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Success in Mathematics and Academic Wellbeing in Primary-School Students

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Received: 5 April 2020; Accepted: 6 May 2020; Published: 7 May 2020



Abstract: The main aim of this study was to analyse possible differences in academic wellbeing on the basis of prior academic achievement in mathematics. We conceptualised wellbeing as a multidimensional construct covering both negative indicators, namely, anxiety and negative feelings, and positive indicators, namely, perceived competence, perceived utility, and mastery motivation. Success in mathematics is expected to be associated with better academic wellbeing. The sample consisted of 897 students from the fifth and sixth years of primary school (50.2% boys and 49.8% girls). Results suggested that success in mathematics is linked to a student's academic wellbeing, in such a way that perceived competence in the subject, perception of usefulness of mathematical content, and mastery motivation was higher in students with better previous performance. Anxiety and negative feelings were also lower when success in mathematics increased. Considering the particular anxiety–self-efficacy interaction suggested by previous research, we concluded that a good way to change negative academic wellbeing would be to increase successful experiences to foster perceived competence, especially in students with high academic anxiety.

Keywords: prior academic achievement; academic wellbeing; math; primary education

1. Introduction

Spanish students' mathematics scores in the results of the Program for International Student Assessment (PISA) 2018 report [1] did not encourage optimism about the teaching and learning process for maths in Spain. The PISA test was carried out between April and May 2018, evaluating more than 35,943 fifteen-year-old students of the more than 370,000 of that age in Spain [2]. Their mean score in mathematics was 481, significantly lower than the mean Organisation for Economic Co-Operation and Development (OECD) score, which is 489 points. Spain ranked 27th of the 36 member countries in maths, lower than in previous years. In addition, only 6.2% and 1.1% of students from Spain achieved high levels in mathematics (five and six, respectively), which is a notable difference when compared to the OECD average, where means are 8.5% and 2.4% [1]. This result indicates a low proportion of excellent students compared to other similar countries. At the other end of the scale, 16% of students were found to have low levels of maths achievement (Level 1), which means that about one in six Spanish students does not have basic mastery of mathematics skills. However, the proportion of students who failed to reach the basic level in maths was very similar to the OECD average (14.8%).

The Spanish results for students' maths skills seem to reflect a problem that continues to call into question the efficacy of the teaching–learning process for this subject [1]. The education system is incapable of achieving the levels of excellence comparable to many countries in similar situations to Spain [3]. More worrying still is the fact that the various education systems do not take the problem seriously, not having taken action to overcome this repeated failure in mathematics teaching and learning [4]. Although the results of many of these reports should be appropriately gauged, and are a long way from offering an exact diagnosis of the situation of the education system, they do provide various indicators about the levels of the quality of mathematics teaching and learning [5].

In this context and in line with ambitious Sustainable Development Goal 4 [6], namely, the attempt to ensure quality education with which young people acquire relevant technical skills and have lifelong learning opportunities, this work focused on wellbeing in the specific field of mathematics, which has exhibited a special relationship with occupational aspirations and choices [7]. There is no doubt that maths skills are constructed and consolidated over many years. As schooling continues, students acquire knowledge and skills in maths, but they are accompanied by motivation, attitude, and emotions associated with teaching and learning this subject. At the same time, students are competent to greater or lesser extents, they trust their own abilities to varying extents, they perceive the level of usefulness of what they are learning, and all of this happens under varying levels of supervision from their parents and teachers [8].

This seems to indicate, therefore, that achievement in mathematics is related to variables like perception of competence, self-efficacy, interest, and motivation. For example, Ahmed, Minnaert, Kuyper, and Van der Werf [9] found that students' beliefs about their competency were one of the most significant predictors of anxiety about and performance in maths. More specifically, the researchers noted that self-evaluation of the students' skills, self-concept, and self-efficacy predicted anxiety and achievement in maths [10].

The effects of motivation and other contextual variables have been studied. Rosário and colleagues [11] looked at the extent to which student successes in mathematics between the ages of 10 and 15 were explained by this group of variables. Results of that research indicated that maths success could be predicted by self-efficacy in this area, school success, and self-regulated learning, and that these could be explained by other motivational variables such as success goals and contextual variables. They also highlighted school success and prior achievement as predictors of maths success.

