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Epistemic beliefs and academic performance across soft and hard disciplines in the first year of college

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ABSTRACT

Mature epistemic beliefs underlie higher-order thinking and learning outcomes. Previous studies have established that epistemic beliefs predict task-specific performance. However, there is mixed evidence regarding the relationships between such beliefs and course-level academic performance. This study investigated whether disciplinary type ('soft' versus 'hard') could account for the mixed findings. A survey was conducted among 1366 Indonesian university students enrolled in 'soft' (design, psychology and law) and 'hard' (engineering, biotechnology and pharmacy) disciplines. Beliefs about the uncertainty of knowledge, the subjectivity of knowledge and authority justification were measured before the start of semester. Findings indicated that, while subjectivity belief was not associated with grade point average in the soft disciplines, it negatively predicted it in the hard disciplines. Meanwhile, uncertainty belief, but not authority belief, was positively associated with grade point average in both disciplines. Hence, the relations between some epistemic beliefs and academic performance may depend on the nature of the discipline.

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Personal epistemology; epistemic belief; academic performance; disciplinary difference; higher education

Introduction

Personal epistemology refers to an individual's views, assumptions and beliefs about the nature and justification of knowledge (Hofer and Pintrich 1997). Scholars have proposed several different ways of conceptualising personal epistemology. Some conceptualise it as unitary cognitive structures that follow stage-like developmental patterns (Kitchener and King 1981; Kuhn, Cheney, and Weinstock 2000; Perry [1970] 1999). Although there are variations in the timing (onset) of key transitions in epistemological development proposed by these models, they largely agree on the nature of the developmental stages. Conceptualised as developmental stages, personal epistemology is often studied as a dependent variable which is assumed to be influenced by education and other formative experiences.

Other authors conceptualise personal epistemology in terms of a collection of 'epistemic beliefs', each of which varies from being naïve to more mature. In this view, epistemic beliefs can vary even among individuals within the same age group. Naïve epistemic belief is reflected in the view that knowledge is unchanging and purely objective. On the more mature end, knowledge is seen as evolving and to a certain degree subjective and it is assumed that these more mature beliefs would facilitate learning. This conceptualisation has allowed researchers to examine the influence of epistemic beliefs on learning and achievement (Cano and Cardelle-Elawar 2008; Kardash and Howell 2000; Mason and Gava 2007; Pieschl, Stahl, and Bromme 2008; Schommer, Amy, and Rhodes 1992).

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This study adopts the second conceptualisation to investigate the relationships between epistemic beliefs and academic performance across different disciplines. Given that academic disciplines are underpinned by different assumptions about what counts as valid knowledge (Becher 1981; Donald 2002; Neumann, Parron, and Becher 2002), the relations between students' personal epistemology and their achievement may vary across disciplines. This conjecture is examined through a prospective survey (Tolmie, Muijs, and McAteer 2011, 41) among a sample of first-year college students across 'soft' and 'hard' disciplines (Biglan 1973) in Indonesia. To provide a rationale for this study, as well as a backdrop to discuss its findings, the following sections briefly review (1) the issue of construct definition, (2) how personal epistemology may relate to learning, and (3) disciplinary differences in learning and teaching.

Scope of personal epistemology

One vexing issue in the personal epistemology literature concerns the scope of the construct. Authors disagree on whether personal epistemology should include beliefs about learning and studying. Among those who prefer to include learning beliefs is Schommer (1990). In her model, personal epistemology is comprised of five belief dimensions, two of which are about learning: whether one's ability to learn is fixed or malleable, and whether learning is quick or gradual. Many recent studies have continued to include learning beliefs under their definition and measurement of personal epistemology (e.g. Chan 2011; Jacobson et al. 2010; Magno 2010; Mason and Gava 2007; Olafson, Schraw, and Veldt 2010). In addition, the term epistemic belief has also been used to refer to study behaviour and preferences (Tsai, Tsai, and Hwang 2011), which arguably should be distinguished from the covert mental processes through which new knowledge is constructed. The same overt behaviour (e.g. reading a book) could entail vastly different mental processes.

Other authors have proposed that personal epistemology should be limited to beliefs about knowledge and knowing (Hofer 2008; Hofer and Pintrich 1997; Sandoval 2005, 2009). They argued that beliefs about knowledge should not be conflated with beliefs about the processes by which individuals acquire knowledge. Hence, Hofer and Pintrich's model of personal epistemology covered only four dimensions. They described these in terms of two beliefs about the nature of knowledge (i.e. whether knowledge is simple or complex, and whether it is certain or uncertain), and two beliefs about knowing (i.e. whether knowledge is obtained directly from observation and authority versus constructed by individuals, and whether knowledge claims should be justified by authority versus through a process of critical evaluation).

