



Differential predictors of under-confidence and over-confidence for mathematics and science students in England

Richard Sheldrake

UCL Institute of Education, University College London, 20 Bedford Way, London, WC1H 0AL, England, United Kingdom



ARTICLE INFO

Article history:

Received 22 August 2015

Received in revised form 31 January 2016

Accepted 19 May 2016

Keywords:

Self-concept

Confidence bias

Calibration

Self-enhancement

TIMSS

ABSTRACT

An enhanced understanding of what predicts students' confidence, and what predicts specific cases of under-confidence or over-confidence, benefits educational practices and motivational theories. For secondary-school students in England, confidence expressed as self-concept was most strongly predicted by (intrinsic) interest, perceived encouragement (praise), and subject-comparisons for mathematics, and by praise, interest, and peer-comparisons for science, controlling for achievement and various other factors. The students' reported subject-comparisons, peer-comparisons, anxiety, interest, and (extrinsic) utility differentially predicted the self-concept beliefs of under-confident, accurate, and over-confident students in various ways. For example, for mathematics, higher utility predicted higher self-concept when over-confident (but not when under-confident). For science, lower subject-comparisons (science thought to be harder than any other subject) predicted lower self-concept when under-confident (but not when over-confident). Understanding what predicts someone's self-concept when they are under-confident or over-confident may help these confidence biases to be corrected by educators or even by the students themselves.

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1. Introduction

Students' confidence has associated with many aspects of education (OECD, 2015), including motivations to learn (Jiang, Song, Lee, & Bong, 2014), interest in particular subjects (Viljaranta, Tolvanen, Aunola, & Nurmi, 2014), and with choices of what subjects to study (Regan & DeWitt, 2015). However, students' confidence does not necessarily correspond to their actual achievement: some students may be under-confident, with lower confidence than would be expected given their achievement, while others may be over-confident. Since students' confidence influences their motivations and their choices, under-confidence may be limiting or detrimental (Bouffard & Narciss, 2011).

It remains important to understand how students' confidence may be influenced. Students may theoretically form their confidence by considering their own achievement, but they may also receive praise or criticism, compare themselves against their peers, be interested in or anxious about their studies, or be subjected to various other potential influences or factors (Bong & Skaalvik, 2003). Prior research has often explored what predicts students' confidence (e.g. Bong & Skaalvik, 2003; Usher & Pajares, 2008b), but not what might associate with or predict specific cases of under-confidence or over-confidence.

An enhanced understanding can lead to practical benefits: over-confidence or under-confidence could potentially be amended via teachers or wider interventions. Addressing under-confidence may help to

(indirectly) increase the numbers of students who chose to study non-compulsory mathematics or science, which remains an important concern for various countries including England (EACEA, 2011; The Royal Society, 2014).

Accordingly, the research presented here explored what factors associated with students' confidence in mathematics and science, and whether any such factors could be associated with under-confidence or over-confidence. The research considered the Trends in International Mathematics and Science Study (TIMSS) of 2011, from the International Association for the Evaluation of Educational Achievement (IEA), and focused on England in order to increase contextualised understanding and relevance to national teaching and policy.

While some studies have undertaken between-country comparisons in under-confidence and over-confidence (e.g. Chen & Zimmerman, 2007; Morony, Kleitman, Lee, & Stankov, 2013; Stankov & Lee, 2014), sometimes defining country-wide or cultural features to help consider any differences (e.g. Chiu & Klassen, 2010; Stankov, 2010), within-country studies remain important. Most students likely select courses within their home country, where under-confidence compared to other students within that country has the most relevance. Nevertheless, compared to other countries, students from across the United Kingdom (which encompasses the country of England, together with Scotland, Wales, and Northern Ireland) have exhibited relatively-accurate confidence, on average, broadly similar to other European countries (e.g. Chiu & Klassen, 2010). England may then provide an informative baseline for other international research or potential comparisons.

E-mail address: rsheldrake@ioe.ac.uk.

1.1. Students' confidence and potential influences

Within educational, psychological, and other research into individual differences, students' confidence, or their various beliefs in their own abilities or achievement, has often been conceptualised into separate 'self-concept' and 'self-efficacy' beliefs, usually specific to particular academic subjects (Bong & Clark, 1999; Bong & Skaalvik, 2003). Self-concept considers someone's current confidence in their abilities or achievement, integrating their historic and current experiences (e.g. particular achievement grades or accomplishments) and evaluative beliefs (e.g. subjective beliefs of 'doing well' or 'being good' at a subject). Alternately, self-efficacy considers someone's confidence in their future capacities or future achievement, covering contextualised and evaluative beliefs (e.g. perceived confidence in gaining a particular future grade or in completing particular future tasks).

Students' self-efficacy beliefs have been theorised to be influenced by four factors (Bandura, 1997): 'mastery experiences' (successfully completing tasks or not, or gaining particular grades or results); 'vicarious experiences' (seeing others succeed); 'social persuasions' (such as feedback or comments from teachers or other people); and 'physiological states' (such as physical and emotional responses such as anxiety). From these, mastery experiences have generally been the most predictive, while the predictive associations of the others have varied across studies (Britner, 2008; Britner & Pajares, 2006; Usher & Pajares, 2008b; Usher & Pajares, 2009).

