

Engagement and Performance in Physics: The Role of Class Instructional Strategies, and Student's Personal and Situational Interest

Antonio González* and Paola-Verónica Paoloni**

*Universidad de Vigo (Spain), **Universidad Nacional de Río Cuarto (Argentina)

Abstract

This study aimed to analyse situational and personal interest in Physics, to establish how both are affected by two instructional strategies (provide opportunities of choice, and make explicit the relevance of contents), and to determine how strategies and interest influenced engagement, disaffection, and performance. Participants were 430 second-year science-technology Baccalaureate students (52.4% girls). Structural equation models corroborated the hypotheses: situational and personal interest were improved by these two instructional strategies. Moreover, both modalities of interest and teaching strategies enhanced academic engagement and performance, protecting students from disaffection. Mediated effects between the assessed variables were also significant.

Keywords: Personal and situational interest, possibility of choice, promoting relevance, academic engagement, disaffection.

Resumen

Este estudio pretende analizar el interés situacional y personal hacia la Física, establecer en qué medida ambos resultan afectados por dos estrategias docentes (ofrecer posibilidades de elección en clase y explicitar la relevancia de los contenidos) y determinar el grado en que estrategias e interés influyen sobre la implicación, la desafección y el rendimiento. Participaron 430 estudiantes de segundo curso del Bachillerato científico-tecnológico (52.4% chicas). Los modelos de ecuaciones estructurales confirman las hipótesis: el interés personal y el situacional se ven potenciados por estas dos estrategias docentes; además, ambos tipos de interés y las estrategias favorecieron la implicación y el rendimiento académico, protegiendo a los alumnos frente a la desafección. Los efectos mediados entre las variables evaluadas también fueron significativos.

Palabras clave: Interés personal y situacional, posibilitar la elección, promover la relevancia, implicación académica, desafección.

Correspondence concerning this article should addressed to Antonio González. Facultad de Ciencias de la Educación. Universidad de Vigo. Campus As Lagoas. 32004. Ourense. Spain. E-mail: aaglez@uvigo.es

Introduction

The most recent PISA report for Spain (INEE, 2013, p. 150) clearly underscores that the students' interest is the driving force behind engagement and the dedication needed to ensure optimum academic performance. The report also emphasises that certain teaching practices and other positive synergies generated in the classroom may enable students to overcome their apathy for a particular subject.

Likewise, recent studies have corroborated the crucial role of personal interest in learning science (Anderman, Sinatra, & Gray, 2012; Hampden-Thompson & Bennett, 2013; Klug, Krause, Schober, Finsterwald, & Spiel, 2014; Logan & Skamp, 2013). These authors have underlined the importance of determining the characteristics of teacher-student interactions that stimulate and develop interest in a specific subject. Moreover, they claim that teaching plays a fundamental role in the maintaining, and waxing or waning of interest for a specific subject; and that once personal interest for a subject has been lost it is difficult to regain.

Bearing in mind this context, this study assessed the impact of teacher-student interactions on situational and personal interest towards Physics, and if these variables conditioned academic engagement, disaffection, and performance. How these constructs have been defined in previous studies will be briefly

reviewed in the following section in order to provide a theoretical framework.

Personal and situational interest

Research on interest has often characterized the phenomenon as arising from the interaction between an individual and his/her environment (Renninger & Hidi, 2011; Krapp & Prenzel, 2011; Schiefele, 2009). Thus, two types have been distinguished: personal and situational interest.

Personal interest is an individual's relatively long-term preference for certain topics and activities (Ainley, 2012; Ainley & Hidi, 2014; Krapp & Prenzel, 2011; Schiefele, 2009). It consisted of two components: the affective, which includes feelings associated to the interaction with the object of interest such as enjoyment or activation; and the cognitive component, which entails assigning particular personal importance to an object or topic.

With regards to situational interest, Hidi and Renninger (2006) suggest it is aroused by certain environmental elements. Krapp and Prenzel (2011), and Renninger and Hidi (2011) distinguished two modalities of situational interest, triggered and maintained. Triggered situational interest catches the student's attention, awakens in the individual affective experiences related to the environment; this is particularly important during the initial stages when the student comes

into first contact with a new subject. In comparison, maintained situational interest demands greater student engagement that begins by establishing significant connections with specific content, and by understanding their relevance and utility. Maintained situational interest consisted of two components: the cognitive, and the affective component (Linnenbrink-García et al., 2010; Linnenbrink-García, Patall, & Messersmith, 2013). The value-related component evaluates the degree to which students value the content they are learning in class because they consider it significant, important, and useful for their future. The feeling-related component includes different emotions (e.g., fascination and enjoyment) experienced by students that maintain their interest in the content for study.

Though conceptually different, situational interest can activate and maintain personal interest (Klug et al., 2014; Krapp & Prenzel, 2011; Renninger & Hidi, 2011; Tsai, Kunter, Lüdtke, Ryan, & Trautwein, 2008). Triggered situational interest initiates this process by bring to the students' attention a topic, which initially may not have been of personal interest to the student. Maintained situational interest provides this nexus: once the students' attention has been drawn to a specific topic, students who consider it attractive and important will probably value it more highly, and have a greater desire to learn, which in turn initiates personal interest.