These authors acknowledged the potentially intimate relations between beliefs about learning and knowledge (Hofer and Pintrich 1997; Sandoval 2005). However, they argued that there is a need to distinguish between the two beliefs because conflating them would hinder empirical and conceptual progress (Sandoval 2009). For one thing, the conflation between the various facets of epistemology may partially explain the low internal consistencies of many survey instruments (Debacker et al. 2008). Furthermore, using the same term to refer to different constructs may result in unnecessary misunderstandings between authors in the field.

The present study also limits the term personal epistemology to refer to beliefs about knowledge. This choice is also motivated by the observation that beliefs about learning and beliefs about knowledge seem to relate differently to academic achievement. The link between beliefs about learning and academic achievement is relatively robust. Prior research has consistently found that academic achievement is positively correlated with stronger belief that learning is gradual and that the ability to learn is malleable (Blackwell, Trzesniewski, and Dweck 2007; Dupeyrat and Marine 2005; Schommer, Crouse, and Rhodes 1992; Schommer et al. 1997; Schommer-Aikins, Duell, and Hutter 2005). This relationship between learning beliefs and achievement is typically explained in terms of motivational dynamics. Students who believe that learning is gradual are willing to invest more time and energy, especially when faced with challenging tasks. Furthermore, those who believe that the ability to learn is malleable are more persistent because they tend to attribute setbacks to unstable causes such as lack of effort and luck (Aditomo 2015; Hong et al. 1999; Robins and Pals 2002; Weiner 1985). However,

the link between beliefs about knowledge (i.e. epistemic beliefs) and academic achievement is much less consistent. This is discussed in the next section.

Epistemic beliefs and academic achievement

A number of authors have postulated that epistemic beliefs can influence learning processes and outcomes (Hofer and Pintrich 1997, 2002; Moshman 1998, 2011; Muis 2007). If beliefs about learning influence achievement via motivational processes, the mechanisms by which epistemic beliefs influence achievement are more cognitive in flavour. Moshman (1998), for instance, defined reasoning as deliberate acts of inference which are constrained by epistemic standards, i.e. beliefs about what counts as valid knowledge. Hence, higher-order thinking requires the activation of appropriate epistemic beliefs. Similarly, Muis (2007) suggested that epistemic beliefs are part of the cognitive and affective resources that are activated when learners attempt to construct a definition of a task. Once activated, epistemic beliefs influence the goals and standards that learners use to monitor progress (Dahl, Bals, and Turi 2005; Muis 2008; Ryan 1984). In addition, mature epistemic beliefs are postulated as a part of individuals' affective disposition to engage in rational thinking (Stanovich 2009; Stanovich and West 1997).

Consistent with the aforementioned theories, there is evidence that personal epistemology is related to the outcomes of specific tasks. This is demonstrated, for instance, in a number of pioneering studies by Schommer and her colleagues. In one study, Schommer (1990) asked college students to draw conclusions from argumentative texts presenting different views on some issues. Belief in 'certain knowledge' was found to predict overly simplistic conclusions. Another study found that belief in simple knowledge predicted poor comprehension of a statistics text (Schommer, Amy, and Rhodes 1992).

Other studies using different methods have also found links between aspects of personal epistemology and task-specific performance. For example, an interview study found that one of the key differences between the reasoning of experts/scientists and novices/students about scientific conclusions was the epistemic criteria they employed to justify claims (Hogan and Maglienti 2001). A case study demonstrated that a university student's difficulty in learning physics stemmed largely from her belief that everyday knowledge is irrelevant for physics reasoning (Lising and Elby 2005), while an experimental study showed that eigth-graders who believed that knowledge is uncertain and complex learned more from a reading exercise compared to their peers holding less mature beliefs (Mason and Gava 2007).

Going beyond studies of learning in specific tasks, it is surprising to find that only few studies have examined the relationship between epistemic beliefs and overall academic performance. The relatively little evidence paints a mixed picture regarding the link between epistemic beliefs and measures of overall achievement. Studies with secondary school students have found that belief in simple knowledge and in certain knowledge predict grade point average (GPA), albeit weakly (Cano 2005; Schommer 1993). A study with college students found a stronger link between epistemic belief in simplicity and certainty of knowledge and GPA for psychology majors (Hofer 2000). Other studies, however, found no relationship between those facets of epistemic beliefs and overall academic achievement (Cano and Cardelle-Elawar 2008; Schommer-Aikins, Duell, and Hutter 2005).

