and student intentions to pursue S&T studies or careers?

STUDY CONTEXT

To shed light on certain items of the questionnaire as well as on our analysis and interpretation of the results, three points regarding the structure of schools in Quebec are worth mentioning here:

1) Since 2001, Quebec schools have been organized into two-year cycles: three cycles of primary school (six years: Y1 to Y6), two cycles of secondary school (Y7 and Y8; Y9 and Y10), and Y11. During the final year of secondary school, students must choose whether or not to pursue science studies by enrolling in optional courses on physics and chemistry.
2) Since the latest reforms were instituted (2001), science education is no longer categorized into independent disciplines (biology, physics, chemistry, etc.) but is rather organized as an integrated program. Thus, from primary school until Y10, science disciplines are grouped under the subject of 'Science and Technology' (S&T), which is composed of integrated content drawn from a variety of scientific fields (biology, chemistry, physics, geology, and astronomy) and from technological fields. Content distribution and depth levels vary from one school year to the next.
3) The social sciences, which have undergone similar changes, now bring together content from history, geography, and citizenship education.

DATA COLLECTION AND ANALYSIS PROCEDURES

Data examined in this article were drawn from a broader study conducted on a sample of 2,571 students (1,448 girls and 1,123 boys) from the Montreal area enrolled in the fifth year of primary school (Y5) to the fifth year of secondary school (Y11), thus representing a total of seven school years. These students come from 40 schools belonging to the five largest school boards in Quebec, all of which are partners of the *Chaire de recherche sur l'intérêt des jeunes à l'égard des sciences et de la technologie* (CRIJEST). Schools were selected in consultation with school board staff, who were instructed to target students who best represented their respective school populations.

The questionnaire used for the study was developed by adapting questions (items) used in other international studies (Ainley & Ainley, 2011; Haussler & Hoffmann, 2002; House, 2009; Juuti, Lavonen, Uitto, Byman, & Meisalo, 2010; Kanter & Konstantopoulos, 2010; Lamb, Annetta, & Vallett, 2012; OECD 2006; Tuan, Chin, & Shieh, 2005) to our own research objectives and to the Quebec context. It includes 139 questions covering 20 dimensions that are intended to examine student interest in S&T and in related careers. The questionnaire was validated with 220 students prior to its official distribution. It was also subjected to statistical validation (Hasni & Potvin, 2015). To allow each student to complete the questionnaire in less than 30 minutes, two versions that each contain a portion of the 139 questions were produced. Many of the components and items appear in both versions to allow us to make desired comparisons across the entire sample, explaining why the number of respondents for some items does not match the total number for the sample.

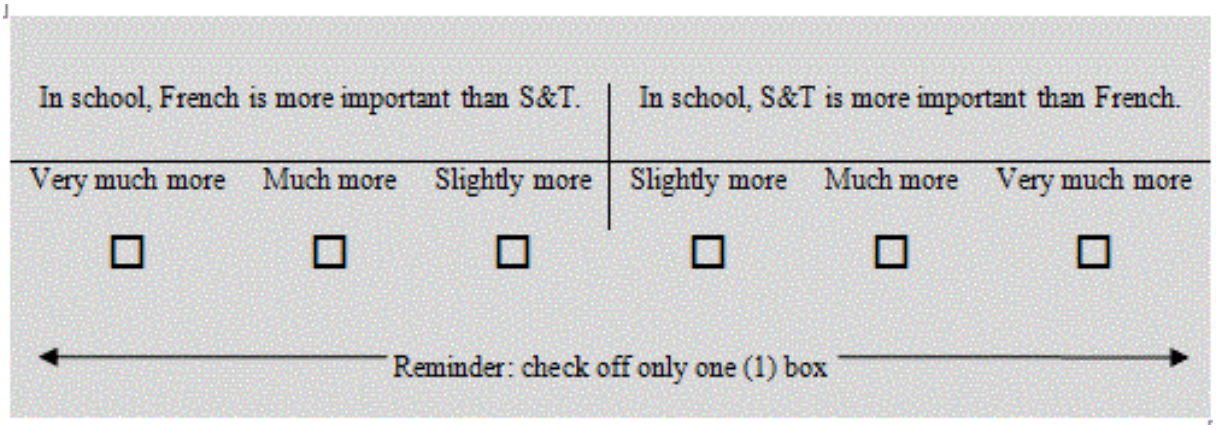

Figure 1. Example of a question focused on studying relative status levels.

Data examined in this article were obtained from 24 questionnaire items, allowing us to study three dimensions of relative status and student intentions (or lack thereof) to pursue S&T studies or careers:

1) Student preferences for S&T relative to the six other main curriculum subjects (the arts, physical education, French, English, mathematics, and the social sciences) were studied using six items (Cronbach's alpha: $\alpha = 0.699$).

2) The same approach was used to study the importance of S&T relative to the other subjects (six items; α = 0.735). The chosen items correspond to six-point Likert scales. **Figure 1** illustrates the item format. This format was chosen to allow students to compare S&T with the other curriculum subjects for each item. We thus use the expressions 'relative preference' and 'relative importance' as opposed to the terms 'order of preference' or 'order of importance' in designating these dimensions.
3) The perceived degree of ease related to S&T and to the six other subjects was studied using seven items (α = 0.830) over a scale ranging from one (very difficult) to six (very easy).
4) The intention to pursue S&T studies or careers later on, which we hereafter refer to as the *Intention to act*, was explored using five questions (α = 0.906) on an agreement scale from one (strongly disagree) to six (strongly agree):

   - *I intend to learn more about careers in S&T*;

   - *I intend to pursue studies in S&T;*

   - *I will certainly not pursue studies in S&T (reversed item);*

   - *I intend to pursue a career in S&T later on;*

   - *I will certainly not pursue a career in S&T later on (reversed item).*

To analyse the data, SPSS® software was used. Descriptive analyses (percentages, means, and standard deviations) provided a general portrait of the sample in terms of the three examined dimensions (degree of ease, relative preference, and relative importance) (objective 1). Following from analytical techniques used in many past studies (e.g., House, 2009; Juuti et al., 2010; Kanter & Konstantopoulos, 2010), we conducted comparison of means tests to study variations according to gender and school year (objective 2). More specifically, we conducted a *t* test to study the answers according to gender, and we conducted an analysis of variance (ANOVA) to study variations according to school year. For the latter analyses, we also conducted a post hoc Bonferroni test to identify significant mean differences between each of the groups (the seven school years). It was thus possible to identify moments when the most significant changes in relative status took place over the course of schooling. To study the relationship between the relative status of S&T and the *Intention to act* (objective 3), we conducted correlation tests.

