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I Am, I'll Be — happy, educated, active, healthy

Motivation in the First and Second Grades of Elementary School: An Analysis Based on Gender and Socioeconomic Status

By Frédéric Guay and Denis Talbot[1]

QLSCD 1998-2010 in brief

This fascicle is based on data from the *Québec Longitudinal Study of Child Development* (QLSCD 1998-2010) which is being conducted by the Institut de la statistique du Québec (Québec Institute of Statistics) in collaboration with various partners (listed on the back cover). The goal of this study is to gain a better understanding of the trajectories which, during early childhood, lead to children's success or failure in the education system.

The target population of the QLSCD comprises children (singleton births) born to mothers residing in Québec in 1997-1998, with the exception of those whose mother, at the time of the child's birth, were living in certain administrative regions of the province (Nord-du-Québec, Terres-Cries-de-la-Baies-James and Nunavik) or on Indian reserves. Certain children were also excluded because of constraints related to the sample frame or major health problems. The initial sample eligible for longitudinal monitoring comprised 2,120 children. The children were followed annually from the age of 5 months to 8 years, and since then have been followed biannually to the age of 12. During the 2002 round, the data collection period was changed in order to visit all the children in the spring, namely during exam time in the education system. It should be noted that the QLSCD is the first large-scale study based on a sample of such magnitude, representative of Québec newborns, who are being monitored in such an intensive manner throughout childhood.

The QLSCD employs a variety of data collection instruments to gather data on the child, the person most knowledgeable of the child (PMK), her or his spouse/partner (if applicable), and the biological parent(s) not residing in the household (if applicable). During each data collection round, the child is asked to participate in a variety of activities designed to assess development. As of the 2004 round, the child's teacher is also being asked to respond to a questionnaire covering various aspects of the child's development and adjustment to school.

Further information on the methodology of the survey and the sources of data can be accessed on the website of the QLSCD (also known as "I Am, I'll Be"), at: www.jesuisjeserai.stat.gouv.qc.ca.

The development of competencies in reading, writing and mathematics is a key element in children's academic achievement in elementary school. These skills not only enrich children's understanding of the world around them, but also contribute to their becoming citizens who can fully participate in the social, economic and political life of society. Although students in the Québec education system score higher than students in many other jurisdictions in reading, mathematics and sciences (Bussière, Knighton and Pennock, 2007), certain young people have difficulty in certain subjects. For example, numerous Québec students, whose language of instruction is French, have problems with syntax, punctuation and spelling (MELS, 2006).

What are the characteristics of students who do well in reading, writing and mathematics? Numerous factors – family, social, pedagogical, individual – have been studied to explain success in these subjects. Some studies have shown that at an equivalent level of cognitive skills, motivated students achieve more academic success than those who are little motivated (Spinath et al., 2006). Motivation in certain subjects at the beginning of elementary school is the topic of this fascicle.

But what is motivation? According to Deci and Ryan (1985), motivation comprises two dimensions – energy and direction. Energy provides a means of maintaining a given behaviour until a goal is attained, while direction gives meaning to the goal to be attained. For example, if an elementary school pupil finishes reading a text on pandas (direction – finish his reading on pandas) this could be attributed to the pleasure this activity gives him or his having extra minutes playing on the computer (energy sources – pleasure or promised reward). We will be referring to intrinsic motivation when the energy source is the pleasure and satisfaction a student experiences when he accomplishes an activity (Deci et Ryan, 2002), and extrinsic motivation when the learning experience results in obtaining something or avoiding consequences. A study conducted by Lepper, Corpus and Iyengar (2005) showed that the more a student engages in school work with intrinsic motivation, the higher his/her marks. Conversely, the more a student engages in school work with extrinsic motivation, the lower his/her marks. Although it would have been productive to assess extrinsic motivation in this fascicle, our analysis here only covers intrinsic motivation.

Motivation has been of great interest to numerous researchers and practitioners in recent decades, particularly because of its malleable nature, namely that it can change over time and with situations. In other words, it is not because a pupil lacks motivation in mathematics that he will in other subjects or in this same subject until the end of his education. Interventions with families or special needs teaching (Reeve et al., 2004) could therefore remedy a lack of motivation in a particular subject. Such interventions could prove particularly important in the first few years of elementary school.

As well as intrinsic motivation, academic self-concept in educational psychology is another dimension of motivation recognized as being associated with achievement in school (Marsh, 2007). Academic self-concept is defined as the subjective evaluation a student makes of his/her skills in a given subject (Marsh and Craven, 1997). A student who tells himself he is capable of rapidly learning mathematics has a high self-concept in this subject. This judgment is not exactly precise, as the student could judge his skills as being lower or higher than his/her real ones in various school subjects. For example, a study conducted by Hackett and Betz (1989) indicated that 54% of men and 44% of women overestimated their mathematical skills, whereas only 16% of men and 18% of women underestimated them.

