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Students' intentions towards studying science at upper-secondary school: the differential effects of under-confidence and over-confidence

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ABSTRACT

Understanding students' intentions to study science at upper-secondary school, at university, and to follow science careers continues as a central concern for international science education. Prior research has highlighted that students' science confidence has been associated with their intentions to study science further, although under-confidence and over-confidence (lower or higher confidence than expected, given someone's attainment) have not been considered in detail. Accordingly, this study explored whether under-confident, accurately evaluating, and over-confident students expressed different attitudes towards their science education, and explored how under-confidence and over-confidence might influence students' science intentions. The questionnaire responses of 1523 students from 12 secondary schools in England were considered through analysis of variance and predictive modelling. Under-confident students expressed consistently lower science attitudes than accurately evaluating and over-confident students, despite reporting the same science grades as accurately evaluating students. Students' intentions to study science were predicted by different factors in different ways, depending on whether the students were under-confident, accurate, or over-confident. For accurately evaluating and over-confident students, science intentions were predicted by their self-efficacy beliefs (their confidence in their expected future science attainment). For under-confident students, science intentions were predicted by their self-concept beliefs (their confidence in currently 'doing well' or 'being good' at science). Many other differences were also apparent. Fundamentally, under-confidence may be detrimental not simply through associating with lower attitudes, but through students considering their choices in different ways. Under-confidence may accordingly require attention to help ensure that students' future choices are not unnecessarily constrained.

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Confidence; calibration; aspirations

1. Introduction

Understanding students' intentions to study science at upper-secondary school, at university, and to follow science careers continues as a central concern for international science

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education (Education, Audiovisual, and Culture Executive Agency, 2011; National Science and Technology Council, 2013). Students' intentions associate with various factors, including their attainment, confidence, (intrinsic) interest in science, and perceived (extrinsic) utility of science (Bøe & Henriksen, 2015; Regan & DeWitt, 2015). Intuitively, promoting higher perceptions of the utility of science, for example, may then help increase the number of students studying science.

Students' confidence, however, appears to require closer consideration. While higher confidence may be motivationally beneficial (Bandura, 1997), students' confidence does not necessarily correspond to their actual attainment. Some students can be under-confident (with lower confidence than would be expected given their attainment) while others can be over-confident (Bouffard & Narciss, 2011). Aiming to increase the number of students studying science through universally increasing confidence may reduce under-confidence for some but further increase over-confidence for others, and it is unclear whether this would be helpful.

Under-confidence and over-confidence have not been considered in detail within science education. For example, controlling for both confidence and attainment within predictive models does not necessarily reveal any differential effects across under-confidence and over-confidence. Instead, other methods are required to identify and explore confidence biases.

Accordingly, the research presented here identified and considered the views of under-confident, accurately evaluating, and over-confident students in order to explore how these cases might be detrimental or beneficial. For example, under-confident students might report lower attitudes towards science, including for factors that predict intentions to study science further. Additionally, the research considered whether students' science intentions were predicted in different ways, depending on whether students were under-confident, accurately evaluating, or over-confident. Any differences would provide greater understanding into how students' choices are made, and provide further insights into the potential impact of under-confidence or over-confidence.

1.1. Students' intentions or choices and influential factors

It remains important to gain a wider understanding of secondary-school students' intentions and/or choices to study science further. In some countries, such as England, science is not compulsory in upper-secondary education. Relatively early experiences or choices at secondary school then become even more important in facilitating or precluding future science careers.

Students' experiences and intentions reported during secondary school have indeed predicted whether they subsequently gained science degrees (Tai, Qi Liu, Maltese, & Fan, 2006; Wang, 2013). Additionally, for a large survey of science graduates, while over half reported that their interest in science developed before or during primary/elementary school, around a third nevertheless reported that their interest developed during secondary school (Maltese, Melki, & Wiebke, 2014). In England, secondary-school students have generally considered science to be interesting, relevant for careers and gaining wider knowledge, and important for school and wider life, although relatively few students have liked science better than other subjects or aspired to be scientists (DeWitt, Archer, & Osborne, 2014; Jenkins & Nelson, 2005).

It remains difficult to determine what factors most strongly associate with students' intentions or choices. For example, various research has highlighted the importance of students' background or characteristics such as gender (Homer, Ryder, & Banner, 2014), ethnicity (Riegle-Crumb, Moore, & Ramos-Wada, 2011), or the attended schools (Bennett, Lubben, & Hampden-Thompson, 2013), although such studies have often not included students' attitudes. Further research has revealed that students' intentions to study science have been predicted more by their own attitudes and beliefs than by their background or gender (DeWitt et al., 2014; Mujtaba & Reiss, 2014). Essentially, various aspects of students' background and context, such as their parents' beliefs (DeWitt et al., 2011) and classroom experiences (Wang, 2012), influence their attitudes about science, which then influence their intentions.

Recent research has highlighted that students' science intentions and/or choices have been predicted by their attainment, confidence, (intrinsic) interest in science, (extrinsic) utility of science (such as in helping to gain a specific career or well-paid employment), and by advice and guidance to study science (Mujtaba & Reiss, 2014; Wang & Degol, 2013). Further factors, including students' conceptions of themselves or their identities, and students' conceptions of science and/or scientists, also appear to be relevant, although it remains harder to quantify their potential impact (Archer et al., 2010; Bøe & Henriksen, 2015).

The importance of students' confidence has been highlighted in various ways. Students' current confidence in science (self-concept) has predicted their intentions to study upper-secondary science (DeWitt & Archer, 2015; Mujtaba & Reiss, 2014). Additionally, students' confidence in their future capabilities (self-efficacy) has been found to influence their ideas of potential careers (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001) and to directly predict their intentions to study specific courses (Bong, 2001) and to enter university (Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014).

Nevertheless, it remains unclear as to what factors most strongly associate with students' intentions, and how different expressions of confidence compare to other factors. Additionally, under-confidence and over-confidence remain under-explored in science education, although recent research in England has considered confidence biases for other subjects (e.g. Sheldrake, Mujtaba, & Reiss, 2015).

1.2. Students' confidence and motivational theories

An increased understanding of students' confidence may help provide wider insights into students' science intentions.

Students' confidence can be conceptualised in various ways. Within educational research, confidence has often been conceptualised as 'self-concept' and 'self-efficacy' beliefs (Bong & Clark, 1999). Self-concept reflects someone's current and relatively generalised beliefs about their abilities within an area, while self-efficacy reflects someone's future-oriented beliefs about their capabilities to successfully undertake particular actions or gain particular outcomes (Bandura, 1997; Bong & Skaalvik, 2003). Self-concept is usually measured through perceptions of attainment-related experiences and more subjective interpretations (such as whether someone thinks that they are 'doing well' or not), while self-efficacy is usually measured through expectations linked to more objective outcomes (such as someone's perceived confidence/capability to gain specific grades at the end of a course) (Bong, 2001; Bong & Skaalvik, 2003).