STUDY LIMITATION

Two limitations of our study are worth mentioning:

1) The study is based on quantitative data that provide us with information on the relative status students assign to S&T and on a potential relationship between this ascribed status and intentions to pursue studies or careers in related fields. However, it does not provide reasons why students have certain views on S&T. Other studies based on qualitative data may shed important light in this regard.

2) Questions (items) on two of the three dimensions of relative status (preference and importance) are based on a format that facilitates individual comparisons between S&T and other subjects (**Figure 1**). This is not the case for the 'degree of ease' dimension items, for which students were asked to present their opinions on the degree of ease (or difficulty) of each subject without comparing it to S&T. The validity of the results is not affected by this difference in item format. However, this difference has led us to present results of this dimension (degree of ease) differently than the results of the two other dimensions (relative preference and relative importance).

RESULTS

We present the results by addressing each of the three objectives.

Relative status of S&T: overview (objective 1)

Degree of ease

Table 1 shows that in regards to perceived ease, all of the subjects score higher than the mean value on the six-level scale (3.50), denoting that students generally consider these subjects easy. The subject of S&T ranks fourth, generating roughly the same mean value as mathematics and French (4.04). Students generally consider physical education, English, and social sciences to be easier than S&T.

Table 1. Degree of ease of curriculum subjects

	Physical education	English	Social sciences	Mathematics	S&T	French
M (SD)	5.15 (1.19)	4.24 (1.62)	4.27 (1.43)	4.04 (1.49)	4.04 (1.35)	4.04 (1.43)

Note: Data on the arts are absent.

Relative preference

To simplify our presentation of the results and to facilitate table and graph comprehension, we present subjects as a reference by examining their degree of preference relative to that of S&T (reversed scale). For each subject, a mean value above the mid-point of the scale (3.50) denotes a higher preference for a given subject relative to S&T; a mean value below the mid-point of the scale denotes a lower preference for a given subject relative to S&T. The same technique is used to present results on relative importance levels.

Table 2. Relative preferences for each curriculum subject relative to that of S&T

	Physical education	Arts	Mathematics	English	Social sciences	French
M (SD)	3.91 (1.79)	3.85 (1.81)	3.50 (1.63)	3.14 (1.71)	3.11 (1.62)	2.97 (1.62)

Table 2 shows that physical education and the arts are (slightly) preferred over S&T, while the opposite is true of English, the social sciences, and French. The mean for mathematics stands at 3.50, denoting that student preferences for this subject are comparable to their preferences for S&T.

Relative importance

Table 3 shows that the students universally consider mathematics (which has the highest mean), French as a first language, and English as a second language to be more important than S&T (means higher than 3.50). By contrast, they generally consider the social sciences, physical education, and the arts to be less important than S&T.

Table 3. Relative importance of each curriculum subject relative to that of S&T

	Mathematics	French	English	Social sciences	Physical education	Arts
M (SD)	4.46 (1.24)	4.33 (1.51)	3.98 (1.56)	2.97 (1.31)	2.97 (1.61)	2.35 (1.39)

Variations in relative status according to gender (objective 2)

Table 4 shows variations in relative status levels (ease, preference, and importance) according to gender.

Degree of ease

With the exception of English, it appears that girls and boys do not share the same views on school subject degrees of ease in general and in regards to S&T in particular. Girls consider French to be easier than boys do. The opposite is found for all other subjects. However, differences between mean values found are not very substantial and only exceed 0.53 for French (in favour of girls) and mathematics (in favour of boys). As for S&T, the difference in means stands at 0.35, in favour of boys.

Relative preference

In regards to relative preferences for mathematics and the social sciences (compared with S&T), there seems to be no distinction between boys and girls: differences in mean values generated are not statistically significant. Boys exhibit a stronger relative preference for physical education (compared to S&T) than girls. The opposite can be observed for languages (French and English), with a difference in means of approximately 0.5.

Table 4. Variations in the relative status of each subject relative to that of S&T by gender

Item	Girls M(SD)	Boys M(SD)	ΔM; *t* value
Degree of ease of each subject			
Physical education	4.98 (1.29)	5.38 (1.00)	-0.40; $t(1284) = -6.06$***
English	4.22 (1.61)	4.27 (1.63)	n.s.
Social sciences	4.17 (1.47)	4.40 (1.37)	-0.23; $t(1277) = -2.76$**
Mathematics	3.79 (1.50)	4.39 (1.40)	-0.60; $t(1216) = -7.00$***
S&T	3.89 (1.35)	4.24 (1.33)	-0.35; $t(1282) = -4.56$***
French	4.26 (1.37)	3.73 (1.46)	0.53; $t(1293) = 6.74$***
Preference for subject x relative to S&T (relative preference)			
Physical education	3.69 (1.79)	4.22 (1.76)	-0.53; $t(1235) = -5.20$***
Arts	4.28 (1.66)	3.27 (1.85)	1.01; $t(1237) = 10.06$**
Mathematics	3.43 (1.65)	3.58 (1.60)	n.s.
English	3.33 (1.70)	2.89 (1.69)	0.44; $t(1243) = 4.44$***
Social sciences	3.15 (1.57)	3.07 (1.71)	n.s.
French	3.26 (1.63)	2.58 (1.53)	0.68; $t(1240) = 7.54$***
Importance of subject x relative to S&T (relative importance)			
Mathematics	4.49 (1.22)	4.43 (1.27)	n.s.
French	4.45 (1.47)	4.17 (1.56)	0.28; $t(1238) = 3.31$**
English	4.08 (1.50)	3.84 (1.62)	0.24; $t(1232) = 2.72$**
Social sciences	3.02 (1.27)	2.91 (1.37)	n.s.
Physical education	2.84 (1.54)	3.14 (1.69)	-0.30; $t(1231) = -3.25$**
Arts	2.47 (1.37)	2.20 (1.40)	0.27; $t(1233) = 3.43$**

