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The Dynamic Processes of Influence Between Contextual and Situational Motivation: A Test of the Hierarchical Model in a Science Education Setting[1]

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The purpose of the present research was to identify some of the psychological processes through which changes in contextual motivation toward science courses can occur. In line with the hierarchical model of intrinsic and extrinsic motivation (Vallerand, 1997), it is proposed that much of the changes in contextual motivation toward science are induced by repeated changes in situational motivation toward science-related activities. Furthermore, situational motivation itself is determined by one's contextual motivation. Finally, contextual science motivation should predict intentions of taking future science classes and pursuing a science career. Participants were high school students engaged in science courses. A longitudinal design with 5 measurement time points was used. Overall, the results of structural equation modeling analyses supported the hypotheses.

There appears to be a dramatic decline in interest for the sciences in the general population (Osborne, Simon, & Collins, 2003). Few young students are interested in pursuing education in a scientific field and few actually obtain university degrees in science or engineering (National Center for Education Statistics, 2006). For example, in Canada, only 8% of the first university degrees are awarded to students in a scientific field of study and 15% to students in engineering (7% and 17%, respectively, in the United States; Organization for Economic Cooperation and Development, 2003). This situation is unfortunately not limited to North America, as the same pattern can be found in France, Germany, Italy, Japan, and the United Kingdom, with Japan having the lowest rate of graduation in science (3%),

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and France the highest (23%; Organization for Economic Cooperation and Development, 2003).

In light of the significant importance for industrialized societies to have a healthy scientific and technological community of experts, it becomes important to identify the factors that promote young students' intentions to pursue a scientific education and eventually to engage in a science-related career. One important factor is the construct of motivation. Numerous theories have been developed over the years to better understand social behavior and what puts it into motion.

One theory that provides a parsimonious and holistic understanding of science education motivation is the hierarchical model of intrinsic and extrinsic motivation (HMIEM; Vallerand, 1997; Vallerand & Ratelle, 2002). This model advances numerous postulates that provide an understanding of the dynamic motivational processes through which motivation can change over time. The purpose of the present study is to test specifically the validity of these processes with respect to the prediction of changes in high school students' general motivation to engage in science courses and their intentions to persist in the scientific field. If these processes are shown to be valid, interesting avenues could be proposed to increase students' motivation toward science.

Self-Determined Motivation Toward Science

The HMIEM (Vallerand, 1997; Vallerand & Ratelle, 2002) follows from the tradition of self-determination theory (SDT; Deci & Ryan, 1985, 1991, 2000; Ryan & Deci, 2000). SDT posits a distinction between different forms of motivation; that is, intrinsic and extrinsic forms of motivation, as well as the relative lack of motivation (i.e., amotivation). These different forms of motivation can be distributed along a self-determination continuum (or engaging in an activity out of choice and pleasure vs. out of internal or external pressure).

The motivation postulated as the most self-determined is *intrinsic motivation*, which is characterized by doing something for the pleasure experienced in the process (e.g., going to a science class for the pleasure of learning; Deci, 1975). However, not all one does is done for the sake of it, and extrinsic forms of motivations are regularly experienced. According to SDT (Deci & Ryan, 1985, 1991, 2000; Ryan & Deci, 2000), different forms of extrinsic motivation exist with different levels of self-determination. With the highest level of self-determination, there is *identified regulation*, which represents a conscious internalization of personally valuable beliefs (e.g., students who go to a science class to achieve the career they desire). The second form of extrinsic motivation is *introjected regulation*, which results from a partial internalization of a value without completely accepting it as one's own (e.g., students who go to a science class to avoid feeling guilty). Finally, *external regulation* refers to the least self-determined form of extrinsic motivation. It is characterized by external pressure and constraints (e.g., students who take science courses because their parents want them to do so). At the end of the continuum, there is the relative lack of motivation, which is termed *amotivation*.[3]

The HMIEM (Vallerand, 1997) has expanded SDT by proposing that motivation can exist at three different levels of generality. Specifically, at the lowest level of the hierarchy, there is situational motivation, which refers to the motivation an individual experiences at a specific time toward a given activity. At the second level of generality, there is contextual motivation, or an individual's general motivation toward a specific context or life domain (e.g., sciences, arts, sports). Finally, at the highest level of generality, there is global motivation. At this level, motivation represents a broad general motivational tendency to interact with the environment with a specific orientation (intrinsic or extrinsic).