Considering the growing interest in positive psychology and its application in educational settings [12], and trying to address the impact of success in mathematics on a series of affective–motivational variables, the construct of wellbeing in relation to the educational context (i.e., academic wellbeing) was included [13,14]. According to Huppert and So [15], wellbeing is a multidimensional construct covering both negative (anxiety and negative feelings) and positive (perceived competence, perceived utility, and mastery motivation) factors as plausible indicators of academic wellbeing.

Stevens, Olivarez, and Hamman [16] proposed a model in which prior achievement in maths had a positive association with self-efficacy for maths, and maths self-efficacy, in turn, had a positive relationship with the final achievement in the subject. Other researchers [17,18] found that variables such as perceived competence, motivation, and anxiety affected the subsequent academic achievement of students.

Other studies [19] showed that some variables, such as perceived self-efficacy, positively predicted academic achievement in maths. In addition, students who had higher perceived self-efficacy and who saw themselves as more capable in a subject were more likely to involve themselves more deeply in tasks related to the subject [20,21].

On the other hand, it is a concern how some students perceive maths as intrinsically complex knowledge, which provokes feelings of anxiety and unease, this even being one of the most common causes of frustrations and negative attitudes towards school [22,23]. Some studies have shown that students' attitudes towards maths and interest in it worsen as they advance through their schooling.

One example is from Watt [24], who performed a study principally aimed at understanding the relationship between attitudes and achievement in maths, analysing the extent to which it was influenced by students' age. Results indicated a change in attitude as students advanced through school, with a progressively more negative attitude towards learning maths and maths itself. Utsumi and Mendes [25] found a clear worsening of attitudes towards maths comparing older and younger students (specifically comparing eight- and six-year-old students, and 16- and 11–12-year-old students). More recent research, such as the study by de Valle and colleagues [26], confirmed similar results in students in the final years of primary school, a decline in academic wellbeing in mathematics in the sixth year.

On a similar note, González-Pienda et al. [27] concluded that, as students advanced from the final year of primary education (11–12 years old) to the end of compulsory secondary education (16), their interest in mathematics progressively decreased, as did their perceptions of the usefulness of the subject, along with perceived competence and confidence in their own maths skills. These studies give us a clear view of students' worsening self-efficacy and perceived competence in mathematics as they move through their schooling.

Mathematics is, without doubt, a rather complex area, both in terms of teaching and learning, with a diversity of attitudes. There are studies that highlight students' perceptions about maths as intrinsically complex knowledge, which provokes feelings of anxiety and unease, and is one of the most common causes of frustration and negative attitudes towards school [28,29].

Students' affective and behavioural dimensions, and the relationship that they have with the maths teaching/learning process have been prominent in research for many years and continue to be so [25,30,31]. In this regard, the affective dimension in mathematics plays a central role affecting student academic achievement. Although it seems somewhat paradoxical, everything seems to indicate that students lose confidence in their own capacity for mathematics as they move through school, which awakens negative feelings and emotions towards it, significantly increasing anxiety [32]. For this reason, it is necessary to increase students' beliefs in their self-efficacy and perceived control as key aspects for motivation and task persistence [33].

With the aim of helping to ensure that all students complete a primary education that guarantees lifelong learning opportunities, this study seeks to explore how far experiences of success are associated with affective–motivational wellbeing. Assuming that achievement plays a significant role in shaping students' educational experiences, aspirations, and paths, we hypothesise in this study the existence of statistically significant differences in those variables linked to academic wellbeing in maths depending on the different levels of prior academic success in the subject.

More specifically, the highest levels of prior maths achievement are expected to be associated with greater academic wellbeing—perceived competence, mastery motivation, and perceived usefulness of the subject. Along the same lines, the highest levels of prior maths achievement are expected to be associated with the lowest levels of anxiety and negative feelings.

2. Materials and Methods

2.1. Participants

The sample comprised 897 pupils aged between 9 and 13 years old ($M = 10.77$) at thirteen primary schools from A Coruña (Spain); 50.2% were boys and 49.8% were girls. Of the total, 437 were in the 5th year (223 boys) and 460 were in the 6th year (233 girls).

2.2. Instruments

We used the *Inventario de Actitud hacia las Matemáticas* (Inventory of Attitudes towards Mathematics, IAM). IAM is an enhanced version of the Fennema–Sherman Mathematics Attitudes Scales (FSS) made by Fennema and Sherman [34] with significant modifications in the scales to assess attitudes towards mathematics. It has since been used by a great number of researchers on the learning and teaching of mathematics [35,36].