Studies conducted on intrinsic motivation and self-concept have shown that these two dimensions of motivation diminish over the course of elementary school. It seems that pupils begin Grade 1 with enthusiasm and perceive themselves as being skilled in mathematics, reading and writing, but unfortunately the enjoyment and perception of competency decreases over time (Eccles et al., 1999).

However, little is known about the characteristics of students whose motivation is most likely to decrease in one or another of these subjects. Certain studies have revealed that boys are less successful than girls in terms of academic achievement. The same applies to students from disadvantaged backgrounds compared to other students (MELS, 2008; Sirin, 2005). Is it possible that motivation decreases more in these groups? This constitutes the main question this fascicle attempts to answer, based on data collected in the *Québec Longitudinal Study of Child Development* (QLSCD, see the box entitled *QLSCD 1998-2010 in brief*) when the children were in Grade 1 and Grade 2 of elementary school.

Analytical methods

Analyses were based on a sample of 1,505 children. The Mplus (5.21) software program was used to construct structural equation models for the purposes of this fascicle. Compared to other statistical methods, these models have the advantage of providing answers to many questions simultaneously, estimating intra-individual changes and keeping track of measurement errors.

First, a confirmative factor analysis model was applied to the data (for more details, see the appendix). The results of this analysis showed that children's understanding of the questions on motivation was the same in Grade 1 and Grade 2 of elementary school (see Box 1). Then, structural equation modeling (SEM) was used to evaluate the following: 1) the effects of gender and socioeconomic status (SES) on children's intrinsic motivation and self-concept in Grade 1, and 2) intra-individual changes in intrinsic motivation and self-concept occurring between Grade 1 and Grade 2 as a function of gender, SES, and the interaction of these two factors.

In certain analyses, the Full-Information-Maximum-Likelihood method (FIML - see the appendix for more details) was used to minimize biases related to partial non-response (approximately 10%).

Box 1

Measuring intrinsic motivation and self-concept in the QLSCD

Intrinsic motivation in the QLSCD was measured using a subscale of the motivation scale on elementary school subjects developed by Guay et al. (in press). Academic self-concept was measured using three statements taken from the *Academic Self Description Questionnaire* (ASDQ). These two instruments were part of the *Paper Questionnaire Administered to the Child* (PQAC) which was filled out during interviews with the children when they were 7 years old (Grade 1, 2005 round) and 8 years old (Grade 2, 2006 round). The child indicated to the interviewer his/her level of intrinsic motivation by rating the following items for each school subject: 1- likes the subject, 2- finds it interesting, and 3- does certain activities associated with this subject without being obliged to. The child indicated his/her self-concept by assessing his/her competency in each subject using the following items: 1- has always done well in the subject, 2- has facility in it, and 3- rapidly learns it. The scores on these scales can vary from 1 to 5. A score of 5 signifies that the student is strongly motivated (intrinsic motivation) or feels very competent in reading, writing or mathematics. The psychometric qualities of these two instruments proved to be satisfactory (Guay et al., in press).

The data were weighted and therefore the adjustments made to them allows for the results to be generalized to the target population of the QLSCD. It should be mentioned here that children who arrived in Québec after their birth are excluded from the QLSCD, though they are part of the same age cohort of the initial sample.[2]

In addition to weighting, taking into account the complex sample design is recommended when conducting statistical tests based on QLSCD data. When this was not done in a particular analysis, the threshold of 0.01 was used to arrive at a significant difference at the threshold of 0.05. For findings in which the threshold of significance observed was between 0.01 and 0.05, the word "trend" will be used in this fascicle.

Intrinsic motivation in Grade 1 and Grade 2 of elementary school

Do Québec pupils in Grade 1 and Grade 2 of elementary school (targeted by the QLSCD) feel motivated in the subjects of mathematics, reading and writing?

The results of tests done using structural equation modeling show that intrinsic motivation varied with the subject (see Table 1). Indeed, in the first two years of elementary school, students derived more pleasure from reading and writing than from mathematics. Figure 1 shows the mean scores of intrinsic motivation for reading, writing and mathematics in the first and second years of primary school. Intrinsic motivation in mathematics significantly decreased between Grade 1 (μ = 4.18) and Grade 2 (μ = 3.94), whereas no significant change was observed in reading or writing.