Top–Down and Bottom–Up (Recursive) Effects

The interaction between the different levels of the hierarchy can help us to understand changes in motivational orientation that can take place over time (Vallerand, 2007). The top–down effect, postulated by Vallerand (1997), posits that motivation at one level of generality can influence motivation at the next lower level of the hierarchy. For instance, contextual motivation toward science can influence situational motivation in a science class on a Tuesday afternoon. Hence, a self-determined contextual motivation (i.e., high levels of intrinsic motivation and identified regulation, but low levels of external regulation and amotivation) generates higher levels of self-determined situational motivation toward a specific scientific class or activity at a given point in time.

Research has supported the validity of the top–down effect in diverse fields of interest (for reviews, see Vallerand, 1997, 2001, 2007). For instance,

[3]According to Deci and Ryan (1985, 1991, 2000), integrated regulation is the form of extrinsic motivation with the highest degree of self-determination; that is, with a higher degree of self-determination than identified regulation. However, the scales used in the present study did not include this form of extrinsic motivation because it is hypothesized to be encountered more often in adults (Vallerand, 1997). Moreover, the scales used in the present research have been developed and validated with young adults and adolescents (Guay, Vallerand, & Blanchard, 2000; Ryan & Connell, 1989).

Ntoumanis and Blaymires (2003) showed that students' situational motivation toward an educational activity was positively predicted by their contextual motivation toward education, measured 1 month before, while their situational motivation toward a physical activity class was predicted by their contextual motivation toward physical activity. Similar findings have also been reported in other life contexts (Gagné, Ryan, & Bargmann, 2003; Guay, Mageau, & Vallerand, 2003).

Another postulate from the HMIEM (Vallerand, 1997) is the recursive (i.e., bottom–up) effect. This postulate posits that a motivational orientation at one level of generality can exert an influence on the next higher level of the hierarchy. Specifically, this postulate suggests that repeatedly experiencing a self-determined motivation at the situational level in some related activities can, through the recursive effect, eventually generate increases in self-determined contextual motivation in this sphere of activities. Accordingly, a student who frequently experiences instances of situational self-determined motivation (i.e., intrinsic motivation or identified regulation) toward a science activity in class will ultimately experience higher levels of contextual self-determined motivation toward science as a whole. Research has been supportive of the recursive effect involving the situational and contextual levels in sports (Blanchard, Mask, Vallerand, de la Sablonnière, & Provencher, 2007). However, no research on the recursive effect has been conducted in education.

The Present Research

The purpose of the present research is to test some of the psychological processes through which changes in contextual motivation toward science take place over time. It is proposed that many of the changes in contextual motivation are induced by repeated experiences of self-determined situational motivation (i.e., recursive effect). Furthermore, situational motivation itself is proposed to be determined at least in part by one's contextual motivation in the relevant life domains (i.e., top–down effect). That is, students' contextual motivation toward science is suggested to determine, in large part, their situational motivation toward a scientific activity. Finally, the resulting contextual motivation toward science courses should predict students' intentions to take science classes in the future, along with eventually pursuing a scientific career.