The following IAM dimensions were used as indicators of students' academic wellbeing:

- perceived competence for mathematics ($\alpha = 0.75$)—level of confidence in oneself for learning and getting good results in maths;
- perceived usefulness of mathematics ($\alpha = 0.60$)—how useful the students feel their maths learning is, especially with respect to the future;
- mastery motivation for mathematics ($\alpha = 0.72$)—student motivation towards learning and understanding maths content for individual pleasure and satisfaction, regardless of the work involved in this type of content;
- maths anxiety ($\alpha = 0.77$)—the level of a student's anxiety about maths; and
- negative feelings towards maths ($\alpha = 0.70$)—the presence and intensity of negative feelings caused by maths-related work.

Each of the items in each dimension had a Likert-type format with 5 response alternatives, from 1 (completely false) to 5 (completely true).

Assessment of academic achievement in maths was through the final grades of participating students in the previous year in maths. Grades were: fail, pass, good, very good, outstanding.

2.3. Procedure

Data were collected during school hours by research assistants after obtaining the consent of the school directors, teachers, and parents. Before data collection, done at a single time point, the participants were informed of the importance of responding honestly to the different questions, and were assured of the completely confidential nature of the data. Data collection was carried out in accordance with the ethical standards of the Ethics Committee of the University of A Coruña (Spain), with written informed consent from the participants as warranted by the Helsinki Declaration.

2.4. Data analysis

Besides descriptive analysis of the variables, we performed multivariate analysis of variance (MANOVA) in order to ascertain whether there were statistically significant differences in the variables linked to attitudes towards mathematics (dependent variables) depending on students' prior academic success in maths (independent variable). Effect sizes were interpreted using the criteria established by Cohen [37], according to which an effect is small when $\eta_p^2 = 0.01$ ($d = 0.20$), moderate when $\eta_p^2 = 0.059$ ($d = 0.50$), and large when $\eta_p^2 = 0.138$ ($d = 0.80$).

3. Results

The correlation study allowed us to see the expected negative correlation between variables used to evaluate positive academic wellbeing (perceived competence, perceived utility, and mastery motivation) and negative academic wellbeing (negative feelings and anxiety) (Table 1).

Table 1. Means (M), standard deviations (SD), asymmetry, kurtosis, and correlation matrix.

	1	2	3	4	5	6
1. Perceived competence	-					
2. Perceived utility	0.31 ^a	-				
3. Mastery motivation	0.68 ^a	−0.36 ^a	-			
4. Anxiety	−0.49 ^a	−0.11 ^a	−0.44 ^a	-		
5. Negative feelings	−0.43	−0.17	−0.50	0.47	-	
6. Prior academic achievement	0.28 ^a	0.10 ^a	0.19 ^a	−0.29 ^a	−0.33 ^a	-
M	4.04	4.55	3.71	2.10	1.77	3.41
SD	0.75	0.71	0.86	1.07	0.87	1.27
Asymmetry	−0.89	−0.77	−0.50	0.93	1.27	−0.43
Kurtosis	0.79	3.15	−0.18	0.10	1.44	−0.91

^a $p < 0.01$.

In line with the hypotheses, correlation-analysis results indicated that there were significant positive relationships between prior academic achievement in maths, perceived competence in the subject, perceived usefulness, and mastery motivation. In contrast, there was a negative relationship between prior achievement in the mathematics, and anxiety and negative feelings. Results suggested that success in mathematics was linked to students' academic wellbeing, such that perceived competence in the subject, perception of usefulness of mathematical content, and mastery orientation increased as previous performance improved. In the same sense, anxiety and negative feelings are less important as achievement in mathematics improves (see Table 1).

Positive academic wellbeing. MANOVA results indicated that differences in the variables used to evaluate positive academic wellbeing on the basis of levels of prior academic performance were, taken together, statistically significant ($\lambda_{Wilks} = 0.909$; $F(12,2355) = 7.22$; $p < 0.001$; $\eta_p^2 = 0.031$) (Table 2), with an effect size that was close to moderate.

In terms of perceived competence in maths, results indicated that there were statistically significant differences in this variable depending on the level of prior academic achievement ($F(4,892) = 21.75$; $p < 0.001$; $\eta_p^2 = 0.089$). In general terms, as prior maths achievement improved, students' perceptions of competence in maths also improved (Table 2 and Figure 1). The effect size was moderate, with the independent variable (prior academic achievement) explaining 8.9% of the dependent variable (perceived competence).