Confidence conceptualised as self-efficacy forms an integral aspect of social-cognitive theory: high self-efficacy beliefs may be motivational and facilitate someone to surpass their normal performance, while low self-efficacy beliefs may be limiting and ensure that some actions are not even attempted (Bandura, 1997). In accordance with these theoretical assumptions, higher self-efficacy has indeed been associated with motivational approaches such as aiming to learn and master academic work (Jiang, Song, Lee, & Bong, 2014) and with persistence (Multon, Brown, & Lent, 1991).

Subsequent applications of social-cognitive theory, such as the expectancy-value model of motivated behavioural choices, have assumed that confidence is motivational regardless of whether it is considered as self-efficacy or as self-concept (Eccles, 2009; Wigfield & Eccles, 2000). These assumptions have again been supported through higher self-concept beliefs associating with beneficial outcomes such as higher attainment (Huang, 2011) and higher interest (Viljaranta, Tolvanen, Aunola, & Nurmi, 2014).

Essentially, high confidence (conceptualised as self-concept and/or as self-efficacy) appears to be beneficial within education, and directly relevant to science intentions. However, it remains unclear whether any benefits occur even if someone is over-confident (they have higher confidence than would be expected given their attainment). Conversely, it remains unclear whether under-confidence (lower confidence than would be expected given their attainment) is necessarily detrimental.

Less research has explored confidence biases, and results have varied. Studies of secondary-school students have, via different approaches and samples, variously associated under-confidence with higher performance (Chiu & Klassen, 2010), over-confidence with higher subsequent progress (Dupeyrat, Escribe, Huet, & Régner, 2011), and higher accuracy (not being over-confident or under-confident) with higher performance (Chen, 2003; Chen & Zimmerman, 2007; Möller & Pohlmann, 2010; Pajares & Graham, 1999).

Little research has explored associations between confidence biases and students' attitudes or motivational beliefs. Nevertheless, over-confidence across both mathematics and languages has been associated with higher persistence and aims to understand and master work, compared to accuracy and under-confidence, while over-confidence in mathematics considered alone associated with higher interest in mathematics (Gonida & Leondari, 2011). In England, over-confidence has been associated with higher interest in mathematics and perceived utility of mathematics at Year 8 (age 13), while accuracy associated with higher affective responses and intentions to study mathematics further at Year 10 (age 15) (Sheldrake, Mujtaba, & Reiss, 2014).

1.3. Research aims

Students' confidence has been associated with their science intentions, together with their interest, perceived utility, and other factors (Bøe & Henriksen, 2015). However, it remains unclear whether under-confidence is necessarily detrimental and over-confidence is necessarily beneficial within science education, and specifically applied to students' science intentions.

Under-confidence may be detrimental in that students may express lower interest and other views, perhaps including lower science intentions. Additionally, under-confidence may be detrimental in that these students may consider different factors when making decisions about studying science further, when compared to other students. For example, when considering their future intentions, under-confident students might focus more on their own (overly low) confidence and less on their interest in science, while other students might focus more on their interest.

These areas were considered through the following research questions.

- What did students report about their intentions and other views concerning their science education? Did under-confident, accurate, and over-confident students express different attitudes or intentions?
- What predicted students' intentions when students were under-confident, accurate, or over-confident? Were there any differences across these cases?

2. Methods

2.1. Sampling

In England, during Year 9 (age 14) students select various subjects to study during Years 10 and 11 (ages 14–16) at General Certificate of Secondary Education (GCSE) or equivalent level, where science is compulsory. Students can then undertake upper-secondary education in Years 12 and 13 (ages 16–18) at Advanced Level General Certificate of Education (A-Level) or equivalent level, where science is optional.

Secondary schools within England were randomly sampled. Schools were invited regardless of type, admissions policies, and other school features, but excluding schools exclusively for those with special educational needs.

The presented research covered 12 participating schools, of which 7 were mixed-admissions comprehensive schools (admitting boys and girls, and not selecting students based on their attainment); mixed-admissions comprehensive schools formed the majority (68%) of all secondary schools within England as of 2014 (Department of Education, 2015). Selective schools (only admitting students based on their attainment) and boys-only and girls-only schools were also represented in the sample. The 12 schools covered a range of prior performance, although on average 60% of their students were reported to have achieved 5 or more A*–C grades (including in both English and mathematics) at GCSE level compared to a national average of 47% as of 2014 (Department of Education, 2015).

The views of students in Years 9–11 were sought regarding their science education and their intentions to study science further. Understanding students' prospective intentions may inform interventions or guidance for students of similar ages.

The presented research explored the views of 1523 students from these schools (685 in Year 9, 489 in Year 10, and 349 in Year 11; 635 girls and 871 boys, the remainder left the gender question blank). Data were collected during the 2014/2015 academic year.

2.2. Measuring students' experiences and beliefs

Students completed science-specific questionnaires, designed to be comparable with a broad range of national and international research to enhance validity (e.g. Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009). Science was considered holistically in accordance with the National Curriculum (Department for Education, 2013) and prior research (e.g. DeWitt & Archer, 2015).

Relevant questionnaire areas are described in the following sections (see also Table 1). The questionnaire broadly applied the expectancy-value model of motivated behavioural choices (Eccles, 2009), with contextually relevant extensions. The various items/factors served as potential predictors of science intentions, and concurrently served as indicators of under-confidence or over-confidence being potentially beneficial or detrimental (Bouffard & Narciss, 2011). For example, lower/higher interest in science may be contextually detrimental/beneficial (from the perspective of science educators) due to interest likely predicting outcomes such as science intentions (Regan & DeWitt, 2015).

The majority of the questionnaire items applied agreement scales with categories of (1) 'strongly disagree', (2) 'disagree', (3) 'slightly disagree', (4) 'slightly agree', (5) 'agree', and (6) 'strongly agree'. Depending on the question phrasing, categories were reverse-scored when necessary so that high item/factor scores (e.g. 6) consistently indicated a positive experience or belief (e.g. doing well, being interested, the absence of anxiety).

When applicable, factors were calculated through averages of the relevant items; single-factor structures (via confirmatory factor analysis) and acceptable indicators of reliability (Cronbach's α coefficients) were confirmed (Table 1).

2.2.1. Science intentions

Students' intentions towards science were measured across upper-secondary (A-Level) study, university study, and a career involving science (agreement/disagreement with,

Table 1. Science-specific item/factor measurement and reliabilities.