The purpose of the present study is to test these hypotheses in a longitudinal study involving five time points (see Figure 1) in which contextual motivation is assessed three times (Times 1, 3, and 5) and situational motivation is assessed twice (Times 2 and 4). It is postulated that the top–down effect will take place at two points in the model (i.e., contextual motivation at

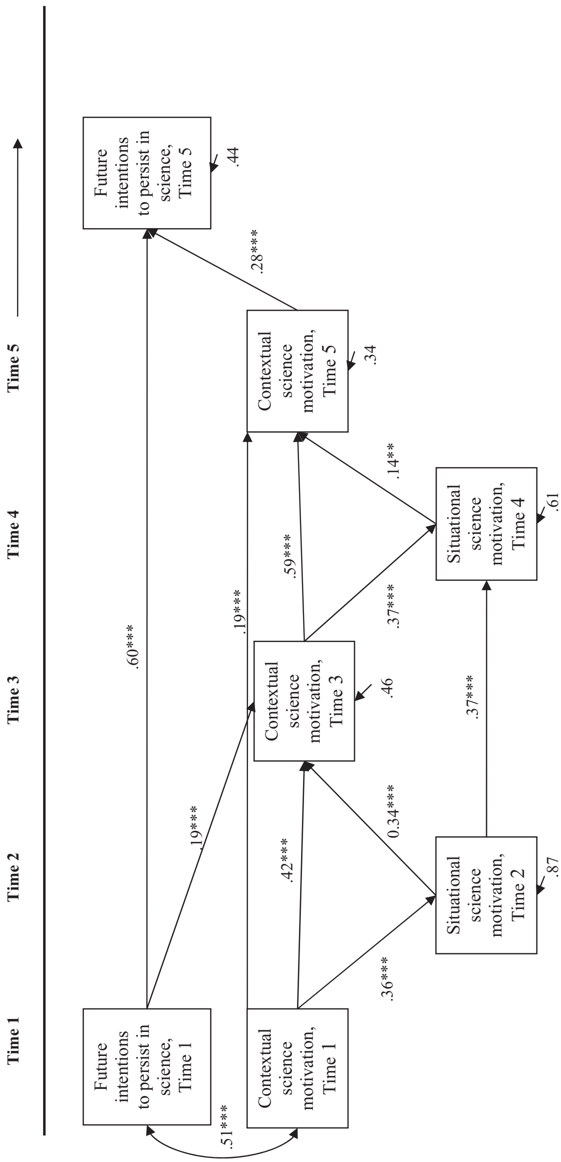

Figure 1. Results of the path analysis. $^{**}p < .01$. $^{***}p < .001$.

Time 1 predicting situational motivation at Time 2; contextual motivation at Time 3 predicting situational motivation at Time 4). In addition, the recursive effect is also expected to take place, with situational motivation predicting changes in subsequent contextual motivation (situational motivation at Time 2 and Time 4 predicting contextual motivation at Time 3 and Time 5, respectively). Finally, contextual motivation at Time 5 is expected to predict intentions to persist in science, even after controlling for students' initial intentions to persist in science (i.e., intentions as measured at Time 1). The more self-determined the contextual motivation, the higher will be the intentions to persist in science. In sum, the present study allows us to chart some of the processes by which one's contextual (or general) motivation can change over time, as well as its ability to predict one's intentions to continue in science.

Method

Participants

Data were collected on five occasions within an academic year. Participants were 10th grade French-Canadian students who were recruited from a Montréal public high school. Total student participation was as follows: 274 students at Time 1; 261 students at Time 2; 248 students at Time 3; 268 students at Time 4; and 238 students at Time 5. Only those who responded to the questionnaires on at least three of the five phases of the study were included in the final analysis. No mean differences were found between participants who participated at all five times and those who did not on all variables relevant to the present study.

Missing data were handled with a maximum likelihood multiple imputations method with an expectation-maximization algorithm (Schafer & Graham, 2002). Final participants were 268 high school students (142 females, 126 males), with a mean age of 15.1 years (SD = 0.5). No gender differences were found on the model variables.

Procedure

Participants met with a trained experimenter on five occasions in their school. The questionnaires were administered according to standardized instructions. It was explained that the purpose of the questionnaires was to learn more about students' attitudes and behaviors toward science education throughout an academic year. Science classes were described as including every science course (i.e., natural sciences) in which they were enrolled that particular academic year.