* $p<0.05$; ** $p<0.01$; *** $p<0.001$; n.s.: not significant

Relative importance

As with relative preference, there appears to be no distinction between boys and girls in regards to the relative importance of mathematics and of the social sciences (compared to S&T): differences in means are not statistically significant. Girls do stand apart from boys in terms of the higher relative importance they assign to languages and the arts (with respect to S&T). However, in all cases, differences in the observed means are slight.

Variations in relative status levels according to school year (objective 2)

To examine changes in relative status according to school year, two indicators were used:

a) The mean variation from one school year to the next (Y5 to Y6, Y6 to Y7, etc.). This indicator is used to describe the progressive evolution of relative status over the course of schooling.
b) Mean disparities between the final year of primary school (Y6) and the end of secondary school; this indicator allows us to verify a hypothesis put forth by many studies that students lose interest in S&T over the course of secondary school relative to their degree of interest during primary school. Given that Y11 is a 'specialization' year in Quebec, we calculated this mean difference between Y6 and Y10 (before specialization) and between Y6 and Y11 (after specialization) (see the last two columns in **Tables 5 to 8**).

Degree of ease

Figure 2 and **Table 5** show that the perceived degree of ease of physical education and French does not vary significantly over the seven years of schooling covered by the study. For the other subjects, a decrease can be seen during the primary-secondary school transition, with a low point occurring in Y8: for students of this school year, all subjects are viewed as presenting a lower degree of ease than in Y6. Analyses complementary to those presented in **Table 5** show that the drop in means between Y6 and Y8 is significant for S&T (1.2***) and the social sciences (0.67*). In other words, these two subjects decline the most in terms of perceptions of ease between Y6 and Y8. For mathematics, these variations are not significant between Y6 and Y8. After Y8, the perceived degree of ease varies depending on the subject (**Figure 2**): non-significant variations can be observed for S&T and mathematics (which remain the most difficult during the second cycle of secondary school); a considerable increase can be seen for English (which is viewed as becoming progressively easier); and fluctuations are observed for the social sciences.

The last two columns of **Table 5** show that students approaching the end of secondary school (Y10 and Y11) view three subjects as being more difficult than students approaching the end of primary school (Y6), namely, mathematics, S&T, and the social sciences. It is important to note, however, that the greatest drop in mean values between Y6 and Y10 (0.94) pertains to S&T. The social sciences recover a slightly higher degree of ease between Y10 and Y11, as the mean for Y11 students is similar to that for Y6 students (no statistically significant difference).