Item/factor	Example item	Items	Cronbach's α
Science intentions	I intend to study science at A-Level	3	.882
Self-concept	I usually do well in science	5	.896
Self-efficacy	What grade do you think you will be able to get at GCSE (or equivalent) science?	2	.835
Interest/intrinsic value	I am interested in the things I learn in science	7	.936
Utility/extrinsic value	I need to do well in science to get the job I want	7	.908
Attainment/personal value	Thinking scientifically is an important part of who I am	2	.886
Cost value (absence of)	I have to give up a lot to do well in science	2	.686
Mastery experiences (current grade)	What overall grade have you got so far this year in science?	1	NA
Mastery norms (what is a good grade)	What grade do you think people need to get in order to be 'good' at science?	1	NA
Subject-comparisons	Science is harder for me than any other subject	1	NA
Peer-comparisons	Science is harder for me than for many of my classmates	1	NA
Social persuasions (praise)	My science teacher tells me I am good at science	3	.797
Vicarious experiences	When I see how another student solves a science problem, I can see myself solving the problem in the same way	1	NA
Anxiety (absence of)	Science makes me confused and nervous	5	.905
Norms/influence (friends)	Most of my friends do well in science	3	.645
Norms/influence (parents)	My parents believe it's important for me to study science	3	.820
Teacher perceptions	My science teacher is easy to understand	8	.904
Teacher/school careers	My science teacher tells me about careers and jobs in science	2	.674
Effort/futility (absence of)	If I put in enough effort I can succeed in science	3	.771
Effort/futility exams (absence of)	I do badly in science whether or not I study for my exams	2	.742
Task score	Appendix 1	10	.645
Task confidence	Appendix 1	10	.897

for example, 'I intend to study science at A-Level') in order to consider aspirations to persist within science across all these stages.

2.2.2. Science confidence (self-concept and self-efficacy)

Students' science confidence was measured through expressions of self-concept (e.g. 'I usually do well in science'); the relevant items were ensured to be comparable with prior research (e.g. Mullis et al., 2009).

Expressions of self-efficacy are inherently contextualised and have accordingly been measured in various ways within prior research, for example as students' confidence to successfully accomplish specific types of tasks or to successfully gain specific grades at the end of their course (Bong, 2001; Bong & Skaalvik, 2003). Researchers have been advised to ensure that the measurement of self-efficacy relates to the area and level of detail being researched (Bong & Clark, 1999; Bong & Skaalvik, 2003).

Given the focus on students' subject-level choices, subject-level expressions of self-efficacy were measured through students' confidence in their capability to gain future attainment ('What grade do you think you will be able to get at GCSE (or equivalent) science?' and 'What grade do you think you would be able to get if you studied your best science subject at A-Level?'). This expression of self-efficacy has strong contextual relevance to students in England who may need to gain specific grades in order to study on particular courses or to enter university. Prior research has similarly considered self-efficacy as future capabilities to gain course-specific attainment (e.g. Bong, 2001), although it remains possible that alternate measures of self-efficacy could be formed.

2.2.3. Potential influences on confidence

Theorised sources, antecedents, or influences on students' confidence were measured (e.g. Bandura, 1997; Bong & Clark, 1999; Mullis et al., 2009). Specifically, these were mastery experiences (the students' current reported science grade); mastery norms ('What grade do you think people need to get in order to be "good" at science?'); subject-comparisons; peer-comparisons; positive vicarious experiences; positive social persuasions (praise); and anxiety (see Table 1 for example items). These theorised influences served as additional predictors (i.e. controlling factors), given their use in prior research and/or theoretical relevance to students' confidence.

2.2.4. Potential influences on intentions (expectancy-value model)

Theorised influences ('subjective-task-values') from the expectancy-value model (e.g. Bøe & Henriksen, 2015; Wigfield & Eccles, 2000) were measured as interest/intrinsic value; utility/extrinsic value; personal/attainment value; and cost value (see Table 1 for example items).

2.2.5. Potential influences on intentions (wider factors)

Further potential influences from the theory of planned behaviour (Ajzen, 1991) were also measured covering implicit influences or 'subjective-norms' regarding the students' friends (e.g. 'Most of my friends do well in science') and parents (e.g. 'My parents believe it's important for me to study science'). Students' 'perceived control' or effort/futility regarding science was covered, considered in general terms (e.g. 'If I put in enough effort I can succeed in science') and regarding examinations/attainment (e.g. 'I do badly in science whether or not I study for my exams').

The students' science learning context was also measured, covering students' views of their teacher and immediate learning context (e.g. 'My science teacher is easy to understand') and the provision of information about science careers (e.g. 'My science teacher tells me about careers and jobs in science').

2.2.6. Students' background characteristics

Students' self-reported background was also measured, given prior research in science education (Regan & DeWitt, 2015). Specifically, students were asked about their gender; background/ethnicity; the highest level of education completed by the students' mother and father (or equivalent guardians); the number of books at home; and whether either parent/guardian worked in any job or area related to science.

2.3. Measuring students' confidence biases

The questionnaire included a selection of assessment/attainment tasks, and students rated their confidence in each answer, so that indicators of under-confidence and over-confidence could be calculated. This approach has been reliably applied within many prior studies (e.g. Chen, 2003; Chen & Zimmerman, 2007; Sheldrake et al., 2014). While any consideration of confidence biases involves an unavoidable degree of imprecision, task-level responses can be directly and efficiently compared.

The tasks were sourced from the Trends in International Mathematics and Science Study (TIMSS) 2011 and accordingly have been internationally validated as reliable indicators of performance (Foy, Arora, & Stanco, 2013; Mullis et al., 2009). TIMSS was designed to cover curricula areas from the majority of participating countries, so task performance should be relatively representative of classroom/examination performance. Practically, TIMSS tasks were also more concise than prior national examination questions (e.g. from discontinued Key Stage 3 tests, GCSE examinations, etc.).

The selected tasks covered areas within the National Curriculum, including photosynthesis, atomic structures, changes of state, electricity and current, and various other areas (broadly covering biology, chemistry, and physics). The tasks used multiple-choice and free-response formats (see Appendix 1 for examples). Answers were scored as in TIMSS (Foy et al., 2013).

After each task, students rated their (task-level) confidence in their answer (i.e. 'How confident are you that you solved this correctly?'), providing a retrospective self-evaluation of their performance.

An indicator of confidence bias ('calibration bias', or the degree of under-confidence through accuracy through to over-confidence) was then calculated via the difference between the students' average task confidence and average task score (both equalised to 0–1 scales).

The indicator was standardised (via a z-score transformation). Students were then assigned to groups based on these values: below −.5 was classified as 'under-confident'; between −.5 and +.5 as 'accurate' (one standard deviation range); and above +.5 as 'over-confident'.