Nevertheless, as Linnenbrink-García et al. (2010, 2013) have pointed out, few empirical studies have analysed jointly situational and personal interest, even though numerous authors have asserted that situational interest can activate and maintain personal interest.

Class interactions: relevance and choice

Teacher-student interactions in the classroom have been analysed from several perspectives such as the teacher's sensitivity towards the student's interests, supporting basic psychological needs, classroom organization and management, instructional methods used to enhance learning, affective relationships in the classroom, and fostering learner autonomy (García-Bacete, Ferrá, Monjas, & Marande, 2014; Morge, Toczek, & Chakroun, 2010; Pianta, Hamre, & Allen, 2012; Roorda, Koonen, Spilt, & Oort, 2011; Sánchez-Oliva, Viladrich, Amado, González-Ponce, & García-Calvo, 2014).

Motivational Self-determination Theory (SDT) operationalizes classroom interactions such as encouraging student "autonomy support" on behalf of the teacher (Jang, Reeve, & Deci, 2010; Reeve, 2009, 2013; Sánchez-Oliva et al., 2014; Su & Reeve, 2011; Vansteenkiste et al., 2012). Black and Deci (2000, p. 742) give an example illustrating autonomy support: "a person in a position of authority (e.g., the teacher) who puts her/himself in the

position of the other (e.g., the student), and adopts their perspective, understands their feelings, and offers relevant information and choice of opportunities". The opposite, according to these authors, is controlling authority that forces others into behaving in a specified manner, with persuasive or coercive explicit or implicit techniques. The former example encompasses two of the basic components of autonomy support: relevance and choice (Jang, 2008; Reeve, 2009, 2013; Su & Reeve, 2011).

According to Assor (2012), Katz and Assor (2007) and Stefanou, Perencivich, DiCintio and Turner (2004), the first behaviour involves offering students the possibility of choosing between different alternatives, such as topics to work on, materials, the members of the group, the way of exhibiting knowledge or problem-solving modalities.

However, though in theory the possibility of choice may be synonymous to autonomy support, in practice the possibility of choice is only meaningful if the alternatives are relevant to the student (Assor, Kaplan, & Roth, 2002; Stefanou et al., 2004). Likewise, for Hulleman, Godes, Hendricks and Harackiewicz (2010), Jang (2008), and Reeve (2009), the most effective means for facilitating relevance consisted in explicitly informing students of the importance an activity or subject for achieving their personal goals.

Previous studies have confirmed that providing choice and promoting

relevance facilitated academic performance and engagement (Assor et al., 2002; Jang, Kim, & Reeve, 2012; Jang, Reeve, & Deci, 2010; Roorda et al., 2011; Vansteenkiste et al., 2012). Notwithstanding, few studies have simultaneously evaluated both teaching strategies (Assor et al., 2002), or have related them to interest (Hulleman et al., 2010; Tsai et al., 2008).

Academic engagement and disaffection

Furthermore, academic engagement has been researched from different approaches focusing on a diversity of topics related to students: whether they identify with the class and participate in it; the satisfaction of their needs in terms of competency, autonomy and relationships; their emotional and behaviour problems related to school; their levels of academic wellbeing; their attitudes to school, classmates, and teachers; their constructive contributions, and interactions during class; the recovery of school dropouts (Lawson & Lawson, 2013; Pianta et al., 2012; Ros, 2009; Ros, Goikoetxea, Gairín, & Lekue, 2012; Skinner, Furrer, Marchand, & Kinderman, 2008). In order to synthesize these approaches, in these studies the notion of engagement consisted of three intensely correlated and mutually supportive dimensions i.e., the behavioural, emotional and cognitive dimensions.

Behavioural academic engagement is defined as the interactions students have with their academic environment that are active, goal directed, flexible, constructive and persistent (Assor, 2012; Skinner, Kinderman, & Furrer, 2009). Thus, effort, attention, concentration, and persistence are considered to be indicators of behavioural engagement. In general, this behaviour is accompanied by emotional engagement (feelings of enthusiasm, enjoyment, and satisfaction) and cognitive engagement (use of self-regulated learning strategies).

On the opposite end of engagement lies behavioural academic disaffection or disengagement, which is operationalized as a lack of effort, poor persistence, reduced attention, and continuously delaying completing tasks (Darby, 2005; Skinner et al., 2008, 2009). This concept comes close to burnout, passiveness, indifference, amotivation, and hopelessness (Salanova, Schaufeli, Martínez, & Bresó, 2010). This behaviour is usually accompanied by poorly efficacious learning strategies, and emotions such discouragement, apathy, boredom, and frustration. In turn, this often leads to absenteeism and early school-leaving (Ros et al., 2012; Salanova et al., 2010).

