Adult students' perceptions of constructivist learning, control-value appraisals, and achievement emotions in further education mathematics

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The current research aimed to explore the links between students' perceptions of cognitive constructivist principles in learning and their achievement emotions in mathematics. The relationships between perceptions of four constructivist-informed classroom practices, students' appraisals of control and value, enjoyment and anxiety were investigated using a quantitative questionnaire-based study with a sample of adult students ($N = 103$) of level 2 mathematics in further education. Multiple regression analyses revealed that perceptions of investigation learning related positively with control appraisals, value appraisals, and enjoyment, and negatively with anxiety. Perceived involvement in learning was negatively, and cooperative learning positively, related to anxiety. Implications for practice are discussed, with our conclusion advocating the use of active learning in mathematics.

Keywords: constructivist learning; control-value theory; further education; adult learning

Introduction

Perceptions of self-competence, task values, and emotions pertaining to mathematics learning are factors that can determine the motivational and cognitive processes that impact performance and achievement (Parr et al., 2019). Further, these factors can be considered important educational outcomes in their own right for students' mental well-being (Pekrun, 2006) and for shaping future attitudes and functionality with mathematics in employment and everyday life (Dalby, 2012).

Unfortunately, negative attitudes towards mathematics are a socially accepted norm in the UK; mathematics is typically viewed as difficult and unenjoyable, a subject associated with failure and anxiety (Boli, 2020). Such attitudes may cause barriers to learning for individuals aiming to achieve their level 2 mathematics qualifications (including GCSE[1] and functional skills[2] qualifications) in Further Education[3] (FE), and may be especially prevalent in adult students due to negative past experiences of mathematics education. Experiences in FE therefore have the potential to reshape adult students' perceptions of self-competence, task values and emotions by providing positive learning experiences and breaking the cycle of negativity associated with mathematics, so that students not only develop mathematical skills, but gain the confidence to use them. The current research aims to explore the potential role of

[1] In England, Wales and Northern Ireland, the GCSE is an academic qualification taken in a particular subject. Studies for GCSEs take place over two or three academic years, and are assessed using examinations in the final year of secondary school, typically at age 16.
[2] GCSE pass equivalent.
[3] In the UK, Further Education includes any study after secondary education that is not part of higher education, i.e. not taken as part of an undergraduate or graduate degree

cognitive constructivist-informed classroom practices (henceforth referred to as constructivist learning) as perceived by the student in fostering positive learning experiences for these students.

Constructivist learning

Constructivist learning seeks to give students intellectual authority and agency in the classroom and emphasise conceptual understanding and mastery of the content (Parr et al., 2019). Constructivism, as a pedagogy, is based on two core principles; firstly, learners should be considered active and responsible agents in their learning process (Alt, 2016), and secondly, learning occurs through building on one's existing knowledge through direct experiences with new information (Parr et al., 2019). To this end, constructivist learning environments should encompass the following core principles (Alt, 2016): (1) *Authentic tasks:* Learning activities should reflect the real-world applications of the content, as well as the everyday experiences of students. (2) *Active learning:* Students should learn new concepts and procedures via active engagement with the content material. (3) *Learning facilitated through discourse:* Skilled teachers play a crucial role as facilitators, rather than instructors. (4) *Collaboration:* Meaning is constructed via the integration of existing knowledge and social interactions.

Constructivist learning is advocated by many authors for promoting the development of richer knowledge and understanding and creating positive, or reducing negative, beliefs, attitudes and emotions when compared with transmission-oriented learning in mathematics (Parr et al., 2019). Despite this, transmission-oriented teaching is prevalent in mathematics classrooms, particularly when faced with high-stakes examinations (Swan, 2006). It can be argued, however, that transmission-oriented practices may be counter-productive, reinforcing anxiety concerning failure, and perpetuating the idea that mathematics is abstract and difficult (Boli, 2020). As such, understanding how students perceive instructional practices and how this relates to their beliefs and emotions surrounding mathematics is an important area of enquiry. A useful theoretical framework to explore this further is the control-value theory (CVT) of achievement emotions (Pekrun, 2006).

The Control-Value Theory of achievement emotions

The CVT of achievement emotions (Pekrun, 2006) provides an integrative framework for studying the antecedents and consequences of emotions experienced in achievement and academic settings. Central to CVT are the antecedents of emotions; CVT stipulates that achievement emotions are determined by an individual's appraisals of subjective control and value pertaining to academic achievement-related activities and outcomes. Subjective control appraisals include perceptions of self-competence, causal expectancies, and causal attributions for success and failure. Subjective value appraisals refer to the perceived valence or importance of achievement-related activities and outcomes (Pekrun, 2006). Appraisals of *intrinsic value* imply that a student values such activities and outcomes in their own right, for example, interest in the content or an appreciation for learning new skills. Appraisals of *utility value* refer to the perceived usefulness of achievement activities and outcomes, such as for everyday life or career aspirations.