Students' self-concept beliefs have been theorised to be influenced by students' mastery experiences, self-comparisons over time, self-comparisons across subjects, comparisons with their peers, and potentially various other factors (Bong & Skaalvik, 2003). Much research has focused on peer-comparisons (Marsh & Parker, 1984; Marsh, Abduljabbar, et al., 2015) and subject-comparisons (Marsh, 1986; Marsh, Lüdtke, et al., 2015), often inferred through specific statistical approaches but also through directly seeking students' views (Huguet et al., 2009; Thijs, Verkuyten, & Helmond, 2010). The effects of peer-comparisons, for example, have been proposed to be large (e.g. Nagengast & Marsh, 2011), but have generally only been considered in isolation. While some research has attempted to explore peer-comparisons and subject-comparisons concurrently, results have varied (Chiu, 2012; Pinxten et al., 2015).

1.2. Motivational benefits or detriments, and biases in students' confidence

Within education, high confidence may be beneficial. Higher self-efficacy has associated with higher motivations to learn and master academic work (mastery goals or goal orientations) (Jiang et al., 2014; Phillips & Gully, 1997), persistence (Multon, Brown, & Lent, 1991), and self-regulation for learning (Usher & Pajares, 2008a; Zimmerman & Schunk, 2011). Higher self-concept has also sometimes been associated with higher subsequent interest (Viljaranta et al., 2014) and higher subsequent achievement (Huang, 2011; Marsh & Martin, 2011; Seaton, Parker, Marsh, Craven, & Yeung, 2014), over and above the effect of prior achievement.

Essentially, the motivational benefits of high confidence appear to be clear, as assumed within social-cognitive theory (Bandura, 1997): high confidence may be beneficial in motivating individuals to surpass their normal performance and overcome initial barriers through persistence or other strategies; but low confidence may mean that some actions are not even attempted. Social-cognitive theory specifically considered self-efficacy beliefs, however; self-concept evolved from general psychological measures and was not originally integrated within wider theory (Shavelson, Hubner, & Stanton, 1976). Nevertheless, subsequent applications of social-cognitive theory, such as the expectancy-value model of students' choices (e.g. Eccles, 2009), have assumed that confidence has a motivational role regardless of whether it is expressed as self-efficacy and/or as self-concept.

However, it remains unclear whether any motivational benefits of high confidence occur regardless of whether someone is accurate in their beliefs (they have correspondingly high achievement) or whether someone is over-confident (they have lower achievement than would be expected given their high beliefs). Someone may also be under-confident, and show lower beliefs than would be expected given their achievement, and it is unclear whether this is always detrimental or limiting. For example, studies of secondary-school students have often associated accurately-evaluated confidence (not being over-confident or under-confident) with higher performance (Chen, 2003; Chen & Zimmerman, 2007; Möller & Pohlmann, 2010; Pajares & Graham, 1999), but have also associated over-confidence with lower performance and under-confidence with higher performance (Chiu & Klassen, 2010). Younger students who consistently over-estimated their abilities over time have reported higher self-esteem than all other students, and generally performed higher than others (Bouffard, Vezeau, Roy, & Lengelé, 2011). Over-confidence has also associated with higher persistence and mastery goals than accuracy and under-confidence (Gonida & Leondari, 2011). In England, over-confidence associated with higher (intrinsic) interest in mathematics and (extrinsic) utility of mathematics at Year 8, while accuracy associated with higher affective responses and intentions to study mathematics further at Year 10 (Sheldrake, Mujtaba, & Reiss, 2014). While it appears uncertain whether over-confident or accurately-evaluated beliefs are the most beneficial, it is often inferred that under-confidence may be detrimental or limiting in various ways (Bouffard & Narciss, 2011).

1.3. Research aims and hypotheses

Diverse research has been undertaken into what predicts students' confidence (whether self-efficacy or self-concept) but often without considering consistent or extensive sets of potential predictors. It remains unclear whether theorised predictors of self-efficacy also predict self-concept, and vice versa, and (especially for self-concept) which factors have the highest predictive associations (or 'effects') when controlling for other factors. Additionally, less research has considered confidence biases and these studies have generally considered differences in students' reported attitudes. It remains unclear whether any factors predictively associate with either under-confidence or over-confidence.

Accordingly, the aims of this study were to: (1) identify what best predicted students' confidence, operationalised as self-concept beliefs, for students in England; and (2) identify what predicted self-concept for cases of under-confidence, accuracy, and over-confidence, and to consider any differences across these cases.

The following hypotheses were made.

Hypothesis 1A. Results would broadly follow those seen when predicting self-efficacy (e.g. Usher & Pajares, 2008b): students' achievement (representing 'mastery experiences') would have a relatively-higher predictive association with self-concept while anxiety, praise, subject-comparisons, and peer-comparisons, would have relatively-lower associations, when controlling for these and other factors. However, subject-comparisons and peer-comparisons could potentially show higher effects (e.g. Marsh, Abduljabbar, et al., 2015; Marsh, Lüdtke, et al., 2015).

Hypothesis 1B. Interest and utility would have moderate predictive associations with self-concept, even when controlling for other factors. Various associations between interest, confidence, and achievement have been seen in prior research (e.g. Viljaranta et al., 2014) and motivational factors such as interest have been theorised to reciprocally associate with confidence (e.g. Eccles, 2009).

Hypothesis 2A. Peer-comparisons/subject-comparisons (i.e. finding science/mathematics harder/easier than other subjects and/or students) would relatively-symmetrically associate with both under-

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