One possible explanation for the mixed finding is that the relationships between epistemic beliefs and overall academic achievement depend on the nature of the discipline. Because academic disciplines differ in their assumptions about what counts as valid knowledge and the standards of justification that are accepted (Becher 1981, 1987), different disciplines may attract students with a certain type of epistemic beliefs (Trautwein and Ludtke 2007), and may also be more 'hospitable' to different sets of epistemic beliefs. The present study extends current research on the links between epistemic beliefs and academic performance in college by considering this possibility in the context of a Southeast Asian culture.

Disciplinary differences in learning and teaching

This study draws upon Biglan's conceptualisation of academic disciplines to develop conjectures on how the disciplines may influence the relationships between epistemic beliefs and achievement. Biglan

(1973; see also Smart and Elton 1982) identified different intellectual clusters within the academic community, which varies along the dimensions of 'soft–hard', 'pure–applied' and 'life–nonlife'. The 'soft–hard' dimension has to do with the extent to which a discipline recognises a common paradigm in the Kuhnian sense of the term (Kuhn 1996). Soft disciplines are characterised by the existence of multiple competing paradigms (e.g. psychology, sociology, anthropology), while hard disciplines are characterised by a single dominant paradigm (e.g. physics, chemistry, biology). The 'pure–applied' dimension refers to whether a discipline's intellectual activity is geared towards advancing our understanding of the world ('pure', e.g. physics, anthropology) or developing solutions to practical problems ('applied', e.g. engineering, accounting). The 'life–nonlife' dimension is related to the object of study, whether a discipline studies living (e.g. biology) or nonliving systems (e.g. physics).

Most studies examining disciplinary differences in teaching practices have focused more on the 'soft–hard' dimension compared to the other two (Neumann 2001). The curricula of hard disciplines are more tightly structured than those in soft disciplines (Donald 1983). In terms of educational objectives, hard disciplines tend to emphasise the mastery and application of 'facts', principles and concepts (Braxton 1995). Soft disciplines place stronger emphasis on broader knowledge and thinking skills, as well as oral and written communication (Braxton 1995; Hativa 1995). These differing goals are reflected in the modes of assessment. While all disciplines use written examinations, the hard disciplines favour weighted examinations, the use of multiple-choice items and practical work. Soft disciplines, on the other hand, give preferences to continuous assessment and more often employ essays, short-answer questions, project reports and oral examinations (Neumann 2001; Smart and Ethington 1995).

Research has also uncovered disciplinary differences in terms of teaching methods and modes of supervising research students (Neumann 2001; Neumann, Parron, and Becher 2002). While lectures are universally employed, lab-based practicum and field trips are favoured in hard disciplines, and tutorials and seminars are more often employed in soft disciplines (Ballantyne, Bain, and Packer 1999). The supervision of research students also shows disciplinary differences. The hard disciplines typically use a group-based apprenticeship model of supervision, where the student's research is closely tied to the supervisor's projects. Meanwhile, the soft disciplines more often employ an individual apprenticeship model, where the student's research is not necessarily closely tied to the that of the supervisor (Neumann 2001; Neumann, Parron, and Becher 2002).

In short, these findings suggest that the underlying epistemology of the disciplines is systematically reflected in academics' teaching preferences and practices. If this is the case, then it is also plausible that the teaching and assessment regimes of different disciplines 'favour' different sets of epistemic beliefs. For example, instead of assuming that a belief in the uncertainty, complexity and subjectivity of knowledge is beneficial across all disciplines, it may be that, for hard disciplines, such beliefs may hinder or at least not facilitate students' learning. For hard disciplines, the existence of a common paradigm also means that there are common figures that are widely accepted as authoritative sources of knowledge. Hence, for those disciplines, an overly critical stance towards scientific authority may not facilitate learning. Furthermore, in hard disciplines, there are standard experimental paradigms, measurements and ways of interpreting data, rendering knowledge as more objective than in soft disciplines, where the definitions and ways of observing core phenomena are sometimes contested. In psychology, for instance, there are competing theories about important phenomena such as 'basic psychological needs', 'normal behaviour' and 'learning'. Consequently, believing that knowledge is objective may lead students to think that there is little need to study a phenomena from various perspectives. This may be beneficial for students in soft disciplines, but detrimental for those studying hard disciplines.