Students first met with the experimenter in November and completed the first questionnaire (Time 1). Two weeks later, students attended a conference given by an eminent scientist who talked about his enthusiasm and interest for his scientific work. Following the conference, students completed the second questionnaire (Time 2). One week later, an experimenter returned to the students' classrooms where they completed the third questionnaire (Time 3). Finally, the two remaining questionnaires were completed in February, one immediately following the presentation of a movie about scientific careers (Time 4) and the other 1 week later in class (Time 5). It was clearly stated that the confidentiality of the students' answers would be maintained at all times. Students completed the questionnaires individually, and they were all thanked for their participation.

Questionnaires

Participants completed a 16-item scale measuring their contextual motivation toward science courses on three occasions (i.e., Times 1, 3, and 5). This scale was based on Ryan and Connell (1989) and contained four questions focusing on different facets of students' science class activities (i.e., "In general, why do you go to your science classes?"; "In general, why do you do your in-class science exercises?"; "In general, why do you listen to your science teachers?"; and "In general, why do you do your science homework?"). Each question was followed by four items associated with a different degree of self-determined motivation: intrinsic motivation (e.g., "For the fun of doing it"), identified regulation (e.g., "Because I choose to do it for my own good"), introjected regulation (e.g., "Because it is what I am supposed to do"), and amotivation (e.g., "I don't know, I don't see what it brings me").

In order to use a single motivation score, a contextual self-determined motivation index was constructed by a summation of specifically weighted scores from the different motivational subscales according to their position on the self-determination continuum. Specifically, scores were first computed for each motivation subscale and then the contextual self-determined index was constructed according to the following equation:

$$2*[\text{Contextual intrinsic motivation score}]+1*[\text{Contextual identified regulation score}]-1*[\text{Contextual introjected regulation score}]-2*[\text{Contextual amotivation score}]^{4}$$

[4]See Vallerand (1997) for support for the validity of the index.

Scores for the self-determined motivation index could vary from +18 to −18.

At Times 2 and 4, participants completed the 16-item Situational Motivation Scale (SIMS; Guay, Vallerand, & Blanchard, 2000). This scale was used to measure participants' situational motivation by asking why they had listened to the conference of the scientist that had finished moments earlier (Time 2). There were four items to assess each degree of self-determined motivation: intrinsic motivation (e.g., "Because the conference was really fun"), identified regulation (e.g., "Because I believed it was important for me"), external regulation (e.g., "Because I did not have another choice than to listen to the conference"), and amotivation (e.g., "I don't know, I didn't see what it brought me"). A situational self-determined motivation index was constructed similarly to the contextual self-determined motivation index. A similar scale was constructed at Time 4 with respect to the scientific video the participants had just watched. Cronbach's alphas for all subscales and the index at the various phases varied from .76 to .96.

At Times 1 and 5, a four-item scale was used to measure students' intentions to pursue their education and eventually a career in the sciences (e.g., "I have the intention of taking some science classes next year," and "I would like to have a scientific career"; Time 1, $\alpha = .92$; Time 5, $\alpha = .93$). All of the items were rated on a 7-point Likert-type scale ranging from 1 (*not at all in agreement*) to 7 (*very highly in agreement*). Finally, demographic questions assessed students' age, gender, nationality, language spoken at home, birthplace, and each parent's working status.

Results

The model tested in the present study was composed of seven observed variables: two exogenous variables (i.e., Future Science Intentions at Time 1, Contextual Science Motivation at Time 1) and five endogenous variables (i.e., Situational Science Motivation at Time 2, Contextual Science Motivation at Time 3, Situational Science Motivation at Time 4, Contextual Science Motivation at Time 5, Future Science Intentions at Time 5). The model was specified as a structural model (i.e., path model) where direct paths were specified between the observed variables. This model was preferred to a model in which both the measurement and structural dimensions are analyzed as a result of the limited sample size of the present data set (Kline, 2005).