2.4. Analytical approaches

Analysis considered students across Years 9–11 to ensure sufficient numbers for reliable predictive modelling when considering under-confident, accurately evaluating, and over-confident students separately, and to increase statistical power and reliability. Other research has similarly considered confidence biases across different years/ages (e.g. Gonida & Leondari, 2011).

Students' reported science intentions and other views (i.e. the items/factors described above) were considered through analysis of variance, with Bonferroni *post hoc* tests, to identify any mean differences across pairs of groups (e.g. between under-confident and accurately evaluating students).

Students' science intentions were also predicted using the various items/factors. The relative predictive associations (i.e. the 'effect' of each item/factor on science intentions) could then be directly compared, controlling for all the other factors. Students' science intentions were predicted for all students, and separately for under-confident, accurately evaluating, and over-confident students, in order to determine whether any predictive associations differed across these cases. Differences were highlighted through modelling pairs of groups together and using Wald tests to compare the coefficient magnitudes (StataCorp, 2013).

2.4.1. Predictive models

Preliminary sensitivity analysis was undertaken via single-level linear regression (via ordinary least-squares estimation) and also via multi-level linear regression (via maximum-likelihood estimation with variable intercepts per school) to account for students being clustered within schools (Snijders & Bosker, 2012). No residual variance remained at the school level when all predictors were included and parameter estimates were similar for both approaches, suggesting that single-level modelling could be sufficient.

The questionnaire unavoidably used many single-item indicators (e.g. ethnicity, parental education, number of books at home, etc.), increasing the risk or impact of missing values. Predictive modelling often only considers those students with responses for every modelled item/factor (e.g. 'listwise deletion' when using ordinary least-squares regression). Increasing the number of predictors increases the risk of reducing the number of considered students (who may also differ in views from the entire sample), which reduces the power of statistical tests to reveal significant differences.

Single-level linear regression models were then reproduced using full-information maximum-likelihood estimation (StataCorp, 2013), allowing all students to be considered even if values were missing on some items/factors. This approach assumed joint normality of all the included items/factors and that any missing responses occurred at random (missing values were either completely random in occurrence, or that any values more likely to be missing than others could be predicted by any other items/factors in the model) (StataCorp, 2013). Applying full-information maximum-likelihood is considered to be one of the best contemporary approaches to handling missing values (Peugh & Enders, 2004).

Within these full-information maximum-likelihood models, standard errors were calculated via relaxing the assumption of independent error variances within schools, helping to account for students being clustered within schools (i.e. the potential similarity of students studying within the same school) (StataCorp, 2013).

The models gave standardised coefficients (how many standard deviations of increase/decrease would occur in the outcome, given one standard deviation increase in the predictor), which provided measures of 'effect size' that were directly comparable across the different predictors. The coefficient of determination (R^2) reported the proportion of variance explained by the model and provided a general indicator of 'goodness of fit'.

3. Results

3.1. Classifying under-confidence and over-confidence

Students' confidence biases on the task level were reflected in their subject-level self-concept confidence beliefs (Table 2).

Accurately evaluating and under-confident students reported similar current grades, yet under-confident students reported significantly lower self-concept and lower self-efficacy beliefs.

Accurately evaluating and over-confident students reported similar self-concept beliefs, yet accurately evaluating students reported significantly higher current grades and higher self-efficacy beliefs.

Surprisingly, accurately evaluating (and not over-confident) students reported the highest self-efficacy beliefs. However, as self-efficacy beliefs are future-orientated beliefs of capability, longitudinal research would be necessary to explicitly consider their accuracy (i.e. comparing students' expected future grades with their actual grades).

3.2. Students' reported experiences and beliefs when under-confident, accurate, and over-confident

On average, students reported moderately positive or somewhat neutral views (Table 2). Under-confident students generally reported the lowest, while accurately evaluating and over-confident students generally reported similarly, including for the students' interest, utility, and personal value of science.

However, there were no differences across the groups for cost value, mastery norms (what grade meant 'being good' at science), the subjective-norms/influences of friends, and perceived control for examinations/attainment. There were no group differences for students' parental/home/background factors (not tabulated for brevity) except for the number of books at home (means (1–5, 3 = 'Around one bookcase'): under-confident = 3.29, accurate = 3.26, over-confident = 2.91; $F(2, 1489) = 11.612$, $p < .001$).[1]

The confidence bias groups were formed by applying ±.5 standard deviations as the group boundaries. Students' science intentions did not significantly differ across the groups ($F(2, 1191) = 2.783$, $p = .062$, slightly above the $p < .05$ criterion), although under-confident students reported slightly lower intentions (Table 2).

Focusing on students with considerable under-confidence/over-confidence by applying ±1 standard deviations as the group boundaries (which some research has done, e.g. Gonida & Leondari, 2011) confirmed that students' science intentions significantly differed across these groups (means (1–6): considerably under-confident = 3.06, broadly

Table 2. Students' reported science-specific experiences/beliefs.