Previous studies found a positive correlation between behavioural academic engagement and performance, and personal and situational interest (Ainley, 2012; Darby, 2005; Jang, 2008; Rotgans & Schmidt, 2011; Skinner et al., 2008, 2009).

The subject of Physics in Baccalaureate

The subject of Physics is considered to be particularly difficult by most teachers and students, the most common reasons for this view were as follows: to understand it properly the student needs an advanced knowledge of mathematics; in Baccalaureate, the content is too extensive and diverse; the understanding of much of this content demands the student has a high degree of abstraction; and students must have problem-solving skills that demand complex integration strategies (Belo, van Driel, van Veen, & Verloop, 2014; Oon & Subramaniam, 2011; Ornek, Robinson, & Haugan, 2008). Among secondary students, this perception of the difficulty of Physics is further exacerbated as interest and engagement in activities required for effective learning wane through time (Belo et al., 2014; Venturini, 2007). Nevertheless, Physics remains a fundamental subject in the science-technology Baccalaureate and its content is a prerequisite for many degrees accessible through this speciality of Baccalaureate.

Moreover, second-year Baccalaureate students have characteristics that differentiate them from other students. For instance, for these students, the academic year finishes at the beginning of May, which means teachers must accelerate the pace of syllabus implementation to adapt it to the cal-

endar of the Selectivity exams. If students pass their subjects, their final grades will count for their final mark for entering university. In addition, many of the candidates aspiring to degrees with the highest entry “cut-off scores” are enrolled in the Baccalaureate speciality of science-technology. These circumstances plus the pressure on them to pass their Selectivity university entrance exams, generates in these students higher levels of stress than those experienced by students in other courses.

Aims of the study

This study assessed two teaching strategies perceived by students (provide opportunities of choice and making explicit the relevance of contents), two components of maintained situational interest (feeling and value), personal interest, behavioural engagement, behavioural disaffection, and performance in the subject of Physics in the Selectivity (Spanish university entrance exam). These variables were evaluated in a sample of second-year science-tech-

nology Baccalaureate students. The objective was to assess the extent to which the students’ personal interest were conditioned by classroom teaching strategies, and to determine how these variables affected engagement, disaffection and academic performance in Physics.

With reference to the relationships between the variables evaluated in this study, these have been partially assessed by several authors (Assor, 2012; Assor et al., 2002; Linnenbrink-García et al., 2013; Reeve, 2013; Roorda et al., 2011). Bearing in mind the proposals of these authors, Figure 1 provides a representation of the relationships that were tested.

According to the model shown in Figure 1 and bearing in mind the findings of previous studies, it was hypothesized that (a) choice and relevance would positively predict situational interest, personal interest, engagement, and performance, and would negatively predict disaffection; (b) situational interest would positively predict personal interest, engagement, and performance, and would negatively predict disaffec-

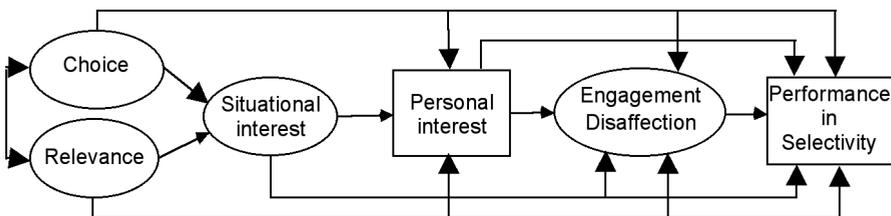


Figure 1. Hypothesised model of the relationships between variables.

tion; and (c) performance would be positively predicted by behavioural engagement, and negatively by disaffection. In terms of mediation, it was hypothesized that (d) situational interest would mediate the relationships between choice-relevance and personal interest; and (e), engagement and disaffection would mediate the relationships between personal interest and performance.

Thus, this study presents previously unreported findings with reference to earlier research: two teaching strategies, choice and relevance, were jointly analysed, which allowed for the comparison between both; the same may be said for the two components of situational interest; behavioural disaffection was evaluated, a variable that has received little attention though crucial for performance; behavioural engagement was estimated by the teachers themselves in order to obtain a more objective view of student behaviour; as an indicator of performance external qualifications were used, and not the evaluations of teachers from the schools themselves; finally, structural equation models were assessed to ascertain the direct and mediated effects between variables.

Method

Participants

The final sample consisted of 430, 2nd year science-technology

Baccalaureate students (girls 52.4% and boys 47.6%), who were enrolled at secondary schools of the Autonomous Community of Galicia in north-western Spain. A total of 23 schools, 16 state schools, and 7 private state-funded schools, were selected; this proportion of state schools and private schools was proportional to the total number of schools teaching Baccalaureate in this area of the Autonomous Community of Galicia. As for the state schools, 4 belonged to primarily rural populations below 10.000 inhabitants. The remaining schools were located in cities with populations ranging from 70.000 to 350.000 inhabitants. In each school, students were selected through cluster sampling, and data was obtained from all of the students enrolled in science-technology Baccalaureate. The number of students per class ranged from 17 to 31 students. At the end of the academic year (in May), the mean age of participants was 17.73 years ($SD = 1.24$), there were no significant differences between boys and girls in this variable.