Table 1

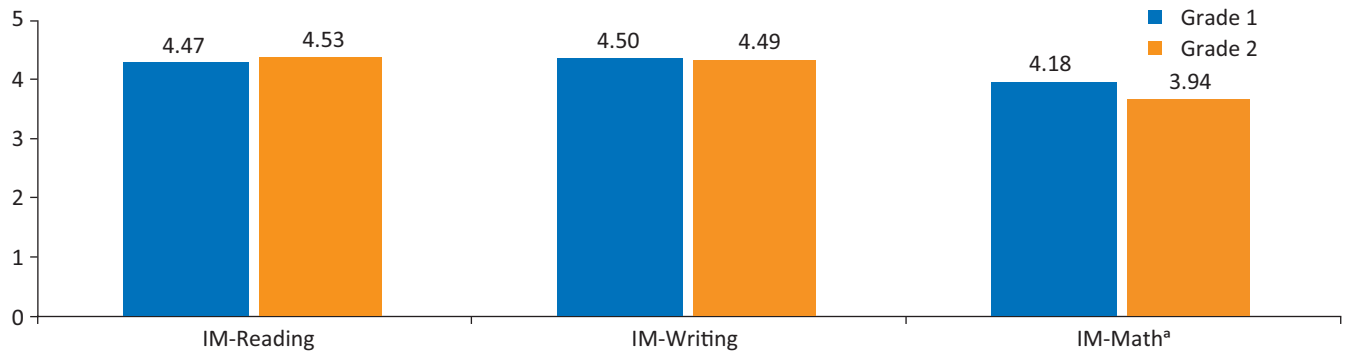
Differences in intrinsic motivation by subject, Grade 1 and Grade 2 of elementary school, Québec, 2005, 2006

Intrinsic Motivation	Diff.	S.E.	T-value	P-value
Grade 1				
Reading vs. writing	−0.031	0.048	−0.654	0.513
Reading vs. mathematics	0.288	0.060	4.816	<0.001
Writing vs. mathematics	0.319	0.063	5.028	<0.001
Grade 2				
Reading vs. writing	0.040	0.048	0.827	0.408
Reading vs. mathematics	0.587	0.071	8.300	<0.001
Writing vs. mathematics	0.547	0.073	7.548	<0.001

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

Figure 1

Mean scores of intrinsic motivation in Grade 1 and Grade 2 of elementary school, Québec, 2005, 2006



IM = Intrinsic Motivation.

a. Significant change by grade level. The Wald statistical test was used after the delta method was employed in the structural equations model.

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

Self-concept in Grade 1 and Grade 2 of elementary school

Do Québec pupils in Grade 1 and Grade 2 of elementary school (targeted by the QLSCD) feel competent in reading, writing and mathematics?

We can see that in Grades 1 and 2, means scores in self-concept significantly differed among the subjects. Indeed, tests conducted using structural equation models revealed a significant difference in Grade 1 between self-concept in writing from that in mathematics. In Grade 2, a significant difference was observed not only between the two aforementioned, but also between self-concept in reading and that in mathematics. Figure 2 shows the mean scores of self-concept in the three subjects by grade level. A significant decrease in self-concept in mathematics was observed in the pupils between Grade 1 and Grade 2, and to a lesser degree, in writing.

Motivation: results in brief

In summary, mathematics was the only subject for which a decrease was observed among pupils between Grade 1 and Grade 2 in both dimensions, intrinsic motivation and self-concept. A decrease in self-concept in writing was also observed between these grades. No significant change was observed in reading, in either intrinsic motivation or self-concept.

The results observed in mathematics corroborate those of other studies conducted on American students (Jacobs et al., 2002). All these findings reveal that motivation in mathematics decreases over the years in school. In contrast, the findings obtained in reading do not support those observed elsewhere (see Jacobs et al., 2002). In fact, we generally see a decrease in self-concept in both reading and writing. QLSCD data for grade 4 and 6 children will certainly give us a better understanding of this result.

Table 2

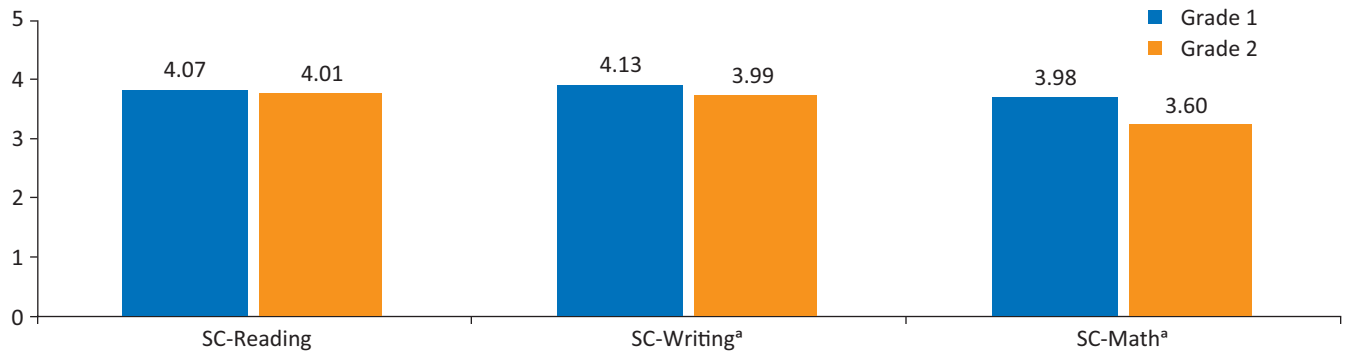
Differences in self-concept by subject, Grade 1 and Grade 2 of elementary school, Québec, 2005, 2006