Discrete achievement emotions are determined by differing combinations of appraisal antecedents; in general, higher appraisals of control and value elicit positive emotions, whereas negative emotions typically result from low control and high value

appraisals. Importantly, perceptions of learning environments are viewed by CVT as antecedents of control and value and are therefore distal determinants of achievement emotions. As such, Pekrun (2006) recommends the following practices intended to foster favourable appraisals of control and value, thus creating the optimal learning environment for enhancing students' positive learning experiences; (1) *Cooperative goal structures* (as opposed to competitive goal structures); (2) *Autonomy and collaboration* (supporting students' independent thinking and opportunities for collaboration); (3) *Instructional quality* (clear, structured, cognitively activating, and appropriately challenging); and (4) *Value Induction* (emphasising academic engagement via authentic learning material).

The features of Pekrun's (2006) optimal learning environment therefore align well with the principles underlying constructivist learning. However, few studies have specifically examined the link between constructivist learning and students' learning experiences using the theoretical framework of CVT (for notable exceptions, see Jacob et al. (2019) and Parr et al. (2019)) and none have done so using an adult FE student sample. This is an important gap to be addressed since perceptions of classroom learning and their relationships with students' learning experiences may differ in students of different levels and ages (Alt, 2015). The current study aimed to fill this gap by investigating students' appraisals of control, value and emotions, and their relations to perceptions of constructivist learning using this unique student sample.

The Current Study

Aims and Hypothesis

The aim was to identify the extent to which adult FE students' appraisals of control, value, and emotions in mathematics relate to their perceptions of the four core principles of constructivist learning (i.e. active learning, authentic tasks, learning facilitated through discourse, collaborative learning). Enjoyment and anxiety were selected for investigation, as they are the two most frequently experienced emotions in academic settings (Pekrun et al., 2002) and they, arguably, have the biggest impact on achievement and well-being. In sum, the following hypothesis was explored:

> Perceptions of constructivist learning were expected to relate positively with control appraisals, value appraisals and enjoyment, and negatively with anxiety.

Method

A sample of 103 adult students (25 male, 78 female, ages 19-65, mean age 37.00, $SD = 12.21$) enrolled in level 2 mathematics courses in FE colleges across the UK completed an online questionnaire measuring four perceptions of constructivist learning, appraisals of control (Self-Description Questionnaire II: Marsh, 1990), intrinsic and utility value (Eccles et al., 2005), enjoyment and anxiety (Achievement Emotions Questionnaire: Pekrun et al., 2011), towards learning mathematics.

Four perceptions of constructivist learning were measured using items assessing involvement (learning is facilitated through discourse), investigation (active learning), and cooperation (collaborative learning) taken from subscales of the What is Happening in this Class? Questionnaire (Skordi & Fraser, 2019) and personal relevance (authentic tasks) taken from a subscale of the Constructivist Learning Environment Survey (Taylor et al., 1997).

Participants were asked to respond to each item on all scales on a 5-point Likert scale, with higher scores indicating higher frequencies of perceived constructivist

learning, higher appraisals of control, intrinsic value, and utility value, more enjoyment, and more anxiety. Cronbach's alpha coefficients for all subscales exceeded the minimum satisfactory value of $.70$ advocated by various authors, thereby indicating strong internal consistency of all scales for this sample of FE students. Multiple linear regression analyses were conducted to determine the extent to which perceptions of constructivist learning contribute to the prediction of appraisals of control, value, enjoyment, and anxiety.

Results

In relation to control appraisals, a significant regression model was found ($F(4,92) = 5.06,\ p = .001$) explaining 18.0% of the variance as predicted by perceptions of constructivist learning. Only investigation was found to be significantly related to control appraisals ($\beta = .43, p < .01$); the more students perceived experiencing investigation learning, the higher they reported control over learning mathematics. Perceptions of involvement, personal relevance and cooperation did not significantly relate to appraisals of control ($p > .05$).

In relation to intrinsic value, a significant model was found in which 17.1% of the variance was explained by perceptions of constructivist learning ($F(4,92) = 4.73$, $p = .002$). Investigation was positively related to intrinsic value ($\beta = .43,\ p < .01$); the more a student perceived experiencing investigation learning, the higher their appraisal of intrinsic value. All other coefficients were nonsignificant ($p > .05$), meaning that perceptions of involvement, personal relevance and cooperation did not relate to students' appraisals of intrinsic value.