Table 2. Descriptive statistics for each level of prior academic achievement in variables linked to positive dimension of academic wellbeing.

Prior Academic Achievement in Maths											
	Fail (1)		Pass (2)		Good (3)		Very Good (4)		Outstanding (5)		Scheffé's Test
	M	SD	M	SD	M	SD	M	SD	M	SD	
Perceived competence	3.80	0.88	3.70	0.83	3.91	0.75	4.18	0.65	4.30	0.60	1-4, 1-5, 2-4, 2-5, 3-4, 3-5
Perceived utility	4.44	0.87	4.42	0.79	4.57	0.65	4.58	0.69	4.62	0.63	
Mastery motivation	3.53	0.84	3.45	0.92	3.61	0.87	3.82	0.82	3.92	0.77	1-5, 2-4, 2-5, 3-5

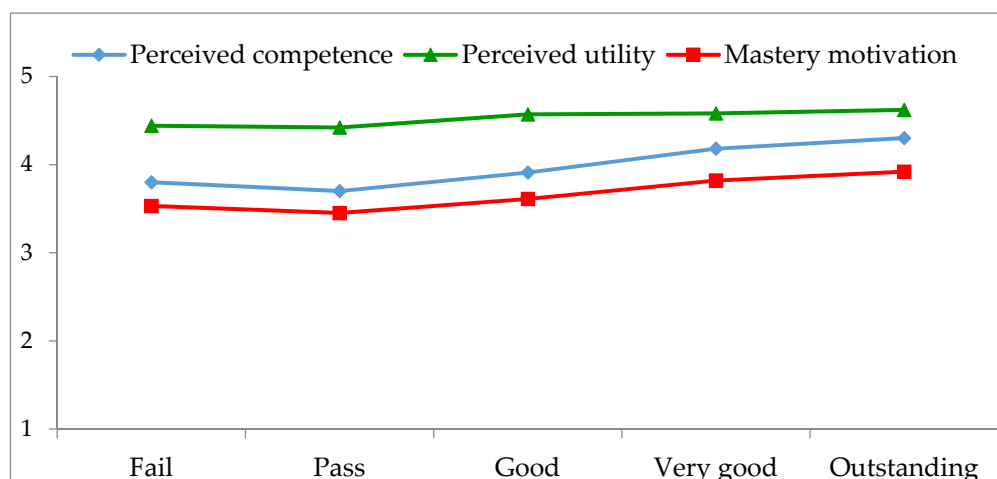


Figure 1. Mean values in perceived competence, perceived usefulness, and mastery motivation for each level of prior academic achievement.

In the perceived utility of mathematics, results also indicated that there were statistically significant differences depending on the different levels of prior achievement ($F(4,892) = 2.53$; $p < 0.05$; $\eta_p^2 = 0.011$), although not as notable as those in the previous case. In this case, the effect size was small. Looking at

the mean values for this variable, there was only progressive improvement in the perceived utility of maths from the highest levels of prior academic achievement in the subject (Table 2 and Figure 1).

With respect to mastery motivation, results showed statistically significant differences in all levels of students' prior achievement in mathematics ($F(4,892) = 9.59$; $p < 0.001$; $\eta_p^2 = 0.041$). In a similar way to perceived usefulness, progressive increase in intrinsic motivation was only seen from the three highest levels of prior performance (Table 2 and Figure 1).

There were also statistically significant differences in anxiety about maths depending on the different levels of prior academic achievement ($F(4,892) = 21.20$; $p < 0.001$; $\eta_p^2 = 0.087$), with a moderate effect size (8.7% of variance). In this case, as prior performance in maths improved, there was a progressive decline in students' levels of anxiety about maths (Table 3 and Figure 2).

Table 3. Descriptive statistics for each level of prior academic achievement in variables linked to negative dimension of academic wellbeing.