Self-Concept	Diff.	S.E.	T-value	P-value
Grade 1				
Reading vs. writing	−0.060	0.046	−1.288	0.198
Reading vs. mathematics	0.096	0.055	1.744	0.081
Writing vs. mathematics	0.155	0.054	2.852	<0.004
Grade 2				
Reading vs. writing	0.017	0.051	0.334	0.739
Reading vs. mathematics	0.418	0.061	6.867	<0.001
Writing vs. mathematics	0.401	0.059	6.841	<0.001

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

Figure 2

Mean scores of self-concept in Grade 1 and Grade 2 of elementary school, Québec, 2005, 2006



SC = Self-concept.

a. Significant change by grade level. The Wald statistical test was used after the delta method was employed in the structural equations model.

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

This general portrait does not provide a means of observing whether the changes occurred in certain groups of individuals (girls vs. boys, low vs. high SES). Indeed, an absence of change in certain subjects could hide an increase or decrease in motivation in one or another of the subjects in certain groups of pupils.

In the following section, intra-individual changes in intrinsic motivation and self-concept are explored in terms of the gender and socioeconomic status of the children.

Intrinsic motivation and self-concept as a function of gender and socioeconomic status

Results on gender

The findings presented in Table 3 indicate that boys in the first year of elementary school had more intrinsic motivation in mathematics and felt more competent in the subject than girls (positive coefficient). Opposite results, however, were observed in the subjects of reading and writing. Except for self-concept in writing where only a trend was observed, girls were generally more motivated in reading and writing than boys (negative coefficient).

Table 3

Intrinsic motivation and self-concept in Grade 1 of elementary school, by gender, Québec, 2005

Grade 1	Effect of gender[a]	*p*
IM-Reading	−0.21	0.00
IM-Writing	−0.22	0.00
IM-Math	0.28	0.00
SC-Reading	−0.09	0.01
SC-Writing	−0.11	0.03[b]
SC-Math	0.28	0.00

a. For the purposes of analysis boys were assigned a value of 1 while girls were assigned a value of 0.

b. The threshold observed was between 0.01 and 0.05, therefore this is to be considered a trend (see the analytical methods section).

IM = Intrinsic Motivation, SC = Self-Concept. The coefficients shown here were not standardized.

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

The gender differences with regards to motivation corroborate the findings of previous research in this field. Indeed, Herbert and Stipek (2005) report lower levels of motivation and self-concept in mathematics among girls beginning in early elementary school. This difference, however, is not attributable to lower skills in math, since girls do as well as boys in this subject, and even sometimes better (Pajares, 2005). Furthermore, additional analyses conducted on the QLSCD data indicated that there was no gender difference in academic achievement in mathematics in Grade 1 (data not shown). The results indicating that girls generally find more pleasure and feel more competent than boys in reading and writing corroborates those reported by Wigfield et al. (1997). All these findings seem to confirm the stereotype that math is for boys and reading and writing is for girls.

Results on socioeconomic status

The findings presented in Table 4 show that the children in Grade 1 who come from families with higher socioeconomic status had more intrinsic motivation and felt more competent in reading. The same trends were observed in writing. However, it should be noted that the coefficients showing significant associations were low, explaining less than 1% of the variance. Therefore, socioeconomic status does not seem to have a strong association with motivation in these subjects at this stage in elementary school. In addition, no significant association was observed between socioeconomic status and either intrinsic motivation or self concept in the subject of mathematics.

Finally, no significant association was observed between gender and socioeconomic status. In other words, the associations between gender and motivation in Grade 1 did not significantly vary with socioeconomic status.

Changes observed between Grade 1 and Grade 2 in elementary school with regards to motivation by gender and socioeconomic status

The last series of results cover intra-individual changes in motivation observed between Grade 1 and Grade 2 of elementary school as a function of gender and socioeconomic status. The findings presented in Table 5 indicate boys' scores in intrinsic motivation in writing decreased more that those of girls (negative coefficient) between the two grade levels. Conversely, the decrease in self-concept in reading and mathematics was more marked among girls (positive coefficient). Higher socioeconomic status tended to be associated with a greater decrease in intrinsic motivation in writing. This finding and the fact that self-concept in reading decreased more among girls than boys seem contrary to expectations (MELS, 2008; Sirin, 2005). These findings can in part be explained by the phenomenon of regression towards the mean. Children with higher socioeconomic status had higher scores in intrinsic motivation in writing in Grade 1 that those with lower socioeconomic status. Girls in Grade 1 had a higher feeling of competency in reading than boys. Therefore the scores of these two groups of pupils were more likely to decrease over time. However, it should be noted that the findings related to socioeconomic status are only trends. Socioeconomic status seems to have had less influence than gender on changes in motivation observed over time.