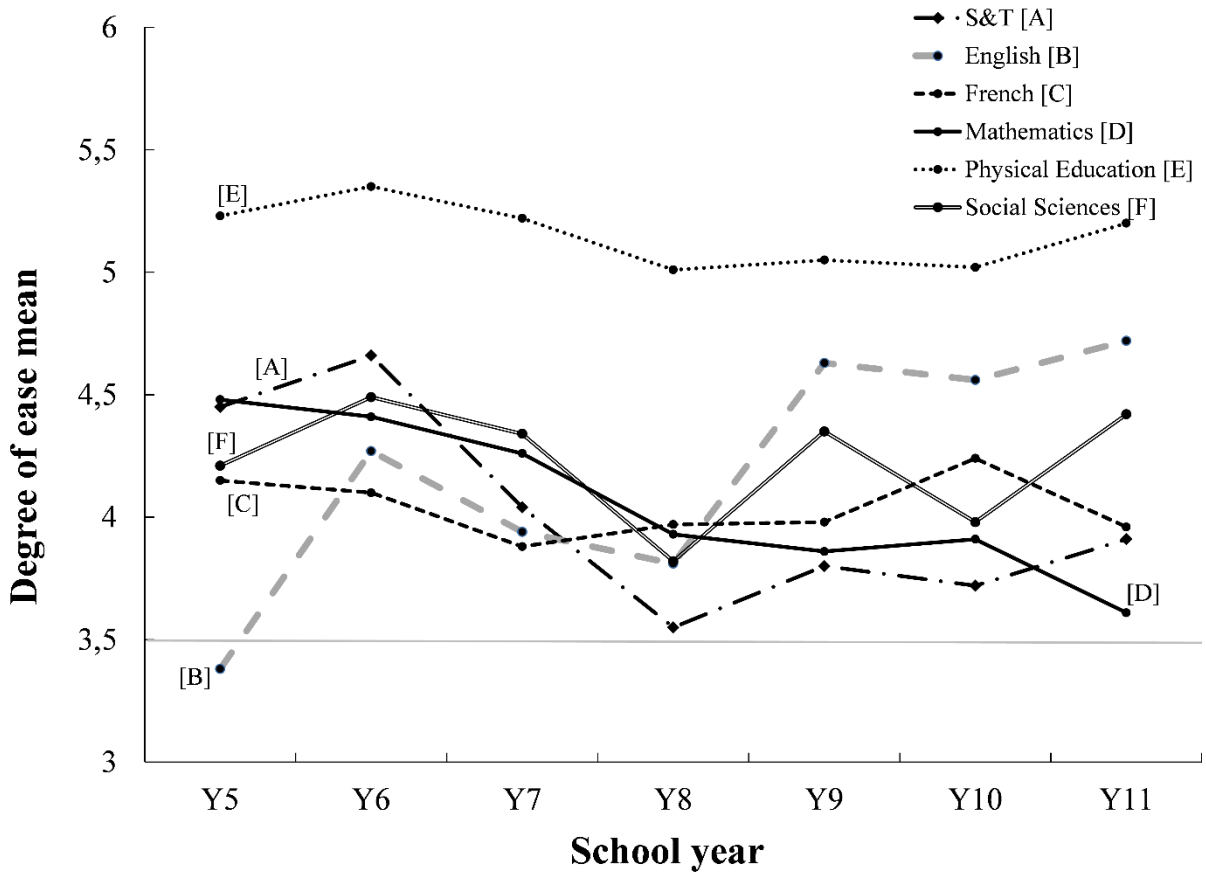

Figure 2. Perceived degree of ease by school year

Table 5. Perceived degree of ease by school year

Subject	F (sig.)	ΔM between school years (MY_n- MY_{n-1}): Post hoc, Bonferroni tests							
		Y5 to Y6	Y6 to Y7	Y7 to Y8	Y8 to Y9	Y9 to Y10	Y10 to Y11	Y6 to Y10	Y6 to Y11
Physical education	F (6, 1275) = 2.188 n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
English	F (6, 1280) = 16.422 ***	0.89***	n.s.	n.s.	0.82**	n.s.	n.s.	n.s.	n.s.
S&T	F (6, 1273) = 14.888***	n.s.	-0.62***	n.s.	n.s.	n.s.	n.s.	-0.94***	-0.75***
French	F (6, 1284) = 1.616 n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Mathematics	F (6, 1207) = 9.435***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.50*	-0.79**
Social sciences	F (6, 1268) = 3.809**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.51**	n.s.

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Relative preference

Figure 3 and **Table 6** enable us to distinguish between two groups of subjects:

1) Preferences for mathematics and physical education progressively decrease in favour of S&T between Y6 and Y9 (primary-secondary school transition), with a slight rise in preferences thereafter between Y9 and Y10. Year-to-year variations are not statistically significant (**Table 6**). Analyses complementary to those reported in **Table 6** show that these variations amount to a significant loss in preferences (mean decrease of 0.90**) for mathematics between Y5 and Y9. Non-significant variations are subsequently observed between Y9 and Y10 (or Y11).
2) The four other subjects overtake S&T between Y6 and Y7 (French and the arts) and between Y6 and Y8 (English and the social sciences). In other words, these subjects become increasingly preferred over S&T. Between Y8 and Y10, however, a general downward trend in the means of various subjects is found (**Figure 3**), denoting a drop in relative preferences for these subjects relative to those for S&T. In other words, students begin to prefer S&T slightly more as of Y8.

When we compare mean values at the end of the last year of primary school (Y6) and at the end of secondary school (Y10 or Y11), the difference is statistically significant for only one subject, namely, the social sciences (mean difference of 0.79). This result denotes that students approaching the end of secondary school prefer the social sciences more heavily (relative to S&T) relative to students approaching the end of primary school.

Relative importance

Figure 4 and **Table 7** show that the relative importance of all subjects (relative to S&T) progressively and globally decreases from Y6 to Y10, denoting that the further students' progress in their education, the more important S&T becomes to them relative to each of the other subjects.

When examining year-to-year variations, it is evident that for four subjects, namely, physical education, arts, mathematics, and social sciences, mean values decrease progressively (**Table 7** shows no statistically significant differences between consecutive years). In regards to languages, significant decreases are found in the transition from Y9 to Y10 for English and from Y8 to Y9 and Y9 to Y10 for French. Between Y10 and Y11, all subjects except for mathematics recover some degree of relative importance relative to S&T (**Figure 4**); this gain is significant only for French (mean difference of 0.69) and for the social sciences (mean difference of 0.52) (**Table 7**).