			Confidence bias groups (±.5 SD group boundaries)							
	All students		Under-confident (U)		Accurate (A)		Over-confident (O)		ANOVA	
Item/factor	*M*	SD	*M*	SD	*M*	SD	*M*	SD	Sig.	Pη^2
Science intentions	3.47	1.55	3.31	1.60	3.50	1.53	3.58	1.55	.062	.005
Self-concept	3.82	1.10	[UA UO] 3.55	1.07	[UA] 3.95	1.06	[UO] 3.91	1.14	**<.001**	.026
Self-efficacy	4.43	1.18	[UA] 4.34	1.16	[UA AO] 4.60	1.13	[AO] 4.28	1.21	**<.001**	.015
Interest/intrinsic value	4.05	1.25	[UA UO] 3.83	1.26	[UA] 4.18	1.21	[UO] 4.08	1.27	**<.001**	.014
Utility/extrinsic value	4.11	1.20	[UA UO] 3.90	1.23	[UA] 4.18	1.17	[UO] 4.21	1.17	**<.001**	.012
Personal/attainment value	3.40	1.48	[UA UO] 3.02	1.42	[UA] 3.51	1.46	[UO] 3.59	1.49	**<.001**	.025
Cost value (absence of)	3.60	1.34	3.62	1.32	3.66	1.32	3.50	1.37	.221	.002
Mastery experiences (current grade)	3.57	1.64	[UO] 3.62	1.53	[AO] 3.72	1.66	[UO AO] 3.26	1.69	**<.001**	.013
Mastery norms (what is a good grade)	4.34	1.02	4.33	1.01	4.37	.94	4.34	1.13	.775	<.001
Subject-comparisons	3.99	1.55	[UA UO] 3.74	1.52	[UA] 4.12	1.56	[UO] 4.03	1.54	**<.001**	.011
Peer-comparisons	4.14	1.36	[UA UO] 3.85	1.42	[UA] 4.28	1.31	[UO] 4.20	1.35	**<.001**	.019
Social persuasions (praise)	3.85	1.18	[UA UO] 3.64	1.16	[UA] 3.96	1.15	[UO] 3.91	1.24	**<.001**	.014
Vicarious experiences	4.00	1.29	[UA UO] 3.83	1.26	[UA] 4.05	1.26	[UO] 4.09	1.37	**.007**	.007
Anxiety (absence of)	4.18	1.24	[UA UO] 3.92	1.21	[UA] 4.31	1.22	[UO] 4.26	1.27	**<.001**	.019
Norms/influence (friends)	3.73	.93	3.73	.85	3.75	.90	3.71	1.06	.830	<.001
Norms/influence (parents)	4.25	1.20	[UA] 4.11	1.20	[UA] 4.35	1.16	4.24	1.25	**.008**	.007
Teacher perceptions	4.33	1.03	[UA] 4.21	.98	[UA] 4.37	1.00	4.38	1.12	**.027**	.006
Teacher/school careers	3.44	1.32	[UA UO] 3.23	1.25	[UA] 3.44	1.26	[UO] 3.65	1.44	**<.001**	.014
Effort/futility (absence of)	4.67	1.06	[UA] 4.56	1.06	[UA AO] 4.79	1.00	[AO] 4.58	1.15	**.001**	.011
Effort/futility exams (absence of)	4.19	1.33	4.10	1.33	4.29	1.30	4.13	1.38	.074	.004
Gender (1 = male)	.58	.49	[UA UO] .47	.50	[UA] .63	.48	[UO] .62	.49	**<.001**	.021
Task score (0–1)	.56	.29	[(ALL)] .75	.19	[(ALL)] .58	.25	[(ALL)] .31	.24	**<.001**	.336
Task confidence (0–1)	.53	.23	[(ALL)] .44	.19	[(ALL)] .56	.25	[(ALL)] .60	.22	**<.001**	.078
Task confidence bias (−1 to +1)	−.02	.26	[(ALL)] −.31	.14	[(ALL)] −.02	.08	[(ALL)] .29	.17	**<.001**	.761
Students (number)	1523		444		653		405			

Notes: Items/factors used 1–6 scales unless otherwise indicated. Means (*M*) and standard deviations (SD) are shown. For group comparisons, significance values (*p*-values; Sig.) and the associated effect size via partial η^2 (Pη^2) are shown from analysis of variance (ANOVA) tests and significant results ($p < .05$) are highlighted in bold for clarity; significant Bonferroni *post hoc* tests ($p < .05$) have been highlighted in superscript (for brevity, '(ALL)' indicates where all pairs were significantly different).

accurate = 3.51, considerably over-confident = 3.62; $F(2, 1191) = 6.433$, $p = .002$). The patterns of means and group differences for the other items/factors remained similar regardless of the group boundaries (Appendix 2).

However, the numbers per group were unbalanced when analysing those with considerable under-confidence/over-confidence (students: considerably under-confident = 217, broadly accurate = 1082, considerably over-confident = 203). Predictive modelling therefore considered the original groups (±.5 standard deviations) to ensure feasible and reliable modelling.

3.3. Predicting students' science intentions

On average, for all students (Table 3, step 1), students' background characteristics only explained a modest amount of variance in their science intentions.

Including students' reported grades, self-concept, and self-efficacy (Table 3, step 2) highlighted that self-concept appeared to be most predictive.

Including theorised influences on intentions (Table 3, step 3) allowed around half of the variance in students' intentions to be explained. Students' perceived utility of science was the strongest predictor, while self-concept had lost significance.

Including the remaining factors (Table 3, step 4) produced no substantial changes in significance for the previous predictors. The largest predictors of students' science intentions (standardised coefficients over .10) were the students' perceived utility of science, personal value of science, self-efficacy, subjective-norms/influences from parents, and interest in science.

Nevertheless, reported membership of some background/ethnicity groups predicted higher intentions while controlling for all other items/factors (although the magnitudes involved were small), highlighting that further (unknown) factors likely need to be considered to explain such differences.

Table 3. Science items/factors predicting students' science intentions (A-Level, university, careers) for all students.

	Step 1		Step 2		Step 3		Step 4	
Item/factor	Std. Est.	Sig.	Std. Est.	Sig.	Std. Est.	Sig.	Std. Est.	Sig.
Intercept/constant	**2.706**	**<.001**	.807	.115	**−.796**	**.039**	−.635	.230
Year (9, 10, 11)	**−.082**	**.001**	−.036	.140	.013	.511	.017	.491
Gender (1 = male)	**.081**	**.023**	−.001	.982	.007	.850	−.005	.907
Ethnicity (Black)	.025	.302	.037	.315	**.055**	**.016**	**.047**	**.026**
Ethnicity (East-Asian)	.026	.154	.019	.241	−.007	.320	−.009	.435
Ethnicity (South-Asian/Indian)	**.223**	**<.001**	**.149**	**<.001**	**.089**	**.001**	**.073**	**.005**
Ethnicity (Mixed)	.027	.249	.017	.211	**.037**	**.015**	**.029**	**.028**
Ethnicity (Other)	**.077**	**.007**	.049	.131	**.047**	**.048**	**.045**	**.047**
Highest level of schooling (mother)	−.028	.442	−.063	.077	−.025	.293	−.023	.349
Highest level of schooling (father)	.071	.099	−.003	.951	−.014	.638	−.022	.465
Number of books at home	**.080**	**<.001**	−.022	.158	−.024	.095	−.022	.239
Parents working in science (1 = yes)	**.078**	**<.001**	**.067**	**<.001**	.031	.051	.017	.316
Mastery experiences (current grade)			.011	.758	−.015	.644	−.010	.766
Self-concept			**.310**	**<.001**	.015	.388	.040	.203
Self-efficacy			**.204**	**.002**	**.113**	**.002**	**.109**	**.001**
Interest/intrinsic value					**.083**	**<.001**	**.100**	**.001**
Utility/extrinsic value					**.501**	**<.001**	**.457**	**<.001**
Personal/attainment value					**.142**	**.003**	**.151**	**<.001**
Cost value (absence of)					**.046**	**.006**	**.041**	**.007**
Mastery norms (what is a good grade)							.001	.967
Subject-comparisons							.028	.254
Peer-comparisons							−.016	.575
Social persuasions (praise)							−.058	.065
Vicarious experiences							**−.066**	**.004**
Anxiety (absence of)							.046	.189
Norms/influence (friends)							**−.050**	**.015**
Norms/influence (parents)							**.109**	**<.001**
Teacher perceptions							−.008	.795
Teacher/school careers							.036	.188
Effort/futility (absence of)							−.024	.309
Effort/futility exams (absence of)							−.036	.136
Task score							.008	.818
Task confidence							.002	.962
Goodness of fit (R^2)	.111		.270		.552		.572	

Notes: Standardised coefficient estimates (Std. Est.) represent measures of effect size; for brevity, only *p*-values (Sig.) are also shown. The ethnicity categories are comparisons against those reporting 'White' backgrounds (the reference category). Significant predictors ($p < .05$) are highlighted in bold for clarity.