Table 4
Intrinsic motivation and self-concept in Grade 1 of elementary school, by socioeconomic status, Québec, 2005

Grade 1	Effect of socio-economic status[a]	*p*
IM-Reading	0.09	0.00
IM-Writing	0.08	0.04[b]
IM-Math	0.02	0.68
SC-Reading	0.09	0.00
SC-Writing	0.07	0.02[b]
SC-Math	0.07	0.08

a. For the purposes of this analysis, socioeconomic status was based on that observed when the children were in kindergarten. This variable was constructed from five sources: the educational level of the Person Most Knowledgeable of the child (PMK), the educational level of the spouse/partner, if applicable, the prestige of the occupation of the PMK and spouse/partner, if applicable, and household income. For more details on the construction of this index, see the technical documentation on the QLSCD website at: http://www.jesuisjeserai.stat.gouv.qc.ca/doc_tech.htm.

b. The threshold observed was between 0.01 and 0.05, therefore this is to be considered a trend (see the analytical methods section).

IM = Intrinsic Motivation, SC = Self-Concept. The coefficients shown here were not standardized.

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

Table 5
Influence of gender and socioeconomic status on the changes observed in intrinsic motivation and self-concept, Québec, 2005, 2006

Change	Effect of gender[a]	*p*	Effect of socioeconomic status	*p*
IM-Reading	−0.05	0.44	−0.03	0.42
IM-Writing	−0.22	0.00	−0.09	0.04[b]
IM-Math	0.09	0.24	0.02	0.69
SC-Reading	0.15	0.01	0.03	0.37
SC-Writing	−0.01	0.87	−0.03	0.48
SC-Math	0.20	0.00	0.04	0.47

a. For the purposes of analysis the data were re-coded. Boys were assigned a value of 1 while girls were assigned a value of 0.

b. The threshold observed was between 0.01 and 0.05, therefore this is to be considered a trend (see the analytical methods section).

IM = Intrinsic Motivation, SC = Self-Concept. The coefficients shown here were not standardized.

Source: Institut de la statistique du Québec, *QLSCD 1998-2010*.

What the findings tell us?

Research shows that intrinsic motivation (Guay, Ratelle and Chanal, 2008) and academic self-concept (Marsh, 2007) are associated with academic achievement. The greater a pupil feels pleasure and feels he/she is competent in a subject, the greater his/her success in school. Therefore, it is important to target the factors associated with these two dimensions of motivation. In this fascicle, the magnitude of these two components of motivation and changes in them over time were examined in relation to gender and socioeconomic status. The selection of these two factors was based on the fact that certain studies indicate that in general, girls and pupils with higher socioeconomic status have higher academic achievement than their peers (MELS, 2008; Sirin, 2005). A number of conclusions can be drawn from these findings.

First, the data collected from children in the QLSCD reveal that they derived pleasure from reading and writing in Grade 1 and Grade 2 of elementary school. However, their motivation in mathematics seemed lower. In parallel, it was observed that pupils felt relatively competent in the three subjects in Grade 1, but in Grade 2, the self-perception of competency in mathematics appeared lower.

Secondly, certain groups of pupils showed more motivation than others in particular subjects in Grade 1. Girls derived more pleasure than boys in reading and writing. They also scored higher than boys in their perception of their reading skills. In contrast, they derived less pleasure than boys in mathematics, and scored lower than boys in their perception of being competent in this subject. We also observed a positive association between socioeconomic status and motivation levels (intrinsic motivation and self-concept) in reading in Grade 1. A similar trend was observed in writing.

With regards to trends in motivation between Grade 1 and Grade 2, the findings indicate a decrease in intrinsic motivation and academic self-concept in mathematics. A decrease was also observed in the perception of writing skills. Certain groups of pupils were more likely to show a decrease in motivation. Compared to girls, boys showed a greater decrease in motivation in writing between the first and second year of primary school. Conversely, self-concept in mathematics and reading showed a greater decrease among girls than boys.

These findings are interesting in many respects. Since the results varied from one subject to another, it is recommended to assess intrinsic motivation and self-concept in relation to each subject and not simply in a general manner (e.g. “I like school” and “I am good in school”). Asking children questions on specific subjects provides a means of targeting the ones that are a source of difficulty in intrinsic motivation and self-concept, and thereby of remedying these through appropriate interventions (Guthrie et al., 2004).