Prior Academic Achievement in Maths											
	Fail (1)		Pass (2)		Good (3)		Very Good (4)		Outstanding (5)		Scheffé's Test
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Anxiety	2.67	1.11	2.47	1.11	2.22	1.10	1.93	0.98	1.73	0.90	1–3, 1–4, 1–5, 2–4, 2–5, 3–5
Negative feelings	2.37	1.05	2.09	1.00	1.88	0.85	1.55	0.69	1.50	0.66	1–3, 1–4, 1–5, 2–4, 2–5, 3–4, 3–5

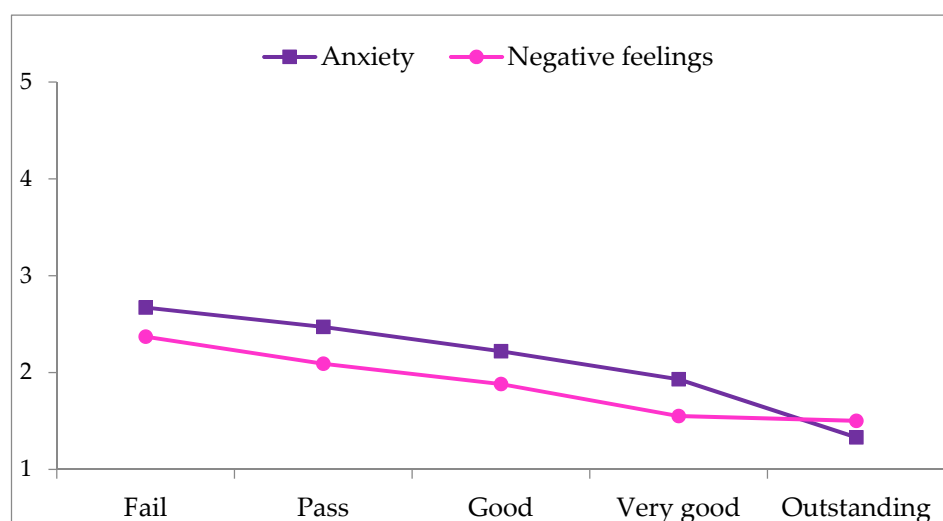


Figure 2. Mean values for anxiety and negative feelings for each level of prior performance in maths.

Statistically significant differences were also seen in the negative feelings caused by maths depending on the level of prior maths performance ($F(4,892) = 19.35$; $p < 0.001$; $\eta_p^2 = 0.114$). In this case, the effect size was close to large. As Table 3 and Figure 2 show, negative feelings associated with maths fell progressively as students' prior performance improved. Thus, according to this trend, the most negative affective and emotional reactions that maths can cause increase as the level of achievement in the subject diminishes. These negative reactions decrease as achievement increases.

Negative academic wellbeing. MANOVA results indicated that differences in variables linked to negative academic wellbeing between levels of prior academic performance were, taken together, statistically significant ($\lambda_{Wilks} = 0.860$; $F(8,1872) = 17.38$; $p < 0.001$; $\eta_p^2 = 0.072$) (Table 3), with an effect size that was close to large.

4. Discussion

Assuming that academic wellbeing is a multidimensional construct that gathers both negative and positive indicators [15], the results of this study indicated that success in mathematics is positively related to competence, perceived utility, and mastery motivation, and negatively related to negative feelings and mathematical anxiety. Specifically, results showed that, the higher the previous academic performance in mathematics was, the greater the students' perceptions of competence were, and the lower their levels of anxiety and negative feelings associated with mathematics were. Although the results fit the hypotheses in general, previous achievement in mathematics had somewhat low explanatory power for variables linked to academic wellbeing, which can be seen in the effect sizes.

Post hoc analysis allowed us to specifically suggest significant differences in student confidence between those with low-to-medium previous performance and the most successful students (fail/pass/good vs. very good/outstanding). Mastery motivation would also allow us to differentiate the most successful students from those with low-to-medium previous performance. At the same time, we saw a progressive increase in the perception of the usefulness of maths from the highest levels of prior academic achievement in the subject.

If the construction of beliefs of self-efficacy in a certain area is produced, above all, from experiences of success and failure in that specific area, it seems feasible that, when students achieve successful results in maths, their perceptions of competence in this area also increase. In other words, achieving ever better prior performance in maths is the main source of information, which contributes to increasing beliefs of self-efficacy in the subject. Feeling oneself to be competent and capable is also related to other motivational variables, such as the perception of the usefulness of maths and intrinsic motivation. In fact, self-efficacy is a key motivational belief that has been conceptually and empirically linked to wellbeing, coping, and self-regulation; students who trust in their ability to use self-regulatory processes also feel more motivated to achieve their personal goals [38–40]

According to expectation–value theory [41], student beliefs about the level of self-confidence they have to successfully face an academic task (self-efficacy) and the extent to which they believe that said task is valuable or useful (task value) are two fundamental components for understanding student commitment and performance [42]. Research has also consistently showed that students' focus on mastery is associated with various positive indicators of academic wellbeing and adaptive patterns of coping and affect. For example, mastery goals were related to the experience of pleasant emotions such as the enjoyment of learning, pride, and positive affect [43–45]. Doubtlessly, being interested in and wanting to learn maths content, perceiving the content as useful, and feeling sufficiently capable of learning it may be the best “antidotes” to counteract negative academic wellbeing in mathematics for many students.