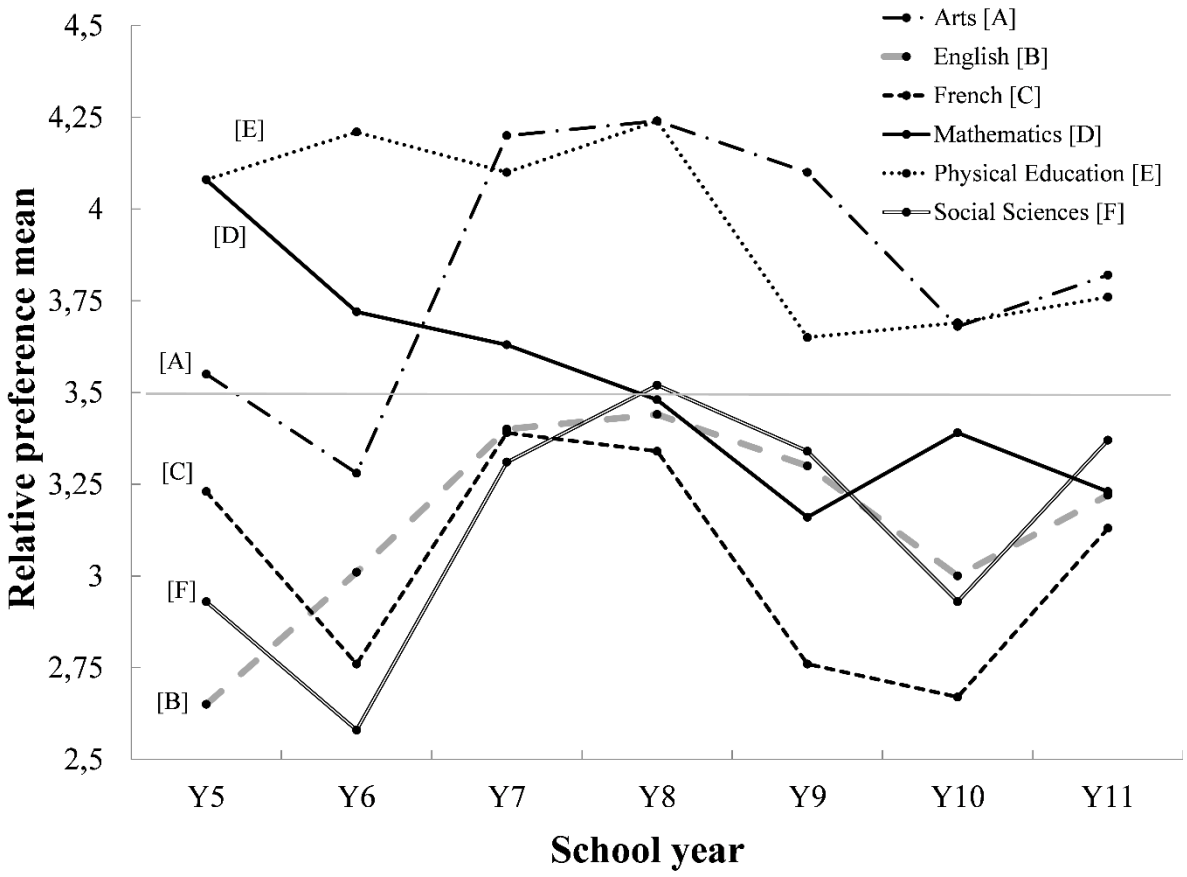

Figure 3. Perceived relative preferences by school year

Table 6. Perceived relative preferences by school year

Subject	F (sig.)	ΔM between grade levels (MY_n- MY_{n-1}): Post hoc, Bonferroni Tests							
		Y5 to Y6	Y6 to Y7	Y7 to Y8	Y8 to Y9	Y9 to Y10	Y10 to Y11	Y6 to Y10	Y6 to Y11
Physical education	F (6, 1226) = 3.572**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
English	F (6, 1234) = 4.173**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Arts	F (6, 1228) = 7.137***	n.s.	0.93***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
French	F (6, 1231) = 6.761***	n.s.	0.63***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Mathematics	F (6, 1232) = 6.674***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Social sciences	F (6, 1233) = 6.764***	n.s.	0.72***	n.s.	n.s.	n.s.	n.s.	n.s.	0.79**

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

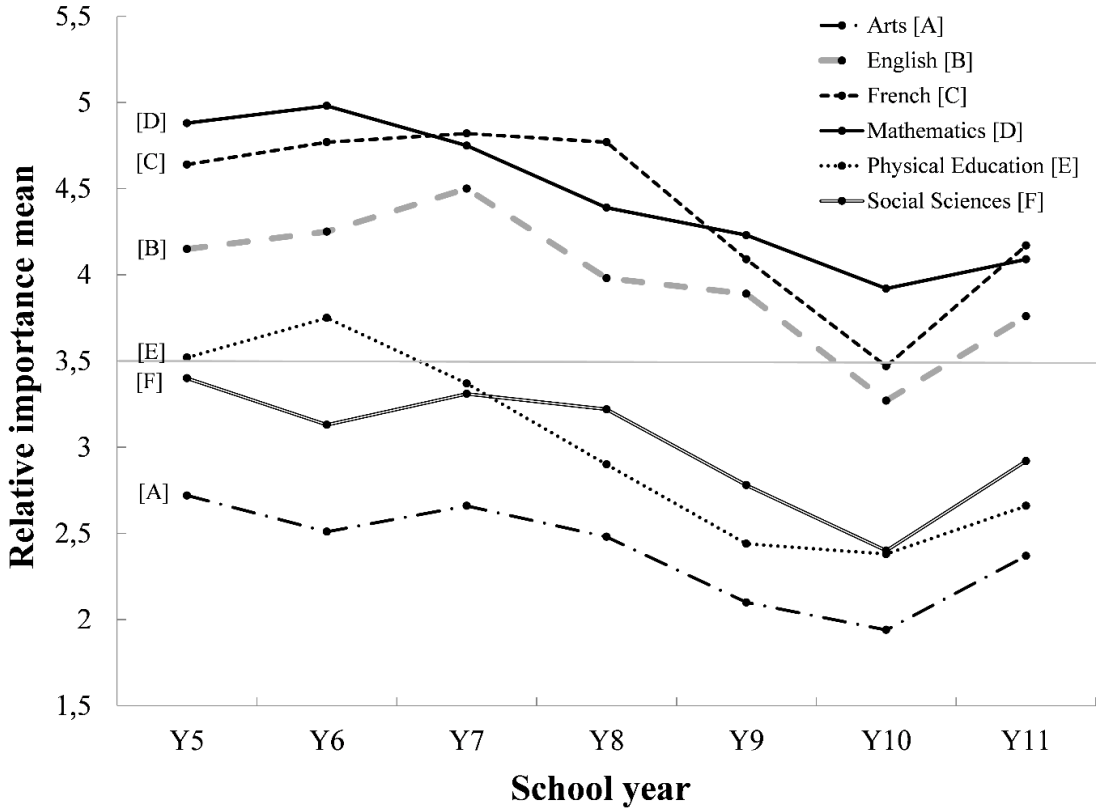

Figure 4. Perceived relative importance by school year

Table 7. Perceived relative importance by school year

Subject	F (sig.)	ΔM between school years (MY_n- MY_{n-1}): Post hoc, Bonferroni Tests							
		Y5 to Y6	Y6 to Y7	Y7 to Y8	Y8 to Y9	Y9 to Y10	Y10 to Y11	Y6 to Y10	Y6 to Y11
Physical education	F (6, 1228) = 25.904***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-1.37***	-1.09***
English	F (6, 1229) = 14.571***	n.s.	n.s.	n.s.	n.s.	-0.62***	n.s.	-0.98***	n.s.
Arts	F (6, 1230) = 9.212***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-0.57***	n.s.
French	F (6, 1235) = 24.089***	n.s.	n.s.	n.s.	-0.69*	-0.61***	0.69**	-1.29***	-0.60*
Mathematics	F (6, 1231) = 12.050***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	-1.06***	-0.89***
Social sciences	F (6, 1231) = 14.821***	n.s.	n.s.	n.s.	n.s.	n.s.	0.52*	-0.73***	n.s.