Moreover, it seems important to advance our understanding of the factors that would explain why boys in Grade 1 derive less pleasure than girls in reading and writing, and scored lower in their perception of their reading skills than girls. In addition, why does intrinsic motivation in writing decrease more in boys than girls between Grade 1 and Grade 2? Do classroom activities and the contents of the textbooks elicit enough interest on the part of boys? Is the classroom atmosphere, indeed the learning environment provided by teachers and parents, conducive to the components of motivation in boys? We should also examine why girls face difficulty in feeling motivated in mathematics, and why their motivation in this subject decreases more than boys between Grade 1 and Grade 2. Perhaps, similar to boys’ possible responses to the contents of textbooks used in reading, the examples used in mathematics textbooks may elicit little interest among girls. Certain authors (Delisle et al., in press) suggest that teachers, parents, popular culture and/or the media promote and reinforce gender stereotypes that lead girls to develop lower motivation in math. From this perspective, it is not the gender of the pupil in itself that may explain the differences observed, but rather beliefs about boys’ and girls’ interests, roles and career paths in society.

Finally, it seems that the socioeconomic status of the family may be linked to motivation and self-concept in reading in Grade 1. We can surmise that parents with a higher socioeconomic status are more likely to buy books, read to their children, and support them in their efforts to learn to read (Desrosiers and Ducharme, 2006). Since we know that reading is at the heart of learning in children (solving problems in math often requires reading skills), such findings appear worrisome for the future of pupils who come from disadvantaged households (Sirin, 2005). Nevertheless, it is incumbent here to indicate that the value explaining socioeconomic status was rather weak. A pupil's gender seems to be a more important factor than socioeconomic status in explaining the variability observed in intrinsic motivation and self-concept.

In conclusion, interventions would seem required to help boys enjoy reading and writing more and help them feel more competent in these subjects. Among girls, interventions should target mathematics. To a certain degree, it would be important to help pupils who come from disadvantaged families feel more competent in reading and derive more pleasure from this subject right from school entry. Researchers in the U.S. have implemented a continuing education program for teachers to help them motivate their students (Guthrie, 2004). The results of this initiative seem promising. It would therefore be productive to implement a pilot project in Québec to assess the relevance of such a program in the provincial education system.

Appendix
Description of structural equation modeling

1. General description

Structural equation modeling (SEM) is mainly used when the questions for which we seek responses involve latent concepts, namely concepts which cannot be measured directly. In such cases, measurement tools must be used which can reveal the influence of the latent concept. Therefore, we use observable variables[3] in SEM to measure the latent concept.

In this fascicle, two dimensions were analyzed – intrinsic motivation and self-concept. These are latent concepts because we cannot measure them directly. Therefore they were measured using the observed variables described in Box 1. For example, an individual with intrinsic motivation tends to say he strongly agrees with a statement such as "I like mathematics," while someone with little intrinsic motivation would most likely disagree with this statement. It is indeed the latent concept (the person's level of intrinsic motivation) which influences the value of the observed variable (the response to the question) and not the contrary.

Structural equation modeling is a very general, potent multivariate analysis tool. Numerous regressions can be conducted simultaneously, and both latent and observed variables can be entered into them.

2. Confirmatory Factor Analysis (CFA) (see the illustration)

Confirmatory Factory Analysis models comprise a sub-class of structural equation models. In these models, the main goal is to verify whether the "measured" part of the model created fits well with the data. In other words, CFA models can test whether the observed variables provide a good measurement of the latent variables they are supposed to be measuring. More specifically, the correlations of regressions are modeled in order to determine the influence of the latent variables on the observed variables.

3. True intra-individual change models (TICM) (see the illustration)

In true intra-individual change models, more than one measurement time is used, and the observed variables must have the property of invariance from one measurement time to another. In other words, the signification given to an observed variable at time 1 should be the same at time 2. Instead of defining a latent variable corresponding to time 1 and a latent variable corresponding to time 2, we construct a latent variable corresponding to a baseline value for the concept, and a latent variable corresponding to the change occurring between time 1 and time 2.