Measurement instruments

Choice and relevance. The students' perception of both teaching strategies was evaluated using two subscales of the *Teacher as Social Context (TaSC)* questionnaire, proposed by Belmont, Skinner, Wellborn and Connell (1992), which consisted of four items for each strategy. The *choice* subscale

evaluated the degree to which students perceived a teacher offered different alternatives to carry out academic activities (e.g. “My Physics teacher gives me many options for doing my tasks”). On the *relevance* subscale, students measured how the Physics teacher communicated the importance and usefulness of the content that was taught (e.g. “My Physics teacher explains how we can use the things we learn in class”). Students scored each item on a five-point scale.

Situational interest. This was evaluated using two subscales of the *Situational Interest Questionnaire* for an academic subject (Linnenbrink-García et al., 2010), each with four items. The *maintained situational interest-feeling* subscale evaluated different feelings of the students that prolonged and maintained interest for the subject of Physics (e.g. “I like the things I’m learning in the Physics class”). The *maintained situational interest-value* subscale enquired about the students’ opinions about the relevance of what they learned in class (e.g. “The things I’m studying in Physics class this year are important for me”). Students scored each item on a five-point scale.

Personal interest. This was evaluated on the *Individual Interest for Science Scale* (Linnenbrink-García et al., 2010). As this scale was designed for Mathematics, it was slightly adapted for Physics. The scale consisted of eight items evaluating two aspects of value: *af-*

fective, which includes the students’ feelings concerning this science (e.g. “I love Physics”); and *cognitive* or evaluative, which estimates the usefulness or importance (e.g. “The way of reasoning in Physics is important for me”). Students scored each item on a five-point scale.

Engagement and disaffection. This was evaluated on the *Behavioural Engagement and Disaffection Questionnaire* (Skinner et al., 2008), with two subscales, one completed by the Physics teachers, and the other by the students. The subscale of *behavioural engagement* consisted of five items evaluating the Physics teachers’ perceptions regarding the degree of attention, effort and persistence of each student (e.g. “In my class, this student works as hard as he/she can”). The *behavioural disaffection* subscale also consisted of five items evaluating the extent to which students consider their behaviour in class to be indicative of a lack of academic engagement (e.g., “When I’m in the Physics class, I just act like I’m working”). In both subscales, students scored each item on a five-point scale.

All of the scales have been used in previous studies, with the corroborated psychometric characteristics of reliability and validity. The Spanish version of each scale was designed using the standard procedure of transcultural translation of the scales (Brislin, 1986).

Academic performance. The school secretaries provided the fi-

nal mark obtained by each student for their Physics Selectivity exam in June or September.

Procedure

First, the headteachers of all the schools were contacted to inform them of the objectives of the study, and to request their participation, and that of the Physics teachers, and the secretaries of the schools. All participants freely volunteered to participate and in the study. Moreover, informed consent was obtained from all parents or legal guardians. The tests were administered to students during their tutorials and in the presence of a counselor. The scales were administered at three intervals throughout the academic year: students were administered the choice and relevance questionnaire at the end of October; two situational interest scales in December; and the personal interest and disaffection questionnaires in April. Teachers were administered the behavioural engagement scale in April. The school secretaries provided the final grades for the Selectivity exams in June or September. All students freely participated in the study, and received no financial compensation or reward in return.

Statistical analyses

Initial statistical analysis determined the reliability coefficients (Cronbach's alpha), the descriptive

statistics, and the correlations between observed variables using the SPSS.22 statistical package.

Confirmatory factorial analysis (CFA) was then undertaken to confirm the fit of the measurement model and a series of structural equation models (SEM) was performed to contrast the proposed mediational model using the AMOS.22 software (Arbuckle, 2013). In both analyses (CFA and SEM), according to suggestions of Byrne (2010), the model fit was evaluated by the following indices: the χ^2 statistic, the χ^2/df indicator, the comparative fit index (CFI), the non-normed fit index (NNFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR).

The data from confirmatory factorial analysis was used to calculate two other indexes for evaluating the reliability of the measures, the coefficient of composite reliability (CR) and the average variance extracted (AVE) (Hair, Black, Babin, Anderson, & Tatham, 2009). The coefficient of composite reliability indicated the internal consistency of the indicators of a latent variable; their value was not based on the number of items composing a factor, a $CR \geq .70$ was considered to be acceptable, and its interpretation is similar to that of the Cronbach's alpha. The average variance extracted indicated the percentage of variance of the factor that had been captured by the construct, compared to the variance of the measurement error,

Table 1

Descriptive Statistics, Correlations between Observed Variables, and Reliability Coefficients