A significant model was found to predict utility value ($F(4,91) = 7.98,\ p < .001$), explaining 26.0% of the variance as predicted by perceptions of constructivist learning. Only investigation was found to be significantly, positively related to utility value ($\beta = .58,\ p < .001$); the more a student perceived experiencing investigation learning, the higher their appraisal of utility value. All other coefficients were nonsignificant ($p > .05$).

A significant regression model was found ($F(4,85) = 8.69, p < .001$), in which perceptions of constructivist learning explained 29.0% of the variance in enjoyment. Investigation was found to be significantly, positively related to enjoyment ($\beta = .59, p < .001$); the more a student perceived experiencing investigation learning, the more they enjoyed learning mathematics. Involvement, personal relevance and cooperation did not significantly relate to enjoyment ($p > .05$).

In relation to anxiety, a significant regression model was found ($F(4,85) = 4.61, p = .002$) in which 17.8% of the variance was explained by perceptions of constructivist learning. Involvement ($\beta = -.28, p < .05$) and investigation ($\beta = -.30, p < .05$) were significantly, negatively related to anxiety, such that students reported less anxiety the more they perceived experiencing investigation and involvement in learning. Personal relevance was significantly, positively related to anxiety ($\beta = .29, p < .05$); the more a student perceived learning as personally relevant, the more they reported feeling anxious. The relationship between cooperation and anxiety was nonsignificant ($p > .05$).

Discussions and Conclusion

Investigation learning, such that students learn via active engagement with the content material, was found to be especially important for the learning experiences of this FE

student sample, as this related positively with appraisals of control, utility value, intrinsic value, and enjoyment, and negatively with anxiety. Our findings are therefore in line with previous findings regarding the potential benefits of active learning in mathematics for enhancing perceptions of competence, task values, and positive emotions in samples of school pupils (Parr et al., 2019) and university students (Alt, 2015), and extend these findings to include adult students in FE.

Perceptions of involvement in learning, such that learning is facilitated through discourse, negatively predicted anxiety, and did not predict students' enjoyment or appraisals of control, intrinsic value, or utility value. Discussion-based learning is thought to increase confidence and foster positive task values by providing opportunities for students to share their thoughts, check their understanding, and engage with peers to tackle meaningful problems (Parr et al., 2019). Our findings that involvement did not predict control, value, or enjoyment were therefore unexpected, although this is not the first study to find such results regarding discussion-based learning in mathematics; Swan (2006) found that FE students (aged 16) who did not learn using discussion-based activities showed a decline in their overall confidence and motivation towards learning maths. In contrast, there were no significant changes in the confidence and motivation of students in the classes that used discussion-based activities. The current study does not, therefore, conclude that involvement is not beneficial to students' learning experiences, rather it may be the case that perceptions of involvement in learning prevented a decline in control, value and enjoyment that may have occurred in its absence.

Regarding personal relevance, such that learning is facilited with reference to real-world applications, the only significant result identified was a positive relationship with anxiety. Our findings are therefore contrary to the majority of literature advocating the use of contextualized, authentic learning material in mathematics (Wang et al., 2017). Here, we speculate that enjoyment and value were unaffected by reference to real-world applications because those applications were not perceived as directly relevant to students' experiences or interests, and may have been perceived as abstract mathematics in a superficial disguise, thereby reinforcing perceptions that mathematics is unrelated to real life (Dalby, 2012). Concerning the positive association with anxiety, contextualised problems may be overchallenging for students as they require the additional cognitive process in transferring between mathematics and reality (although it should be noted that a negative relationship with control was not identified, which we would have expected if this was the case). Consequently, teachers cannot assume that it is sufficient to select reality-based problems for enhancing positive learning experiences in mathematics; students' interests and content difficulty must be considered when designing contextualised instructional material.

In sum, the current study contributed to the literature by integrating cognitive constructivist theories and CVT to investigate students' learning experiences using a student sample that is underrepresented in the literature to date. This study therefore makes an important theoretical contribution that can underpin future research into students' learning experiences.

Our findings indicate the potential benefits of investigation learning, as this yielded the most favourable associations with students' appraisals of control, value, and emotions. Investigation learning is a student-centred practice that encourages students to construct new knowledge through active learning, which promotes deep understanding of the content, thereby contributing to students' appraisals of control and value and, in turn, emotions. Thus, implementing investigation learning may be a

promising route through which FE teachers can create more positive learning experiences in mathematics for adult students.

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