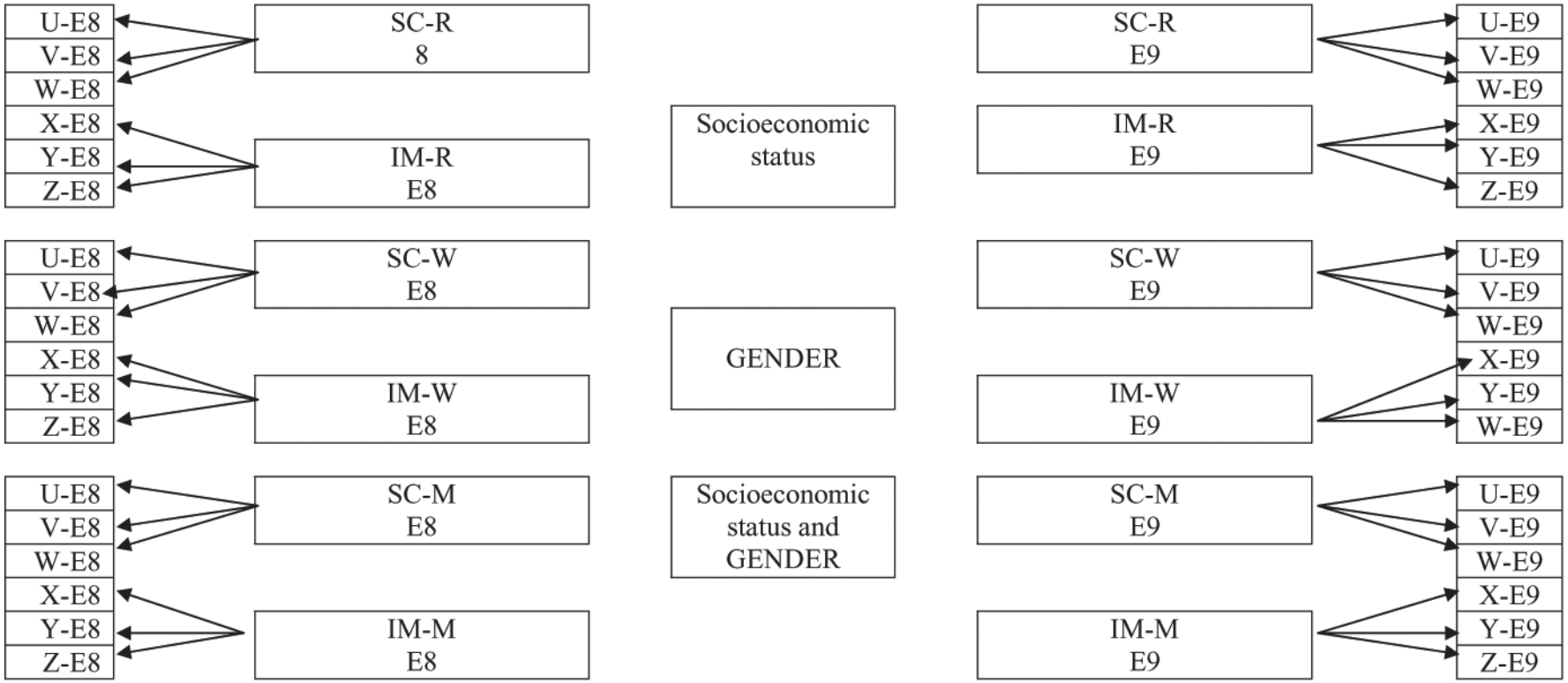
4. Processing missing data using the Full Information Maximum Likelihood (FIML) method

This method of processing missing values from a data set, which is relatively complex, is used to obtain unbiased results to construct a model, provided that the data are not "Missing Not At Random" (MNAR). MNAR is present if the probability that a given data is missing is dependent on its true, observable value (e.g. not responding to the question "sex" is still dependent on the sex of a person).

If the probability that a given data is missing is completely random, or depends on the value of other variables, the process is then termed MCAR or MAR (Missing Completely at Random and Missing at Random respectively). The principle of this method is to establish a measurement of likelihood which is different for each observation while taking advantage of all the data available for this observation, but which does not require the input of any data that are not available.

Graphic representation of Confirmatory Factor Analysis (CFA)