Variable	1	2	3	4	5	6	7	8
1. Choice	—							
2. Relevance	.33	—						
3. Situational I. Feeling	.43	.43	—					
4. Situational I. Value	.34	.47	.41	—				
5. Personal interest	.32	.40	.50	.57	—			
6. Behavioural engagement	.25	.28	.39	.42	.50	—		
7. Behavioural disaffection	-.27	-.34	-.42	-.46	-.53	-.44	—	
8. Academic performance	.32	.35	.42	.46	.54	.48	-.46	—
<i>Mean</i>	3.3	3.4	3.5	3.5	3.8	3.6	2.5	7.3
<i>SD</i>	1.0	.97	.98	.98	1.0	.84	.74	1.4
<i>Cronbach's alpha</i>	.85	.84	.84	.85	.79	.78	.77	—
<i>Composite reliability</i>	.78	.76	.78	.79	.73	.74	.72	—
<i>Average variance extracted</i>	.49	.50	.51	.54	.52	.48	.51	—

Note. All correlations were statistically significant at $p < .01$.

around AVE = .50 or higher were considered to be optimum values.

The analysis of mediation between variables was performed in line with the four stages recommended by Kenny, Kashy and Bolger (1998). In the first stage, the independent variables were analysed to determine if they predicted the dependent variables. Step 2 analysed if the independent variable was related to the mediator; in this stage, the mediator was treated as a dependent variable. Step 3 examines the effect of the mediator on the dependent variable to determine if it was predicted by both the independent variable and the mediator. In the fourth stage, the direct and indirect effects obtained in the third stage were analysed to determine if there was a completely mediated

(the direct effect of the independent variable on the dependent variable was non-significant when mediators were included) or partially mediated relationship (direct effect remained significant).

Results

Preliminary analyses

Table 1 shows the correlations between observed variables, the descriptive statistics, and the reliability indexes.

All correlations were positive, with the exception of the links between disaffection and the other variables. It is worth noting the relationships between both instructional strategies ($r = .33$), between both

components of situational interest ($r = .41$), and between engagement and disaffection ($r = -.44$).

As for the reliability indexes, all were within the limits established by Hair et al. (2009). In all cases the Cronbach's alpha and composite reliability values were higher than the minimum limit (.70), whereas the percentages for the average variance extracted were adequate, all coming close to the 50% mark.

Measurement model

In order to test the robustness of the evaluation instruments, the measurement model underwent confirmatory factorial analysis using the AMOS.22 software (Arbuckle, 2013). The following were considered as latent variables: choice, with four indicators; relevance, with four indicators; situational interest-feeling, with four indicators; situational interest-value, with four indicators; the mean for personal interest, given that this scale consisted of eight items; disaffection, with five indicators; and engagement, with five indicators.

All of the indicators obtained asymmetry indices and kurtosis below 11.961, confirming the univariate normality assumption (Arbuckle, 2013; Byrne, 2010). No atypical multivariate observations (outliers) were found. Nevertheless, Mardia's multivariate kurtosis coefficient (28.20) exceeded the critical ratio (7.13). Thus, in order to determine the influence of non-normality on

the estimators, two types of analysis were performed: one for the original sample using the maximum likelihood method; the other for the 500 bootstrap samples, using the maximum likelihood method; a 95% confidence interval was set to evaluate corrected bias, as recommended by Arbuckle (2013) and Byrne (2010). Discrepancies between estimators (bias) calculated using both methods were minimal i.e., differences only on the third decimal. Moreover, none of the confidence intervals for the bias included zero, which would suggest that the accuracy of the estimators was not affected by multivariate non-normality (Byrne, 2010). Therefore, we proceeded to review the results of the analysis performed on the original sample. No re-specifications of the initial model were carried out. The measurement model is shown in Figure 2.

The measurement model provided an excellent fit to the data: $\chi^2 (df = 324, N = 430) = 439.6$, $p < .001$; $\chi^2/df = 1.36$; NNFI = .975; CFI = .977; RMSEA = .029; SRMR = .034. All of the standardized factorial loads were significant ($\beta > .55$; $p < .01$). All correlations between latent constructs were significant ($p < .01$).

Structural model

Several structural equation modeling (SEM) analyses were performed to test the structural model proposed in Figure 1. Two types of