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

When considering the gap between the last year of primary school (Y6) and the end of secondary school (last two columns in **Table 7**), it is evident that all subjects decline in relative importance relative to S&T between Y6 and Y10 (before specialization). A substantial decline can be seen in the means of subjects that acquire high status in the hierarchy of subjects, namely, French (mean drop of 1.29), mathematics (mean drop of 1.06), and English (mean drop of 0.98). In Y10, the mean relative importance of these subjects is close to 3.5 (**Figure 3**), denoting that for students of this school year, these subjects are roughly considered to be as important as S&T.

Three school subjects, namely, English, arts, and the social sciences, show a recovery in their relative degrees of importance between Y10 and Y11 (**Table 7**), as the mean difference between Y6 and Y11 is not statistically significant. For the three other subjects (physical education, mathematics, and French), the loss in relative importance in favour of S&T remains significant until Y11.

Intentions to pursue S&T studies or careers (Intention to act) and their relationship to relative status (objective 3)

A mean value of 3.80 was found for answers obtained on the five *Intention to act* dimension items. This value is slightly higher than the mean value found through the six-level scale (3.50), denoting that student intentions to pursue studies or careers in S&T are neither strong nor weak.

A slight difference between means can be observed for girls and boys (M = 3.73, SD = 1.45): girls show a lower *Intention to act* than boys (M = 3.89, SD = 1.43); t (2389) = -2,659, p<0.01. However, the mean difference is very small (0.16).

Table 8 and **Figure 5** show that *Intention to act* levels decrease slightly between Y6 and Y8 before increasing more substantially between Y8 and Y10 (with a significant mean increase occurring between Y8 and Y9). This mean increase is subsequently lost between Y10 and Y11. In other words, between Y8 and Y10, student intentions to pursue S&T studies or careers increase significantly.

A comparison between means for the end of primary school and for the end of secondary school (last two columns of **Table 8**) shows that students in their last year of secondary school (before specialization (Y10)) show a stronger *Intention to act* than students approaching the end of primary school (Y6). This difference disappears during the transition from Y10 to Y11.

Correlation tests were conducted to examine the relationship between the three dimensions of relative status (ease, preference, and importance) and the *Intention to act* (the intention to pursue studies or careers in S&T).

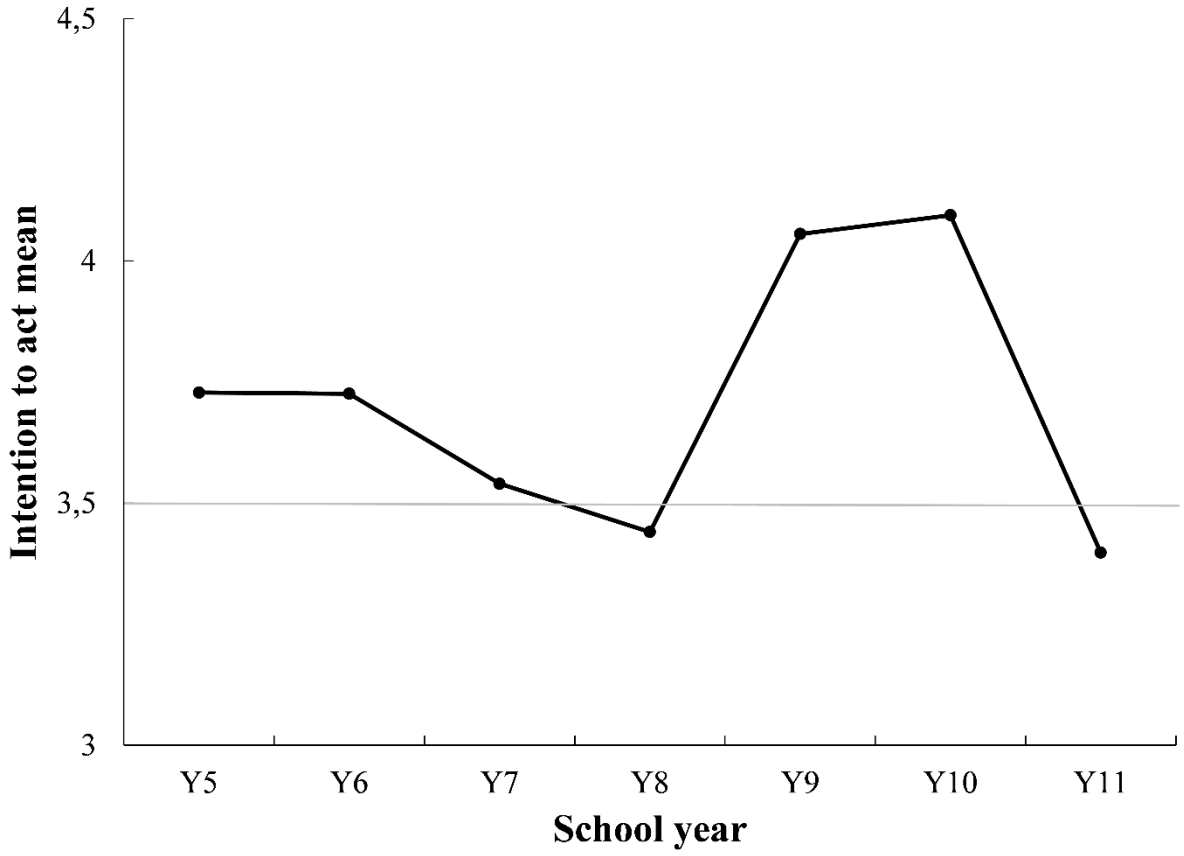

Figure 5. *Intention to act* variations by school year

Table 8. *Intention to act* levels by school year

F (sig.)	ΔM between school years (MY_n- MY_{n-1}): Post hoc, Bonferroni Tests							
	Y5 to Y6	Y6 to Y7	Y7 to Y8	Y8 to Y9	Y9 to Y10	Y10 to Y11	Y6 to Y10	Y6 to Y11
F (6, 2386) = 25.761***	n.s.	n.s.	n.s.	0.62***	n.s.	-0.70***	0.37 **	n.s.