Post hoc analysis suggested that anxiety and negative feelings are higher in students with low performance than in successful students in mathematics (fail/pass vs. very good/outstanding). According to Ashcraft [46], anxiety is one of the main factors that leads students to avoiding anything related to maths. In fact, around 20% of students exhibit this type of anxiety [47], linked to numerical and mathematical tasks, and problem-solving activities. Allen and Vallée-Tourangeau [48] went beyond that, stating that maths anxiety impedes performance in simple arithmetic tasks, in addition to limiting the capacity of working memory and attentional functions in particular. Goetz et al. [49] carried out a study with fifth- and sixth-year students in order to examine the relationship between academic performance in the subject and emotional wellbeing. According to these authors, good academic achievement in maths lead to the increased enjoyment of activities related to the subject, and a reduction in anxiety in this area. Subsequently, Goetz, Frenzel, Hall, and Pekrun [50] examined the function of academic achievement as a precursor of students' positive emotional experiences. Results showed that achievement in maths in the previous school year positively predicted enjoyment in maths classes, again concluding that, the better the prior achievement is, the more positive the feelings towards the subject are.

Analysis of the impact of success on the academic wellbeing of the students cannot avoid the complex interaction between anxiety and self-efficacy. Built on success, strong self-efficacy beliefs in mathematics would neutralize the negative effects of anxiety, and the higher success in mathematics is, the more effective the “antidote” is [51]. Indeed, self-confidence seems particularly explanatory of performance when high levels of anxiety are experienced [52]. In this context, a good way to change negative academic wellbeing would be to increase successful experiences in order to nurture perceived competence, especially among students with high academic anxiety. The source of anxiety would not be so much the threat of the events themselves, but the lack of efficacy to deactivate this threat [53]. Teachers would play a key role in making it possible for maths content and tasks to become challenges that students find motivating rather than see them as threats.

Although schools already recognize the importance of students’ educational and vocational guidance, less attention has been given to supporting their academic wellbeing. However, results from recent studies indicated that students’ experiences of emotional stress may affect their aspirations and decisions regarding their future education [54]. In this sense, we understand the need to support the wellbeing of students in the academic field. One key pillar for improving students’ academic wellbeing in technical subjects such as maths are teachers. Wahono and Chang [55] stated that both the teachers’ attitudes towards their subjects and their teaching had a significant impact on their students. For this reason, Kim, Bae, Choi, Kim, and Lim [56] advocated for training focused on sustainable education from university, so that future teachers would learn methodologies to motivate students and thus improve their perceptions of maths. Increasing training around academic motivation and psychological wellbeing in teaching students’ curriculum should be taken into account. Thus, the need is again for school institutions to focus on understanding the new challenges that today’s knowledge society presents. The psychological wellbeing of students influences their integral development as people, and it must be promoted by school. It must also constitute a base for the preparatory and ongoing training, and the development of teachers.

Author Contributions: Conceptualisation, A.V. and B.R.; methodology, A.V.; software, A.V.; validation, A.V. and S.R.; investigation, I.P.; resources, B.S.; data curation, B.S.; writing—original-draft preparation, A.V. and B.R.; writing—review and editing, S.R.; visualisation, T.V. and C.R.-L.; supervision, B.R.; project administration, I.P. and A.V.; funding acquisition, S.R. and A.V. All authors have read and agreed to the published version of the manuscript.

Funding: This work was carried out thanks to funding from research projects EDU2013-44062-P (MINECO, Ministerio de Economía, Industria y Competitividad, Gobierno de España) and EDU2017-82984-P (MEIC, Ministerio de Economía y Competitividad), and to the financing received by one of the authors in the FPU programme (MCIU, Ministerio de Educación, Cultura y Deporte).

Conflicts of Interest: The authors declare no conflict of interest.

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