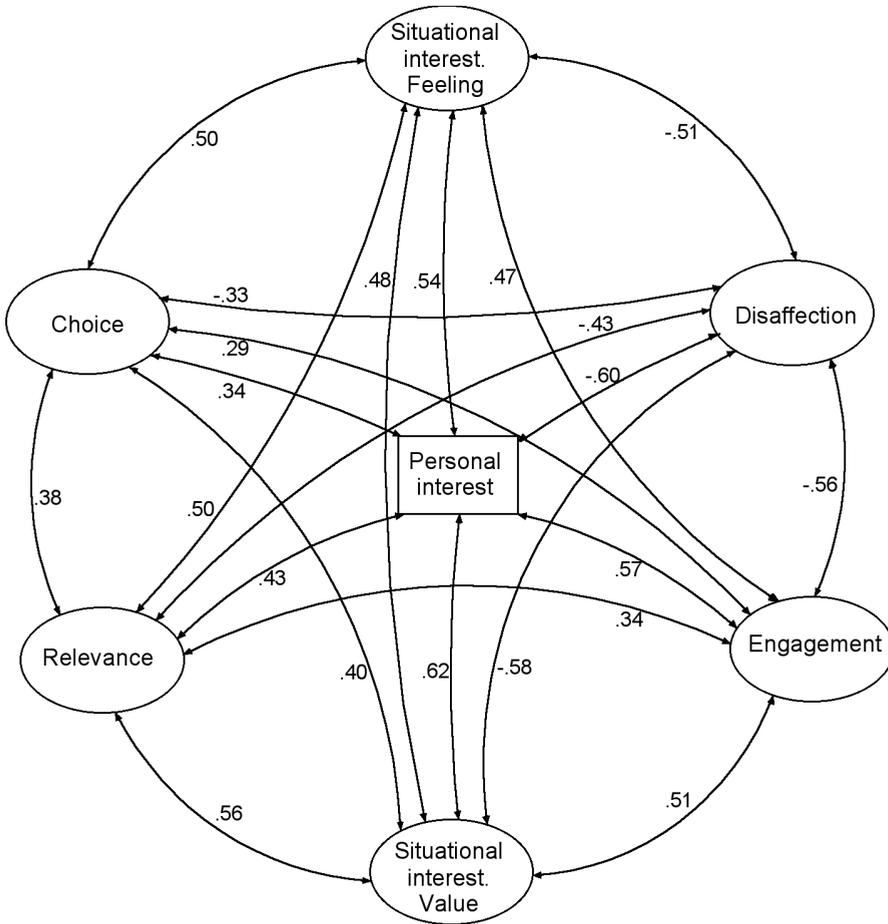


Figure 2. Measurement model.

Note. For clarity of presentation, observed indicators were not drawn.

analysis were applied to the measurement model i.e., with the original sample, and with the 500-sample randomly obtained by re-sampling. As no differences were found between both analyses, only the estimators obtained for the original sample were presented.

In accordance with the first stage recommended by Kenny et al. (1998) for evaluating possible mediated effects, the direct nexus between the independent and the dependent variables were computed. The pairs of variables under evaluation are shown in Table 2, and the

Table 2

Total, Direct, and Indirect Effects between Variables

Total mediation	Total effect ⁽¹⁾	Direct effect (<i>p</i>)	Indirect effect
			Total (<i>p</i>) ⁽³⁾
Choice → Personal I.	.215	-.014 (ns) ⁽²⁾	.229 (.004)
Choice → Disaffection	-.202	.004 (ns)	-.207 (.003)
Choice → Engagement	.195	-.011 (ns)	.206 (.002)
Choice → Grade	.220	.052 (ns)	.168 (.003)
Relevance → Personal I.	.364	.004 (ns)	.360 (.002)
Relevance → Disaffection	-.365	-.036 (ns)	-.329 (.003)
Relevance → Engagement	.276	-.047 (ns)	.323 (.002)
Relevance → Grade	.306	.038 (ns)	.268 (.002)
Partial mediation			
S.I. Feeling → Disaffection	-.323	-.227 (.01)	-.097 (.006)
S.I. Feeling → Engagement	.304	.198 (.01)	.106 (.004)
S.I. Feeling → Grade	.296	.118 (.03)	.178 (.003)
S.I. Value → Disaffection	-.445	-.305 (.01)	-.140 (.005)
S.I. Value → Engagement	.382	.227 (.01)	.154 (.002)
S.I. Value → Grade	.382	.142 (.02)	.239 (.003)
Personal I. → Grade	.280	.152 (.01)	.127 (.005)

Notes. ⁽¹⁾ All total effects were significant ($p < .001$). ⁽²⁾ ns = non-significant effect. ⁽³⁾ The probability associated to the sum of standardized indirect effects and their respective confidence intervals were estimated using the “bias-corrected confidence interval bootstrap test” of AMOS. 22 (confidence level = 95%; samples = 500).

direct nexus between them appears in the total effects column. As shown in Table 2, all of the regression coefficients between the pairs of variables were significant ($p < .001$); and all of the regression models obtained adequate indexes of model fit to data.

The second stage suggested by Kenny et al. (1998), involved analysing the relationships between each dependent variable and its respective mediator, and by analysing pairs of variables. Similar to the results in the first step, all of

the models had a good fit to data, and all of the regression coefficients between variables were significant ($p < .001$).