The various theorised influences on students' confidence, such as receiving praise or students comparing themselves against their peers, were not predictive of students' intentions, except for vicarious experiences (un-intuitively) predicting lower intentions but only with a small magnitude.

Similarly, the subjective-norms/influences of friends, controlling for all other factors, (again, un-intuitively) predicted lower intentions although only with a small magnitude.

3.4. Predicting students' science intentions when under-confident, accurate, and over-confident

When predicting students' science intentions for under-confident, accurate, and over-confident students (Table 4), the predictive associations of various items/factors were confirmed to differ (statistically significantly) across these cases. In statistical terminology (Baron & Kenny, 1986), confidence biases therefore 'moderated' the relations between the various predictors and students' intentions. Essentially, students with different confidence biases can be inferred to form their intentions or to be influenced in different ways.

Controlling for all other factors, the science intentions of under-confident students were predicted by their science self-concept beliefs but not by their self-efficacy beliefs. Conversely, the science intentions of accurately evaluating and over-confident students were predicted by their self-efficacy beliefs but not by their self-concept beliefs.

Students' perceived utility of science had a lower predictive association with intentions for over-confident students than for accurate or under-confident students. Students' personal value of science had a higher predictive association with intentions for under-confident students than for accurate students (and was not significantly predictive for over-confident students). The subjective-norm/influence of parents had a higher predictive association with intentions for over-confident students than for under-confident students (where it was not significantly predictive).

Differences associated with reported background/ethnicity also occurred across the groups, including that reporting a South-Asian/Indian or a Mixed background predicted higher science intentions (compared to White students) only for over-confident students. Reporting higher levels of education undertaken by the students' father or male guardian predicted lower science intentions only for over-confident students.

Various other differences were also apparent, although the associated predictive coefficients were generally smaller (around or less than .10).

4. Discussion

The presented research helped clarify the importance of students' confidence within science education, and highlighted that considering under-confidence and over-confidence provided new insights.

What did students report about their intentions and other views concerning their science education? Did under-confident, accurate, and over-confident students express different attitudes or intentions?

Compared to accurately evaluating students, under-confident students generally reported lower across the considered factors. Students with considerable under-confidence indeed reported lower science intentions. Given that accurately evaluating and under-confident

Table 4. Science items/factors predicting students' science intentions (A-Level, university, careers) across confidence bias groups (±.5 SD group boundaries).

	Under-confident (U)		Accurate (A)		Over-confident (O)	
Item/factor	Std. Est.	Sig.	Std. Est.	Sig.	Std. Est.	Sig.
Intercept/constant	−.519	.264	−.236	.780	−1.519	.052
Year (9, 10, 11)	−.005	.853	−.009	.815	.090	.143
Gender (1 = male)	.030	.665	−.022	.507	.014	.779
Ethnicity (Black)	.062	.135	.034	.511	.010	.831
Ethnicity (East-Asian)	$^{UA\ UO}$.090	.073	^{UA} **−.064**	**.027**	^{UO} −.018	.765
Ethnicity (South-Asian/Indian)	^{UO}.026	.384	.067	.185	^{UO} **.136**	**<.001**
Ethnicity (Mixed)	.010	.620	.032	.107	**.095**	**.046**
Ethnicity (Other)	^{UA} **.052**	**.025**	^{UA} **.042**	**.011**	.085	.166
Highest level of schooling (mother)	^{UO} −.057	.155	^{AO} −.039	.260	$^{UO\ AO}$.140	.052
Highest level of schooling (father)	^{UO}.041	.186	−.016	.651	^{UO} **−.147**	**.018**
Number of books at home	.015	.554	−.063	.128	−.009	.853
Parents working in science (1 = yes)	.027	.352	−.003	.890	.032	.386
Mastery experiences (current grade)	−.079	.157	−.025	.667	.043	.652
Self-concept	$^{UA\ UO}$ **.147**	**.015**	^{UA} −.014	.694	^{UO}.014	.810
Self-efficacy	.048	.424	**.138**	**.001**	**.108**	**.015**
Interest/intrinsic value	.020	.842	**.133**	**<.001**	**.135**	**.027**
Utility/extrinsic value	^{UO} **.551**	**<.001**	^{AO} **.460**	**<.001**	$^{UO\ AO}$ **.290**	**<.001**
Personal/attainment value	^{UA} **.215**	**<.001**	^{UA} **.116**	**.046**	.144	.114
Cost value (absence of)	.056	.137	.047	.090	.020	.646
Mastery norms (what is a good grade)	^{UO}.036	.271	^{AO}.026	.395	$^{UO\ AO}$ **−.070**	**.009**
Subject-comparisons	.018	.778	.020	.706	.051	.378
Peer-comparisons	−.016	.719	−.009	.733	.018	.819
Social persuasions (praise)	**−.101**	**.016**	−.053	.069	−.049	.249
Vicarious experiences	^{UO} −.024	.457	**−.091**	**.003**	^{UO} **−.105**	**.010**
Anxiety (absence of)	.021	.765	.040	.263	.066	.169
Norms/influence (friends)	^{UA}.008	.532	^{UA} **−.072**	**.003**	−.099	.132
Norms/influence (parents)	^{UO}.042	.211	**.116**	**<.001**	^{UO} **.223**	**<.001**
Teacher perceptions	−.047	.372	.007	.902	.042	.465
Teacher/school careers	−.002	.983	.030	.059	.050	.395
Effort/futility (absence of)	^{UO} **−.072**	**.016**	−.008	.879	^{UO}.043	.388
Effort/futility exams (absence of)	$^{UA\ UO}$ **.080**	**.001**	^{UA} **−.114**	**.001**	^{UO} −.036	.552
Task score	−.023	.718	^{AO}.097	.255	^{AO} **−.108**	**.009**
Task confidence	−.003	.982	.026	.828	−.026	.438
Goodness of fit (R^2)	.657		.592		.563	

Notes: Standardised coefficient estimates (Std. Est.) represent measures of effect size; for brevity, only *p*-values (Sig.) are also shown. The ethnicity categories are comparisons against those reporting 'White' backgrounds (the reference category). Significant predictors ($p < .05$) are highlighted in bold for clarity. Differences in coefficient magnitude across paired groups ($p < .05$ via Wald tests for separate paired-group models) are highlighted in superscript.

students reported the same current grades, under-confidence may be considered detrimental within science education.