* p<0.05; ** p<0.01; *** p<0.001

Table 9. Correlations between the *Intention to act* and relative preference and relative importance levels

	Relative preferences for each subject					
	Physical education	**English**	**Arts**	**French**	**Mathematics**	**Social sciences**
Intention to act	-0.41**	-0.38**	-0.41**	-0.39**	-0.24**	-0.28**

	Relative degrees of importance ascribed to each subject					
	Physical education	**English**	**Arts**	**French**	**Mathematics**	**Social sciences**
Intention to act	-0.41**	-0.35**	-0.43**	-0.33**	-0.27**	-0.34**

** The correlation is significant at the 0.01 level (bilateral).

The correlation between the *Intention to act* and perceived degrees of ease for the different subjects shows a significant relationship for four subjects: mathematics (r = 0.10, p<0.001), S&T (r = 0.26, p <0.001), the social sciences (r = 0.17, p<0.001), and English (r = 0.067, p<0.05). These correlations are positive but are very weak. No significant correlation was found between the *Intention to act* and the perceived ease of French (r = 0.03, p = n.s.) or physical education (r = - 0.01, p = n.s.).

Respectively, the relative preference and relative importance of most subjects (relative to S&T) (**Table 9**) is moderately (r approximately 0.3) to strongly (r approximately 0.5) correlated with the *Intention to act*. These correlations are also negative, meaning that the higher the relative preference for or relative importance of a certain subject, the lower the intention to pursue S&T studies or careers. These correlations are much more pronounced for physical education, the arts, and languages (r higher than 0.4).

DISCUSSION

Our discussion will address the three research questions stated at the beginning of this article.

What relative status do primary and secondary school students assign to S&T?

For the three dimensions examined to study relative status levels, S&T occupies an intermediate position relative to the other curriculum subjects.

1) In regards to degrees of ease, S&T is ranked fourth ex æquo mathematics and French. Even if they are generally perceived as easy (mean value of 4.04), all of these subjects are ranked after physical education, English, and the social sciences. This intermediate degree of perceived S&T difficulty has been reported in other studies (e.g., Hendley, Stables, and Stables 1996).

2) In regards to relative preference levels, S&T is ranked third (together with mathematics): students prefer only physical education and the arts over S&T.

   Without an in-depth analysis of reasons why students made these choices, it is difficult to suggest solid hypotheses in interpreting these data. It may be postulated that subjects preferred most over S&T are those that are most visible in life outside of school and in the media, namely, the arts and sports. Alternatively, students may view some subjects as being more action-focused (e.g., the arts or sports) rather than concept-focused (with such subjects generally being more challenging to master). In our survey questionnaire, we used two open-ended questions have students justify why they preferred some subject to others. A reading of their answers (currently under analysis) appears to favour the latter hypothesis: in regards to art, students largely respond with statements such as 'I like creating plays,' 'I'm learning to draw,' and 'I like working with my hands.' For physical education, students noted the following: 'I like to be active' and 'I like sports.' All of these justifications highlight a preference for action-based learning over conceptual or theoretical learning.

3) In regards to relative degrees of perceived importance, S&T is ranked after mathematics, French, and English, i.e., subjects that are ascribed a high status in the curricular hierarchy. The main hypothesis that may be put forward to explain these results is sociological in nature (Bernstein, 1971, 1997; Young, 1971, 1997). Subjects considered more important than S&T are those that are valued in the curriculum, and particularly in primary school: they are described as fundamental or 'core' subjects (as opposed to so-called secondary subjects, including S&T); they are considered essential to succeeding in school and in society; they are given more space in school schedules than other subjects; and they are decisive subjects that influence student transitions from one school year to the next (due to ministry exams, for example). In this vein, it is relevant to note that the importance that students assign to S&T (and to other subjects) is similar to the hierarchy of subjects cited by primary teachers and S&T secondary teachers in our past studies (Hasni et al., 2012; Lenoir & Hasni, 2010).

How do relative status levels vary by gender and school year?

While differences between boys' and girls' perceptions of relative importance are minor (arts and languages are considered slightly more important than S&T for girls), gender differences between relative preferences and perceptions of subject levels of ease are more pronounced:

✓ In regards to the perceived easiness of S&T, boys score slightly higher than girls. Similar results are found for the other subjects, with the exception of French (easier for girls than for boys).

✓ Regarding relative preferences, girls set themselves apart from boys by their stronger attraction to the arts and languages (relative to S&T); the opposite is found for physical education.

What is the situation in terms of variations by school year? We first address results found for Y6 to Y10 before discussing variations observed between Y10 and Y11 (years of potential student specialization). Two variations are observed:

1) S&T loses its relative status over the course of the primary-secondary school transition (between Y6 and Y8) in terms of a) the perceived easiness of this subject (**Figure 2**) and b) student relative preferences for S&T relative to the other subjects (English, French, the arts, and the social sciences) (**Figure 3**).

Qualitative data are needed to explain the decline in the perceived easiness of S&T and in relative preferences for this subject relative to the four other subjects. However, a number of hypotheses may account for this result. Among these hypotheses, it is important to stress changes that students experience in the primary-secondary school transition: such students transition from a teacher-focused classroom (with all subjects being taught by the same teacher) to a subject-focused classroom (with each subject generally being taught by a different teacher), and such students are also exposed to changes in teaching methods, among other things. This hypothesis, which appears to be supported by the results of prior studies on the primary-secondary school transition (Rice, 2001), does not in itself explain some of the other results obtained. For example, the decrease in the relative preference of S&T relative to that of the four other subjects at the start of secondary school can likely be explained by hypotheses related to S&T programs and teaching methods. Indeed, in primary school, students are often encouraged to explore surrounding objects and phenomena without undergoing evaluation or ministry examination. In secondary school, teaching methods often focus on memorization and on 'covering the program,' and evaluation (with compulsory ministry criteria) takes on a more substantial role in the curriculum. In primary school, a scarcity of science activities in the classroom likely contributes to the desirability of this subject. Moreover, in the more specific context of Quebec, no official period of time is allotted for S&T instruction in primary school, even if an official program is associated with this subject; in many cases, the subject is viewed by students as being a reward for subjects recognized as core subjects.