All observed variables of the present study had normal distributions. Table 1 presents the correlation matrix involving all variables for the final sample of students, along with the standard deviations and the means. The

Table 1

Correlation Matrix Involving All Variables of the Path Model

Variable	*M*	*SD*	1	2	3	4	5	6
1. Future intentions, Time 1	4.26	1.25	—					
2. Contextual motivation, Time 1	4.02	5.74	.51**	—				
3. Situational motivation, Time 2	4.66	5.93	.27**	.36**	—			
4. Contextual motivation, Time 3	3.19	6.41	.49**	.64**	.54**	—		
5. Situational motivation, Time 4	0.42	6.88	.23**	.35**	.55**	.56**	—	
6. Contextual motivation, Time 5	3.01	6.89	.49**	.61**	.49**	.79**	.54**	—
7. Future intentions, Time 5	4.25	1.44	.72**	.53**	.30**	.54**	.37**	.56**

Note. $N = 168$.
$^{**}p < .01$.

hypothesized model was tested with LISREL 8.80. The covariance matrix served as a database for the analysis, and the method of estimation was maximum likelihood. Much research has indicated that maximum likelihood performs well when data are multivariate normally distributed (Chou & Bentler, 1995), which is the case with the present data set. Paths were specified according to hypotheses derived from the HMIEM (Vallerand, 1997). The results provide significant support for the proposed model, $\chi^2(9, N = 268) = 23.14$, $p < .05$ (normed fit index [NFI] = .98, non-normed fit index [NNFI] = .98, comparative fit index [CFI] = .99, root mean square error of approximation [RMSEA] = .08 [0.04; 0.12], standardized root mean residual [SRMR] = .04, normed $\chi^2 = 2.57$).

Figure 1 displays the path coefficients of the integrated model, as well as the measurement errors. The estimated paths dealing with the postulated top–down effect were all found to be significant (t values > 3.29). Namely, the path between contextual self-determined science motivation at Time 1 and situational self-determined science motivation at Time 2 ($\beta = .36$), as well as that between contextual self-determined science motivation at Time 3 and situational self-determined science motivation at Time 4 ($\beta = .37$) were found to be significant. The estimated paths dealing with the postulated recursive (bottom–up) effect were also found to be significant (t values > 2.58). Specifically, the path between situational self-determined science motivation at Time 2 and contextual self-determined science motivation at Time 3 ($\beta = .34$), as well as that between situational self-determined science motivation at Time 4 and contextual self-determined science motivation at Time 5 ($\beta = .14$) were found to be significant. Furthermore, the various paths were found to be significant, even when controlling for the stability of contextual motivation over time, as well as for the stability of future science intentions over time (see Figure 1). Finally, a significant path coefficient (t value > 3.29) was found between contextual self-determined science motivation at Time 5 and future science intentions at Time 5 ($\beta = .28$).[5]

[5]An alternative model was also tested. To determine whether or not an alternative model explains the data significantly better than the proposed model, we must consider the chi-square difference between the two models. Because only one variable was assessed at Times 2, 3, and 4, the only meaningful alternative model that could be tested was one in which the position of the contextual self-determined science motivation at Time 5 and the future science intentions at Time 5 variables in the model in Figure 1 were reversed. The results reveal a poor fit of the model to the data; the chi-square value was significant, $\chi^2(9, N = 268) = 125.89$; and the other fit indexes were unsatisfactory (NCI = 13.99, NFI = .90, NNFI = .78, RMSEA = .22 [0.19; 0.26], SRMR = 0.10); therefore, indicating a bad fit to the data. In addition, the value of the chi-square difference between this alternative model and the original model was significant ($p > .05$), indicating that the original model offers a better explanation of the data. With all of these considerations in mind, it can be concluded that the model proposed in the present study is authentically valid, and that it reflects the most parsimonious explanation of the data.

Discussion

The purpose of the present study was to test some of the processes by which changes in contextual motivation toward science take place, as proposed by the HMIEM (Vallerand, 1997). Specifically, the top–down and the bottom–up (recursive) effects were tested. Overall, the results from a structural equation modeling analysis supported the hypothesized model. That is, the results supported the HMIEM's two postulates, as well as the impact of science motivation on students' future intentions. The present findings lead to a number of implications in the understanding of human motivation.