In the third step described by Kenny et al. (1998), the nexuses among all of the variables under evaluation were established. The indexes revealed the model fitted adequately the data: $\chi^2(df = 326, N = 430) = 461.5, p < .001$; $\chi^2/df = 1.41$; NNFI = .969; CFI = .973; RMSEA = .031; SRMR = .041. The analysis of the direct effects (see Figure 3) showed choice and

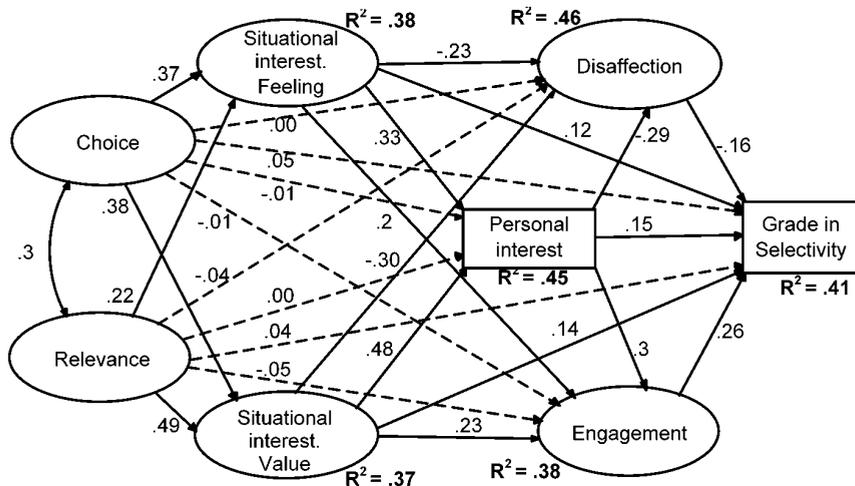


Figure 3. Structural relations between variables (standardized regression weights).

Note. Dashed lines represent non-significant coefficients ($p > .05$). The other values were significant ($p < .01$). For clarity of presentation, observed indicators were not drawn.

relevance positively predicted situational interest-feeling and situational interest-value. Both components of situational interest (feeling and value) positively predicted personal interest, engagement, and performance, and negatively predicted disaffection. Personal interest positively predicted engagement and performance, and negatively disaffection. Behavioural engagement positively predicted performance, whereas disaffection negatively predicted performance.

Finally, the last stage recommended by Kenny et al. (1998) was to establish the total or partial mediation between variables. The data obtained in the previous stage (Figure 3) revealed the direct effects

that linked choice and relevance with personal interest, disaffection, engagement, and the grade in Selectivity were not significant. The paths relating the rest of the variables of the model to each other were significant. This indicated there was total mediation between some variables (these appear at the top of Table 2), and partial mediation between other variables (these appear at the bottom of Table 2).

As for the total mediations, situational interest-feeling and situational interest-value mediated the relationships that linked choice and relevance with personal interest. Moreover, three types of interest mediated the relationships between choice-relevance and engagement-

disaffection. Finally, personal and situational interest and engagement-disaffection mediated the relationship between choice-relevance and performance. In all of these cases the direct effects were not significant, but the indirect and total effects were significant (see top of Table 2).

With regards to partial mediation, personal interest mediated the relationships between situational interest and engagement-disaffection. Moreover, engagement-disaffection mediated the relationships between personal interest and academic performance. In all of these cases, the total, direct, and indirect effects were significant (see bottom of Table 2).

Discussion

This study corroborated the results of previous research, and provided novel data for improving our understanding of the relationships between the variables under evaluation.

First, choice and relevance positively predicted engagement and performance, which agreed with previous studies (Assor et al., 2002; Hulleman et al., 2010; Linnenbrink-García et al., 2013; Roorda et al., 2011). Of these authors, only Assor et al. (2002) evaluated both teaching strategies simultaneously in Israeli secondary students (8-14 years). Moreover, the results obtained in this study were not as unequivocal as has been previously

established. Thus, as expected, students who perceived their teachers had offered them more possibilities of choice also believed their teachers explained better the relevance and utility of different topics dealt with in the Physics class. Furthermore, these students, who enjoyed the subject more and considered it was important for their personal future, exhibited more personal interest towards the content and reasoning of this science. The sign on the indexes that linked the other variables with choice/relevance was identical for both, but the impact of relevance was in all cases higher than the possibility of choice. This corroborated the hypothesis contending that the possibility of choice makes more sense when students are presented relevant alternatives, which are coherent with their personal goals and values (Katz & Assor, 2007; Stefanou et al., 2004).

Second, situational interest predicted personal interest, engagement, and performance, which agreed with the findings of other authors (Ainley, 2012; Ainley & Hidi, 2014; Jang, 2008; Linnenbrink-García et al., 2013; Rotgans & Schmidt, 2011). Of these studies, only Linnenbrink-García et al. (2013) evaluated both components of interest towards science in a three-week summer course for intellectually gifted students. In this study the total effects of interest-value were higher than interest-feeling towards the subject of Physics. Even more than enjoyment, impor-

tance given to the subject was the main force driving personal interest for this science, engagement in class, and in raising their final grades in the Selectivity exams. As for mediation, students who were more conscious of the possibility of choice and the relevance of content were also more interested for this science partly owing to more enjoyment, and for considering the subject to be more important.