What predicted students' intentions when students were under-confident, accurate, or over-confident? Were there any differences across these cases?

Across all students, the strongest predictors of students' intentions towards studying science further were the students' perceived utility of science, personal value of science, self-efficacy (confidence in their expected future science attainment), influences from parents, and interest in science.

However, students' intentions were predicted by different factors in different ways, depending on whether students were under-confident, accurate, or over-confident. The pattern of predictive factors was broadly similar for all students considered together and for accurately evaluating students. For under-confident students, however, science intentions were most strongly predicted by their perceived utility of science, personal value of science, and their self-concept beliefs (subjective beliefs about currently 'doing well' or 'being good' at science); however, self-efficacy beliefs, interest, and parental influences were not significantly predictive. Under-confidence may be detrimental not simply through associating with lower attitudes, but through students considering their choices in different ways.

On a wider level, the results cohered with earlier research that has also highlighted the importance of perceived utility, interest, and support/encouragement to pursue science (e.g. Mujtaba & Reiss, 2014; Regan & DeWitt, 2015; Sjaastad, 2012). The results presented above also extended earlier research through highlighting that support or guidance may be more relevant or less relevant to different students: parental influences predicted science intentions for over-confident students but not for under-confident students. Researchers may need to explore whether guidance is sometimes perceived as pressure or inadvertently reduces self-reflection for some students, and/or which forms of support or encouragement are the most beneficial.

The results also extended earlier research through quantitatively highlighting the predictive association between science intentions and someone's personal value of science (e.g. 'Thinking scientifically is an important part of who I am'). The personal value of science to someone's identity has been increasingly explored in prior research, but generally only through qualitative methods (e.g. Aschbacher, Li, & Roth, 2010; Holmegaard, Ulriksen, & Madsen, 2015). The results presented above highlighted that students' personal value of science predicted science intentions across all students (at a higher magnitude than students' interest in science), and for under-confident and for accurately evaluating students, but not for over-confident students. Accordingly, researchers may need to further explore the effects of over-confidence and/or someone's personal value of science on students' retention within science. For example, it is possible to hypothesise that if someone does not necessarily consider personally valuing science as relevant to their choices, then they may only persist within science education for as long as their other goals are met.

4.1. Under-confidence in science education

Considering students' confidence may help ensure that their future choices are not unnecessarily constrained. The results presented above highlight that under-confident students do not lack ability: they reported the same current grades as accurately evaluating students and they scored the highest on the questionnaire tasks.

For under-confident students, interest in science and influences from parents were not predictive of science intentions. Educators may need to address under-confidence before assuming that increasing interest in science entails increased participation for all students.

For under-confident students, science intentions were predicted by their self-concept beliefs and not by their self-efficacy beliefs. Educators and students may need to discuss perceived abilities, current grades, and expected grades so that under-confidence/over-confidence could be revealed, and so that students can focus more on their self-efficacy.

Compared to other students, the science intentions of under-confident students were predicted more by their perceived utility of science and their personal value of science (science as being part of their identity). Accordingly, these may be beneficial areas for educators to promote.

Attempting to directly influence students' confidence may have unforeseen results. Higher praise may increase students' confidence (Bandura, 1997). However, praise (un-intuitively) predicted lower science intentions for under-confident students, controlling for the other factors. However, it remains unclear if higher praise would ultimately have a positive effect on intentions, via the indirect effect of higher confidence beliefs, regardless of the negative direct effect.

Nevertheless, it may be beneficial to initially focus on practice examination papers to provide more tangible reassurance and increase students' confidence about their expected grades, for example, or to increase self-regulated learning or self-reflection (e.g. Dignath & Büttner, 2008).

4.2. Over-confidence in science education

The results presented above highlight that accurately evaluating and over-confident students generally reported similar attitudes to science, self-concept beliefs, and intentions to study science further. However, over-confident students reported lower current grades and lower self-efficacy.

While under-confidence may provide an obvious area for intervention, over-confidence should not be overlooked. While high confidence may be motivationally beneficial (Bandura, 1997), students may be ultimately disappointed or encounter problems if they are sufficiently over-confident as to lack the attainment necessary to meet their goals.

The science intentions of over-confident students were most strongly predicted by their perceived utility of science and by parental influences. Compared to other students, the effects of parental influences were relatively higher and the effect of perceived utility was relatively lower.

Educators could discuss intentions and current/expected grades with students, and help ensure that everyone can meet any pre-requisite attainment for their goals. Students' mentioning parental influences may not necessarily be a cause for concern (this factor also predicted science intentions for accurately evaluating students), but may suggest that educators need to be ready to provide closer support if any difficulties arise.

4.3. Limitations and implications to subsequent research

While science is considered holistically in the National Curriculum, students in England ultimately need, if they continue with science, to select specific subjects (e.g. physics) at A-Level and at university. While the presented results provide a plausible overview, different factors may be relevant for different science subjects.

Confidence biases and groups can be explored and defined in various ways. While some research has applied paired tasks and confidence ratings (e.g. Chen, 2003), as applied here, other research has explored students' beliefs and attainment compared (relatively) across samples (e.g. Dupeyrat et al., 2011). Different methods may provide different insights.

The results generalise across students in Years 9–11, and provide plausible findings for future refinement and focused exploration. Further research with increased numbers of students and schools (via stratified sampling) would allow individual academic years to be considered separately, and to consider any potential effects of schools in more detail.

4.4. Conclusions

Considering students' confidence may help ensure that their future choices are not unnecessarily constrained. Under-confident students expressed consistently lower science attitudes than accurately evaluating and over-confident students, despite reporting the same science grades as accurately evaluating students.

Under-confidence may be detrimental not simply through associating with lower attitudes, but through students considering their choices in different ways. For under-confident students, the strongest predictors of their intentions towards studying science further were their perceived utility of science, personal value of science, and self-concept beliefs.

Across all students, however, science intentions were most strongly predicted by perceived utility of science, personal value of science, self-efficacy, influences from parents, and interest in science.

Policy, practice, and research in science education may need to further consider how different students may be influenced in different ways. Otherwise, attempting to increase every apparently relevant factor may not necessarily produce the expected gains in science participation.

Note

1. Following TIMSS, the number of books was measured/scaled as (1) none or very few (0–10 books), or enough books to fill (2) around one shelf (11–25 books), (3) around one bookcase (26–100 books), (4) around two bookcases (101–200 books), or (5) three bookcases or more (over 200 books).

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Notes on contributor

Richard Sheldrake is currently researching various aspects of students' attitudes and motivational beliefs, especially in relation to their subject choices and educational progression. He has worked on a range of research projects within science and mathematics education at the UCL Institute of Education, and has focused on applying advanced quantitative analysis.