Motivational Changes Over Time: A Dynamic Process

The present research helped reveal a dynamic process of motivational changes over time in which situational motivation resulted in part from contextual motivation and in which situational motivation, in turn, influenced subsequent contextual motivation. This dynamic interaction between two levels of the motivational hierarchy (Vallerand, 1997) underscores the importance of the top–down effect, as well as of the recursive (i.e., bottom–up) effect. More precisely, the significant path coefficient found between students' situational self-determined motivation experienced following the eminent scientist's conference and their contextual science self-determined motivation reported 1 week later ($\beta = .34$), as well as the significant path found between students' situational self-determined motivation following the presentation of the scientific video and their self-determined science motivation experienced 1 week later ($\beta = .14$) are signs of the important impact situational self-determined motivation can eventually have on the changes in one's general motivational orientation toward science.

Furthermore, contextual motivational orientations also have an impact on students' situational motivation that is experienced toward a specific activity (i.e., top–down postulate from HMIEM; Vallerand, 1997). Within the present study, students' contextual self-determined motivation toward science positively predicted their situational self-determined motivation experienced toward the scientific conference at Time 2 ($\beta = .36$), as well as their situational self-determined motivation toward the scientific video at Time 4 ($\beta = .37$). These findings are in line with past research that has demonstrated the interaction between the different levels of the motivational hierarchy (Blanchard et al., 2007; Gagné et al., 2003; Guay et al., 2003; Ntoumanis & Blaymires, 2003; Vallerand, 1997; Williams, Grow, Freedman, Ryan, & Deci, 1996).

An additional finding of interest from the present research is the appreciable stability found between corresponding levels of the motivational hierarchy over time. Specifically, all stability path coefficients were significant.[6] These results can be explained by the abundant experiences students of this level have had with the educational setting. In fact, within familiar contexts, contextual motivation appears to be relatively stable (Guay et al., 2003). It would appear that as time goes by, individuals are believed to have gathered extensive knowledge specific to a given context, and eventually to display a typical motivational orientation toward that particular context (Vallerand, 1997). For instance, individuals who go to their first science class are not likely to have developed a contextual motivation toward science. However, after several scientific classes, an individual should develop a more stable motivational orientation toward science.

The results of the present study suggest that motivational changes can occur even within well known contexts, such as science. Specifically, students' contextual self-determined motivation was positively influenced by specific experiences at Times 2 and 4, even though their science motivation (i.e., their contextual self-determined motivation) showed a high level of stability. Future research is needed to more fully understand the magnitude of motivational changes that can occur within contexts with which people have different levels of familiarity.

The findings showing that the significant path between Time 2 and Time 4 situational motivation variables ($\beta = .35$) was smaller than most of the stability coefficients involving contextual motivation variables (βs = .42, .59, .19) is consistent with the HMIEM (Vallerand, 1997). More precisely, the HMIEM posits that as one moves from the situational to the contextual level, stability should increase. Indeed, because situational motivation refers to one's motivation here and now, it is likely to be influenced by a host of personal and situational factors. Thus, situational motivation is expected to vary more than contextual motivation. Future research should seek to identify the specific social factors that can positively influence individuals' situational motivation toward science. This would allow us to derive insights as to how best to facilitate students' situational motivation toward science-related activities and, in turn, how to increase their more enduring contextual motivation toward science.

[6]These coefficients include the three involving contextual self-determined science motivation (Time 1–Time 3, $\beta = .42$; Time 3–Time 5, $\beta = .59$; Time 1–Time 5, $\beta = .19$) and situational self-determined science motivation (Time 2–Time 4, $\beta = .35$).

Self-Determined Motivation and Future Behavioral Intentions

The significant path found between students' self-determined science motivation at Time 5 and their future intentions to pursue an education and eventually a career within the sciences (β = .28), even after controlling for initial levels of future science intentions, suggests that higher levels of self-determined contextual motivation positively influence future behavioral intentions. This is in line with past work that demonstrated that behavioral outcomes in specific contexts were predicted by contextual self-determined motivation toward the corresponding context (e.g., Aunola, Leskinen, & Nurmi, 2006; Grouzet et al., 2005; Guay & Vallerand, 1997; Sarrazin, Vallerand, Guillet, Pelletier, & Cury, 2002; Vallerand & Bissonnette, 1992; Vallerand, Fortier, & Guay, 1997).