2) S&T progressively rises in relative status between Y6 and Y10 in terms of a) relative preferences for this subject relative to mathematics and physical education (**Figure 3**) and b) relative degree of importance ascribed to this subject relative to all other subjects (**Figure 4**). In the last year of secondary school before specialization (Y10), S&T achieves approximately the same levels of importance as subjects with traditionally high level of hierarchical status (mathematics, French, and English) (**Figure 4**). In addition, the more students advance in their schooling, the larger the gap between other subjects (the arts, physical education, and the social sciences) in favour of S&T becomes. This observation is an important one: although various studies that have specifically examined S&T show that student interest in this subject decreases as students' progress through school, our study shows that S&T grows in perceived importance relative to all other curriculum subjects (taken one by one) and that it is eventually preferred over mathematics and physical education. In other words, we

consider the 'specific' drop in interest in S&T reported by various studies less worrisome when the subject is compared to other curriculum subjects. Even if, in terms of hierarchy, curricula penalize S&T at the primary school level, this subject recovers its importance in students' eyes as they progress through their studies.

We would like to conclude this section by returning to changes observed between Y10 and Y11. In regards to both relative status and relative importance levels, S&T loses some ground to all of the other subjects. This loss is not statistically significant, however (**Tables 6 and 7**), and it may be attributed to the fact that during the Y10-to-Y11 transition, students choose whether to pursue science studies: they either a) abandon S&T courses to study other subjects (in which case it is normal for S&T to decline in relative status in their view) or b) specialize in S&T by enrolling in optional courses in this subject. Optional courses are in physics and chemistry, which students generally consider to be the most difficult subjects (Krapp & Prenzel, 2011). This perception of difficulty may account for the decline in relative preferences for S&T.

The relationship between relative status levels and intentions to pursue S&T studies or careers

The mean score for the *Intention to act* dimension (the intention to pursue studies or careers in S&T) progressively decreases between Y5 and Y9, albeit without deviating far from the mean value on the six-point scale (3.50). A substantial recovery in the *Intention to act* value is found during the second cycle of secondary school (between Y8 and Y10). This observation is important, as during the same period, students view S&T as being difficult (**Figure 2**). Students' views on subject difficulty thus do not appear to constitute a major barrier when they decide to pursue S&T studies or careers. In addition, this mean increase in *Intention to act* levels goes hand-in-hand with an increase in relative preferences for (**Figure 3**) and in relative degrees of importance (**Figure 4**) ascribed to S&T, thus suggesting a relationship between these dimensions. This observation is borne out of correlation tests. Student perceptions of the easiness of S&T (or of other subjects) are weakly correlated with intentions to pursue S&T studies or careers. The same correlation is particularly pronounced in terms of relative preference and relative importance levels (**Table 9**). The correlation is especially strong for the relative status of S&T relative to language subjects (French and English), the arts, and physical education. This negative correlation denotes that when students assign high preferences or importance to these subjects relative to S&T, they present limited intentions to pursue S&T studies or careers. Aschbacher, Ing et Tsai (2014) noted that two thirds of the students in their study "did not see a strong personal value or utility in learning science, and this was associated with less interest in STE-M careers" (p.741).

CONCLUSION

Our study documents a little-explored topic related to studies on interest in S&T: the status of S&T relative to other curriculum subjects and the relationship between this status level and student intentions to pursue S&T studies or careers.

While they show that S&T is ascribed an intermediate relative status in terms of the three dimensions in question (ease, preference, and importance), the findings indicate that differences, albeit slight, do exist between girls and boys and that they are very pronounced by school year. Generally speaking, the further students' progress through their education, the more they view S&T to be difficult. Through similar trends are found in other subjects, this perception of difficulty is more pronounced in the case of S&T.

In regards relative status levels, S&T loses ground to most other subjects during the primary-secondary school transition (between Y6 and Y8) and then slightly regains its status during the second cycle of secondary school.

S&T increases in relative importance relative to all other subjects from Y5 to Y10. Moreover, our findings highlight an important relationship between two dimensions of relative status (relative preference and relative importance) and student intentions to pursue S&T studies or careers.

These findings present major implications for curriculum development and for S&T instruction. In particular, it is important to stress the need to diminish the hierarchy of subjects, which appears to place S&T at a disadvantage from primary school. Why is S&T not mandatory in primary school? Why must it be allotted one hour of instruction per week while other subjects occupy large portions of the school schedule? Why is S&T not subjected to ministry exams like the other subjects are? These questions may appear trivial, but they are worth asking and debating.

In the classroom, it is important to clearly show students how each subject—including S&T—contributes to their education. Accordingly, in primary school, for example, we cannot continue to act as if the priority remains to essentially teach students reading, writing, and arithmetic skills (through languages and mathematics). It is important to assert the educational value of S&T from primary school and to clearly illustrate its contribution. Teaching methods that allow students to develop a stronger relationship with S&T must also be documented and applied more widely in schools. Our recent review of 228 studies in the field of S&T (Potvin & Hasni, 2014) reveals the impact that some of these methods have on student interest (I/M/A) in S&T (e.g., the process of scientific inquiry, the contextualization of learning (teaching S&T while drawing connections to life outside of school), and collaborative work).

However, to reflect more deeply on the practical impact of these findings, it is important to understand why students assign S&T (and other subjects) the statuses described in this article. Complementary research (involving interviews, for example) may shed more light on this issue and may confirm hypotheses put forward in our interpretation of the results. Other complementary avenues of research may involve verifying the impact of certain teaching methods (contextualization, scientific inquiry, integration, and interdisciplinarity, etc.) on the relative status of S&T or studying the relationship between

the status ascribed to S&T and interest-related dimensions other than intentions to pursue S&T studies or careers (examined in this article).

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