Third, in agreement with previous results (Ainley, 2012; Jang, 2008; Linnenbrink-García et al., 2013; Rotgans & Schmidt, 2011), personal interest positively predicted engagement and performance. Moreover, students with higher situational interest for the subject of Physics were more involved in class, partly because they were more personally interested in this science.

Finally, behavioural engagement positively predicted performance, which agreed with previous research (Skinner et al., 2008, 2009). In this study, engagement was evaluated by the teachers, and the final mark in the Selectivity exam was taken as the indicator of performance, which improved reliability in the assessment of the relationships between these variables. As for the mediated effects, the students with higher personal and situational interest obtained better marks, partly owing to more attention, effort, and persistence in undertaking their academic tasks.

The results on behavioural disaffection, which has been researched less than engagement (Skinner et al.,

2008, 2009), were somewhat striking. All of the variables under evaluation were negatively related to disaffection. Thus, students with low levels of attention, participation, effort, and persistence in classroom activities obtained poorer results in Physics. Examining its predictors, possibility of choice, promoting relevance, situational interest for the subject of Physics, and personal interest for this science protected students from disaffection in class. Moreover, disaffection mediated the relationship between personal interest and performance.

Educational applications

This study has underscored the impact of specific teacher-student interactions on enhancing interest and engagement, and minimizing disaffection. This finding as well as similar results obtained in previous studies support numerous proposals and interventions for teachers to raise their students' interest, enjoyment, and engagement using a variety of strategies (Belo et al., 2014; Hampden-Thompson & Bennett, 2013; Klug et al., 2014; Morge et al., 2010; Pianta et al., 2012). Briefly, examples of a few teaching activities aimed at raising relevance and promoting choice are described below.

In order to enhance the relevance of the sciences, Anderman et al. (2012), Logan and Skamp (2013), and Oon and Subramaniam (2011) recommend: class discussion on the scientific subject mat-

ter to be studied, which should focus on the world surrounding the students, and be meaningful to their own lives; explicitly establishing the greatest number of possible connections between the science taught in classrooms and the world outside; explain to students the utility of certain skills associated to the knowledge of science —logical reasoning, the ability to analyse, and problems solving skills— for their academic and professional future; whenever possible, present problems in practical contexts, not entirely in terms of hypothetical conditions. These and other similar teaching strategies are particularly crucial when the content is not of great interest to students (Assor, 2012; Hulleman et al., 2010; Jang, 2008).

In order to facilitate choice, Anderman et al. (2012) and Logan and Skamp (2013) suggested taking into account the students' previous knowledge and skills, and to propose activities that are graded according to difficulty to minimize boredom and disaffection. Assor (2012) and Darby (2005) also recommend certain flexibility in the choice of classmates in a group, and the choice of classroom topics in accordance with the students' personal interests and goals.

Su and Reeve (2011), and Reeve (2009) assert that teachers, and other professionals, can easily learn these and other instructional strategies that facilitate learner autonomy. Previously, however, it is crucial for teachers to be aware of

the motivation and engagement of their students, paying particular attention to levels of enjoyment, attention, effort, and persistence in carrying out different activities in the classroom.

Though the model proposed has been confirmed, there are several limitations to this study, which may provide clues for new avenues of research.

With reference to the variables, only the two extremes of behavioural engagement were evaluated. Future research can focus on other dimensions of engagement, such as cognitive (strategies) or affective (emotions) (Lawson & Lawson, 2013; Ros et al., 2012; Skinner et al., 2008, 2009).

Neither have other components of autonomy support been evaluated (Jang et al., 2010; Sánchez-Oliva et al., 2014; Stefanou et al., 2004), such as accept the students' expression of negative feelings, offer clear guidelines and constructive feedback in undertaking tasks. These have proven to be efficacious for enhancing interest, engagement, and performance.

As for the experimental design, it would be most useful to examine the evolution of these variables throughout several grades (see Jang et al., 2012; Logan & Skamp, 2013), and to examine how they interact. Though the model under analysis has been well corroborated both theoretically and empirically, there are clear indicators of reciprocal causality among these variables.

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Antonio González is Lecturer of Basic Psychology at Vigo University (Spain), and coordinator of the Official Master "Researching adolescents in school contexts". He was a state-registered teacher for pre-school, primary, and secondary education in Madrid and Galicia (Spain). He was awarded his degree and Ph.D. in Psychology by the Complutense University. Published the book "*Academic motivation. Theory, application and evaluation*" (Ed. Pirámide). His research areas of interest are: motivation, emotions, engagement, and learning strategies.

Paola Verónica Paoloni is a Lecturer at the University Nacional de Río Cuarto (Córdoba, Argentina), and lectures on several Post-graduate courses at other universities. She is a researcher at the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). She was awarded her degree and masters by the University Nacional de Río Cuarto, and her Ph.D. in Psychology by the University Nacional de San Luis (Argentina). Her main areas of research are: learning contexts, self-regulation strategies, academic emotions, and motivation.

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