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Appendix 1. Example task score and confidence items

Two example pairs of tasks and confidence ratings are provide below. Tasks were sourced from TIMSS 2011 (Foy et al., 2013) and were used for research purposes, as described in the main article.

The IEA has released TIMSS tasks for non-commercial, educational, and research purposes only; please see the relevant documentation for further details (Foy et al., 2013).

Example task

Which of the following best describes the purpose of cellular respiration?

- ☐ To provide energy for cell activities.
- ☐ To produce sugar for storage in cells.
- ☐ To release oxygen for breathing.
- ☐ To supply carbon dioxide for photosynthesis.

	Not at all confident	Not very confident	Confident	Very confident
How confident are you that you solved this correctly?	☐	☐	☐	☐

Notes: TIMSS reference S032611. Correct answer: A (Foy et al., 2013). Retrospective confidence ratings (i.e. 'How confident are you that you solved this correctly?') were not part of TIMSS, and were added as part of the presented research study. The exact format and presentation from the questionnaire is not exactly reproduced here (e.g. page layout, typeface, size, etc.).

Example task

The amount of carbon dioxide in the air is increasing in a large city due to the growing number of vehicles. The mayor wants to plant more trees.

Do you agree with the mayor's suggestion?

☐ Yes ☐ No

Please explain why you agree or not.

	Not at all confident	Not very confident	Confident	Very confident
How confident are you that you solved this correctly?	☐	☐	☐	☐

Notes: TIMSS reference S052091. Correct answers (either): 'Yes', with an explanation that trees absorb carbon dioxide (during photosynthesis); 'No', with a valid explanation related to reducing carbon dioxide emission (Foy et al., 2013). Retrospective confidence ratings (i.e. 'How confident are you that you solved this correctly?') were not part of TIMSS, and were added as part of the presented research study. The exact format and presentation from the questionnaire is not exactly reproduced here (e.g. page layout, typeface, size, etc.).

Appendix 2. Considerable under-confidence/over-confidence groups (±1 SD group boundaries)

			Confidence bias groups (±1 SD group boundaries)							
	All students		Considerably under-confident (U)		Broadly accurate (A)		Considerably over-confident (O)		ANOVA	
Item/factor	*M*	SD	*M*	SD	*M*	SD	*M*	SD	Sig.	$P\eta^2$
Intentions towards science	3.47	1.55	[UA UO] 3.06	1.55	[UA] 3.51	1.55	[UO] 3.62	1.51	**.002**	.011
Self-concept	3.82	1.10	[UA UO] 3.40	.99	[UA] 3.88	1.08	[UO] 3.94	1.19	**<.001**	.025
Self-efficacy	4.43	1.18	[UA] 4.22	1.20	[UA AO] 4.52	1.16	[AO] 4.23	1.16	**<.001**	.013
Interest/intrinsic value	4.05	1.25	[UA UO] 3.60	1.27	[UA] 4.12	1.22	[UO] 4.13	1.31	**<.001**	.020
Utility/extrinsic value	4.11	1.20	[UA UO] 3.78	1.20	[UA] 4.14	1.19	[UO] 4.27	1.16	**<.001**	.012
Personal/attainment value	3.40	1.48	[UA UO] 2.82	1.41	[UA] 3.45	1.46	[UO] 3.65	1.50	**<.001**	.024
Cost value (absence of)	3.60	1.34	3.56	1.43	[AO] 3.66	1.29	[AO] 3.35	1.47	**.020**	.006
Mastery experiences (current grade)	3.57	1.64	3.53	1.47	[AO] 3.63	1.67	[AO] 3.24	1.61	**.031**	.006
Mastery norms (what is a good grade)	4.34	1.02	4.39	.96	4.35	1.00	4.28	1.11	.510	.001
Subject-comparisons	3.99	1.55	[UA] 3.66	1.50	[UA] 4.05	1.56	3.97	1.53	**.005**	.007
Peer-comparisons	4.14	1.36	[UA UO] 3.73	1.40	[UA] 4.21	1.34	[UO] 4.15	1.41	**<.001**	.015
Social persuasions (praise)	3.85	1.18	[UA UO] 3.47	1.15	[UA] 3.92	1.15	[UO] 3.85	1.31	**<.001**	.016
Vicarious experiences	4.00	1.29	[UA UO] 3.68	1.33	[UA] 4.03	1.25	[UO] 4.13	1.45	**.001**	.010
Anxiety (absence of)	4.18	1.24	[UA UO] 3.80	1.19	[UA] 4.26	1.22	[UO] 4.16	1.33	**<.001**	.016
Norms/influence (friends)	3.73	.93	3.75	.84	3.72	.90	3.77	1.15	.811	<.001
Norms/influence (parents)	4.25	1.20	[UA UO] 3.98	1.20	[UA] 4.29	1.18	[UO] 4.30	1.26	**.004**	.008
Teacher perceptions	4.33	1.03	[UA UO] 4.06	1.07	[UA] 4.36	.99	[UO] 4.41	1.18	**.002**	.010
Teacher/school careers	3.44	1.32	[UO] 3.19	1.28	[AO] 3.42	1.28	[UO AO] 3.77	1.53	**<.001**	.012
Effort/futility (absence of)	4.67	1.06	4.54	1.10	4.71	1.04	4.56	1.15	.061	.004
Effort/futility exams (absence of)	4.19	1.33	[UA] 3.93	1.41	[UA AO] 4.28	1.29	[AO] 3.96	1.47	**.001**	.012
Gender (1 = male)	.58	.49	[UA UO] .43	.50	[UA] .61	.49	[UO] .58	.50	**<.001**	.015
Task score (0–1)	.56	.29	[(ALL)] .80	.18	[(ALL)] .58	.25	[(ALL)] .21	.20	**<.001**	.311
Task confidence (0–1)	.53	.23	[(ALL)] .39	.18	[(ALL)] .55	.24	[(ALL)] .62	.20	**<.001**	.078
Task confidence bias (−1 to +1)	−.02	.26	[(ALL)] −.41	.12	[(ALL)] −.03	.13	[(ALL)] .41	.17	**<.001**	.717
Students (number)	1523		217		1082		203			

Notes: Items/factors used 1–6 scales unless otherwise indicated. Means (*M*) and standard deviations (SD) are shown. For group comparisons, significance values (*p*-values; Sig.) and the associated effect size via partial η^2 ($P\eta^2$) are shown from analysis of variance (ANOVA) tests and significant results ($p < .05$) are highlighted in bold for clarity; significant Bonferroni *post hoc* tests ($p < .05$) have been highlighted in superscript (for brevity, '(ALL)' indicates where all pairs were significantly different).