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Modeling relations between students' justification for knowing beliefs in science, motivation for understanding what they read in science, and science achievement

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ABSTRACT

In this study, we generated and tested a hypothesized model that specified direct and indirect linkages between different types of beliefs concerning the justification for knowing in science, motivation for science reading comprehension, and science achievement. Using a path analysis approach with a sample of 122 lower-secondary school students, results indicated that students' science reading comprehension self-efficacy predicted their achievement, with the justification belief variables indirectly affecting science achievement through their influence on science reading self-efficacy. Specifically, there was a negative indirect effect of personal justification on science achievement mediated by science reading comprehension self-efficacy, whereas both justification by authority and justification by multiple sources had positive indirect effects on science achievement mediated by self-efficacy. Beliefs in personal justification and justification by multiple sources affected achievement directly as well as indirectly. Both theoretical and educational implications of the results are discussed.

1. Introduction

During the last decades, educational psychologists have devoted much attention to students' beliefs concerning the nature of knowledge and the process of knowing, that is, their epistemic beliefs (Hofer & Bendixen, 2012), and the roles they play in cognition and academic achievement (Bendixen & Feucht, 2010; Hofer & Pintrich, 2002; Khine, 2008). At the same time, there has been a growing interest in the potential role of epistemic beliefs in achievement-related motivation, with this interest dating back to Hofer and Pintrich's (1997) seminal review, suggesting that epistemic beliefs may function as implicit theories about knowledge and knowing that are activated by academic tasks and domains and influence individuals' motivational approach to these tasks and domains. In this way, achievement motivation can be considered to mediate relationships between student epistemic beliefs instigated by academic tasks and domains and actual achievement (see also, Pintrich, 2002).

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The basic idea that forms of motivation may mediate between epistemic beliefs and achievement was further elaborated in theoretical models proposed by Buehl (2003) and Muis (2007). In those models, epistemic beliefs were considered to be activated initially during learners' perceptions and definitions of particular tasks and then to affect motivational components such as self-beliefs, values, and achievement goals, which were conceived of as standards set for learning by Muis (2007). In turn, an adaptive motivational approach to learning tasks may enhance students' achievement in an academic domain. In accordance with this view, our main assumption in the present study is that motivation is a contributor to academic achievement through which epistemic beliefs work. Specifically, we set out to test this assumption about mediation by creating a model where the components of the expectancy-value theory of motivation (Wigfield & Eccles, 2000) mediated the effects of different types of epistemic beliefs concerning the justification for knowing on achievement. Because we targeted students' achievement in the domain of science, the motivational components were focusing on students' motivation for understanding what they read in science, in accordance with the current emphasis on the importance of literacy to achievement in science (Webb, 2010; Yore, Bisanz, & Hand, 2003). Likewise, justification for knowing beliefs in this study concerned the justification of knowledge claims in the domain of science. Although several other studies have examined epistemic beliefs in relation to motivation (see Section 1.4), this is the first study that examines expectancies and values as mediating motivational constructs that link different types of justification beliefs to achievement in science.

In the following, we describe a multidimensional perspective on justification beliefs and the expectancy-value theory of motivation, before we briefly review prior research on relationships between expectancy and value components and achievement and between justification beliefs and these motivational constructs. We also include a brief discussion of correlations between the different types of justification beliefs and between the expectancy and value components before we present the hypothesized model that guided our empirical work.

1.1. A multidimensional perspective on justification beliefs

In educational psychology, thinking about epistemic belief dimensions has been heavily influenced by Hofer and Pintrich (1997), who described a system of beliefs about the certainty of knowledge, the simplicity of knowledge, the source of knowledge, and the justification for knowing. According to Hofer and Pintrich (1997), the justification dimension ranges from justification through observation and authority, or on the basis of what feels right, to the use of rules of inquiry and the evaluation and integration of multiple sources.

More recently, Greene, Azevedo, and Torney-Purta (2008) argued that the justification for knowing dimension figuring in Hofer and Pintrich's (1997) conceptualization should be elaborated and differentiated into more than one dimension, especially highlighting separate dimensions of justification by authority and personal justification. According to Greene et al. (2008), a multidimensional perspective on justification beliefs follows from philosophical epistemology, which identifies a number of different sources, both external and internal to the individual, that can be legitimately used to justify knowledge claims. Building on Greene et al. (2008), Ferguson and colleagues used think-aloud (Ferguson, Bråten, & Strømsø, 2012) and questionnaire data (Ferguson, Bråten, Strømsø, & Anmarkrud, 2013) to differentiate three types of sources that students draw on in their effort to justify knowledge claims, with a third dimension reflecting that students consider which claims to believe on the basis of cross-checking, comparing, and corroborating across several sources of information (termed "justification by multiple sources" by Ferguson and colleagues) included in their trichotomous framework along with justification by an external authoritative source and justification by personal opinion, which were highlighted by Greene et al. (2008). This trichotomous justification belief framework also formed the basis for measuring justification for knowing beliefs concerning science in the present study.

Investigating these three dimensions of justification for knowing (i.e., justification by authority, personal justification, and justification by multiple sources) in relation to students' performance when reading conflicting information, Bråten and colleagues (Braasch, Bråten, Britt, Steffens, & Strømsø, in press; Bråten, Ferguson, Strømsø, & Anmarkrud, 2013, 2014; Ferguson & Bråten, 2013; Kendeou, Braasch, & Bråten, 2013; Strømsø, Bråten, Anmarkrud, & Ferguson, 2013) have generally found that beliefs in justification by multiple sources positively and beliefs in personal justification negatively predict performance, with results concerning justification by authority being less consistent. However, no prior study examined potential indirect effects of these three justification belief dimensions on performance.

Thus, while we, in line with recent conceptual and empirical work (e.g., Chinn, Buckland, & Samarapungavan, 2011; Greene & Yu, 2014; Kuhn, Iordanou, Pease, & Wirkala, 2008), acknowledge that science learners may endorse means of justification not captured or specified by the three dimensions that we investigated, our focus on these dimensions were warranted by the need to better understand the mediational mechanisms by which they may influence performance.

1.2. Expectancy and value components of achievement motivation

Broadly speaking, the expectancy-value framework proposed by Eccles, Wigfield, and colleagues (e.g., Eccles, Wigfield, & Schiefele, 1998; Wigfield & Eccles, 2000) assumes that how well students believe they can do on achievement tasks and how valuable they consider those tasks to be directly influence effort, persistence, and performance as well as choices of which tasks to pursue. Accordingly, Eccles et al. (1998) linked the two motivation components of expectancy-value theory to two questions that students can ask themselves: "Can I do this task?" and "Do I want to do this task and why?" The first question captures the expectancy component, with this component being quite similar to Bandura's (1997) construct of perceived self-efficacy,