The present results underscore an important factor that influences students' persistence in science education. It appears that through the repeated experience of increases in situational self-determined motivation over time, students' contextual self-determined motivation should increase, which should then positively impact their future behavioral intentions to continue in a scientific field. This finding is of considerable importance because it underscores a dynamic mechanism by which people's global motivational orientations toward specific life domains can be rendered more self-determined in nature. With a situational motivation toward science that is repeatedly experienced as intrinsic and identified, students are likely to internalize the hard work of a scientific education as more stimulating and rewarding, and should eventually persist within that field of study.

The influence exerted by self-determined situational motivation is probably initiated very early in children's education. In fact, a longitudinal study that was conducted with elementary school children showed that their preschool mathematic performance predicted their situational self-determined motivation toward a specific mathematic task, which subsequently predicted their mathematic performance (Aunola et al., 2006). These results are in line with the developmental perspective of Harter (1999), who argued that the construct of self is a cognitive construction that takes place from the specific to the general. Thus, specific experiences of situational self-determined motivation lead to higher order representations about one's general motivational orientation in science, which can lead students to persevere in science and eventually reach higher levels of performance.

From an applied perspective, promising intervention programs could be developed by designing repeated instances of situational intrinsic motivation in science courses, which should eventually produce changes in students' contextual self-determined motivation toward science and ensuing consequences. Specifically, schools, as well as teachers, could help increase students' self-determined motivation by providing stimulating and innovative activities inside and outside the classrooms. The present results suggest that if students regularly engage in scientific projects that stimulate them, they should eventually transfer these situational instances of great involvement into their global representation of science. In other words, their experiences of self-determination at the situational level should eventually influence their contextual motivational pattern, thus increasing their contextual self-determined motivation toward the context of science in general.

It is believed that simple class activities that involve students' active participation, as well as field trips in which new knowledge about the environment is acquired are as influential as a dynamic and interesting teacher can be. Future research is nonetheless needed in order to verify these hypotheses empirically as well as uncover what teaching characteristics are most likely to influence greater science self-determined motivation in students.

Study Limitations

Some limitations of the present study should be noted. First, although the structural equation modeling technique that was used within the present study provides a strong test of the proposed relationships between the model variables, it cannot lead to definitive conclusions about causality because it is correlational in nature. Future research using experimental designs should be used to replicate and confirm the present findings.

Second, although the present research was longitudinal in nature, it took place over a short period of only 4 months. Further research is needed to assess the validity of the top–down and recursive effects over a period of years.

Third, situational motivations were assessed after special science-related events (i.e., scientific conference, video presentation), which might differ from day-to-day scientific classroom activities. However, we believe that the top–down and recursive effects would have been similarly observed if situational self-determined science motivations had been assessed after regular classroom activities. Future research is nonetheless needed to clarify this issue.

Fourth, the present study did not use an experimental design, which could have induced actual changes in contextual self-determined science motivation over time. Specifically, the present results suggest a mechanism of motivational changes with which interventions could be designed in order to impact on people's motivation toward a specific context in a proactive manner, as opposed to the observational approach taken by the present study. Future research should investigate this issue more deeply to solidify the validity of the HMIEM's hypotheses regarding the top–down and recursive effects.

Finally, all variables came from students' self-reports. Even though these measures have been used repeatedly in past research and are valid measurements of the model's variables, more objective measures, including some from other sources (e.g., science teachers), would be highly informative. Furthermore, the repeated use over time of self-report measures might have created a method effect that could be responsible, in part, for the high stability coefficient values observed among contextual self-determined science motivation variables.

In sum, the present research has uncovered a mechanism responsible for changes in students' enduring motivational orientations toward science-related activities and future intentions to persist in science. Such a mechanism involves top–down and bottom–up effects between contextual and situational motivation. Thus, future research along the present lines would appear to be promising for the study of science education.

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