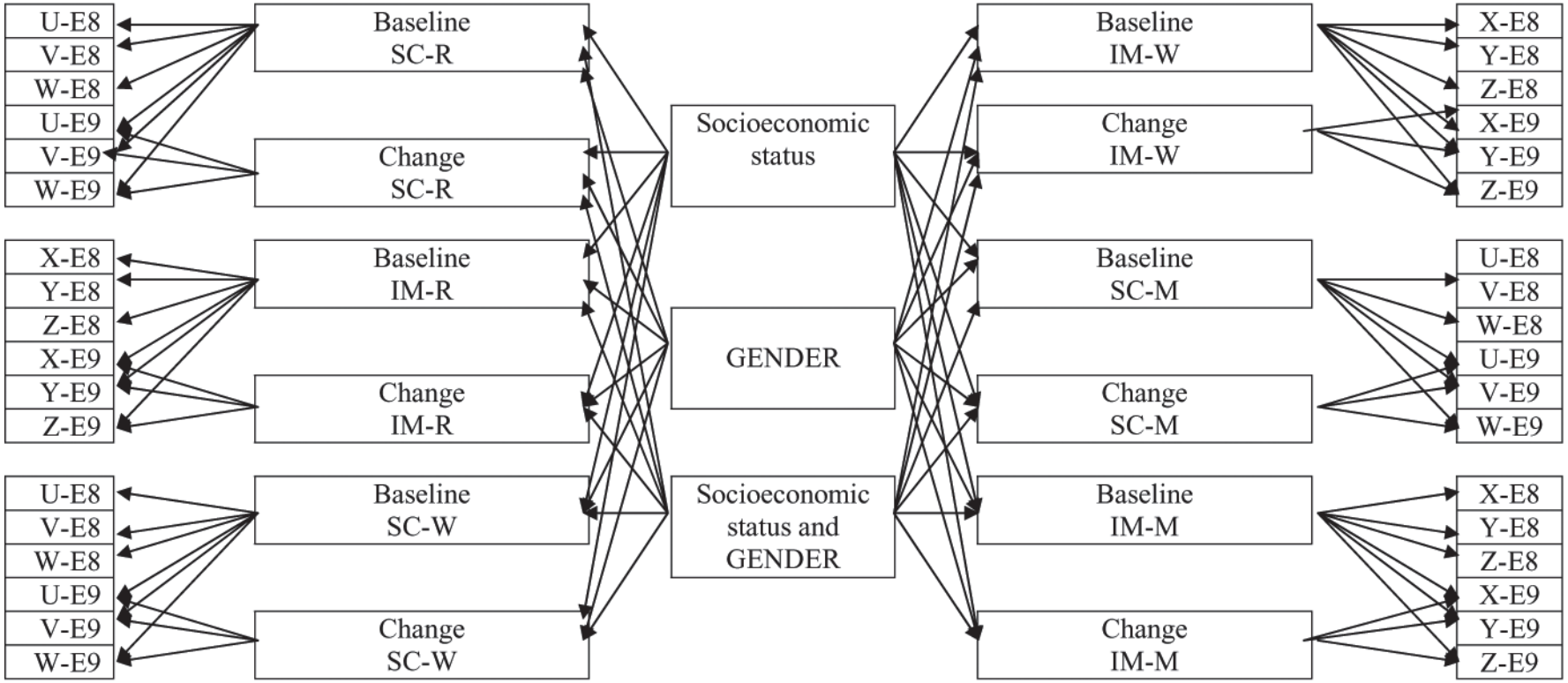
Latent concepts	Observed variables for each concept	Subject	Round
SC: Self-concept	U: Likes the subject	R: Reading	Grade 1 = E8
	V: Finds the subject interesting	M: Mathematics	Grade 2 = E9
	W: Would do certain activities associated with the subject without being obliged	W: Writing	
IM: Intrinsic motivation	X: Thinks he will do well in this subject		
	Y: Thinks he is competent in this subject		
	Z: Thinks he will rapidly learn this subject		



Note: The covariance among all the observed variables (gender, socioeconomic status and the interaction of these two) and the latent variables (SC-R E8, IM-R E8,...) are estimated. Correlated errors were estimated for the questions which were asked at the two measurement times (rounds 8 and 9) and for parallel items, namely the statements which are identical except for the subject to which they refer (for example: "I have always done well in reading" and "I have always done well in writing").

Graphic representation of the True Intra-individual Change Models (TICM)

Latent concepts	Observed variables for each concept	Subject	Round
SC: Self-concept	U: Likes the subject	R: Reading	Grade 1 = E8
	V: Finds the subject interesting	M: Mathematics	Grade 2 = E9
	W: Would do certain activities associated with the subject without being obliged	W: Writing	
IM: Intrinsic motivation	X: Thinks he will do well in this subject		
	Y: Thinks he is competent in this subject		
	Z: Thinks he will rapidly learn this subject		



Note: The observed variables can be correlated among themselves and the residual errors of the latent variables can be correlated among themselves. The correlated errors were estimated for the questions that were asked at the two measurement times (rounds 8 and 9) and for the parallel items, namely the statements that are identical except for the subject to which they refer (for example: "I have always done well in reading" and "I have always done well in writing").

Notes

1. Frédérick Guay is a Professor in the Département des fondements et pratiques en éducation at Université Laval and is the chairholder of the Canada Research Chair in Motivation and Academic Success. He is also an ongoing member of the Groupe de recherche sur l'inadaptation psychosociale (GRIP) (Research Unit on Psychosocial Maladjustment). Denis Talbot is a consultant in the Service de consultation statistique(SCS)(Statistical Consulting Service) in the Département de mathématiques et de statistiques, Faculté des sciences et de génie at Université Laval.

2. Based on data from the *Régie de l'assurance maladie du Québec* (Québec Health Insurance Program), the Institut de la statistique du Québec estimates that approximately 9% of children who were 8 years of age on July 1, 2006 were born outside of Québec (Source: Institut de la statistique du Québec, processing the *Fichier d'inscription des personnes assurées* (Registry of Insured Persons) of the *Régie de l'assurance maladie du Québec*, 2006).

3. Also known as "measurable" or "manifest" variables.

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