Overview of the current study

The present study is motivated by the limited and mixed findings regarding the relationship between beliefs about knowledge and academic performance. Whether or not beliefs about knowledge relate to learning and performance warrants further investigation. On the one hand, epistemological maturity is considered a key element of university students' intellectual development (Perry [1970] 1999).

On the other hand, the mixed findings suggest that beliefs about knowledge considered to be more mature do not always manifest in better academic performance. The present study examines one possible explanation, which is that the relationships between epistemic beliefs and performance may be systematically linked with differences in academic disciplines. Note that, while Biglan (1973) described three dimensions along which disciplines could differ (soft–hard, pure–applied and life–nonlife), the present study examines only the soft–hard dimension. This focus is based on findings of prior studies that suggest a link between the soft–hard dimension and variations in teaching practices and, hence, possibly, learning processes and student achievement.

To measure epistemic beliefs, this study uses an instrument based on a model of personal epistemology developed by Greene (2007). Factor analytic studies using the instrument of the original developers (Greene, Torney-Purta, and Azevedo 2010), as well as others (Aditomo 2014), indicated it requires modification, especially pertaining to the simple/certain knowledge dimension. The current study uses a modified version that includes three dimensions. The first is called 'certainty belief' and concerns whether knowledge in a discipline/field changes over time. The second is based on the 'personal justification' dimension of Greene's (2007) original model. In the modified version, it focuses on the belief that whether what counts as valid knowledge depends on the perspective of the knowing subject, and therefore needs to be personally constructed. The opposite pole in this dimension represents a belief that knowledge is objectively knowable, independent of the subject's perspective, and therefore demands no active construction on the part of the knower. As such, the dimension is re-labelled here as 'subjectivity belief'. The third dimension is 'authority belief' and retains the original meaning of the view that authority can be trusted to justify knowledge claims.

Following prior theorisation, maturity in personal epistemology is reflected in a stronger belief that knowledge is uncertain/changing and to some degree subjective. Maturity is also reflected in the belief that claims, even those from seemingly authoritative sources, need to be critically evaluated. Maturity in epistemic beliefs should be related to better academic performance. Going beyond this generic prediction to consider the epistemological variation between disciplines, a different pattern of association is proposed for hard disciplines. Because of the acceptance of a unifying paradigm in hard disciplines, the belief in uncertain/complex knowledge, in the subjectivity of knowledge and scepticism towards authority do not necessarily aid students' academic performance. Indeed, because hard disciplines contain a large body of widely accepted factual knowledge, believing that knowledge is certain/simple and objective, and also relying on authority as a source of knowledge, may be beneficial. In other words, for hard disciplines, the associations between dimensions of personal epistemology and overall academic performance should go in opposite directions – or at least be weaker – compared to soft disciplines.

Based on the previous discussion, the present study addresses the following question: does the relationship between epistemic beliefs and academic performance depend on whether a student is studying a soft or hard discipline? In this study, the 'soft–hard' dimension is operationalised in terms of the programme/department in which students are enrolled. The soft discipline cluster was represented by the departments of design, psychology and law; while the hard discipline cluster was represented by the departments of pharmacy, engineering and biotechnology.

Method

Study design

To predict academic performance at university, the study followed a prospective survey design. Unlike cross-sectional surveys, a prospective survey is conducted in two stages to ensure temporal ordering between the predictor and criterion variables (Tolmie, Muijs, and McAteer 2011, 41). A questionnaire was distributed during the third day of orientation week (prior to the start of the first semester) to collect information on students' demography, epistemic beliefs and other psychological variables. The purpose of the study was explained and students were asked to complete the questionnaire at their convenience. Completed questionnaires were collected during the fourth and fifth days of orientation

Table 1. Participants' demographic information.

Variable	Levels	Frequency	%
Age	16 years	6	0.4
	17–19 years	1317	97.3
	20–23 years	31	2.3
Gender	Male	557	40.8
	Female	808	59.2
Ethnicity	Chinese	589	44.4
	Javanese	530	39.9
	Other	207	15.7
Father's education	High school or below	738	54.0
	Diploma or undergraduate degree	500	36.6
	Postgraduate degree	127	9.3
Mother's education	High school or below	835	61.1
	Diploma or undergraduate degree	480	35.1
	Postgraduate degree	50	3.6

week. Participants also completed a number of other instruments unrelated to the present study. High school exit examination grades and first-semester GPA were collected from the university registrar.

Participants and setting

A total of 1366 first-year undergraduate students in a mid-sized, private university in Indonesia participated. They were enrolled in six departments: design (n = 58), psychology (n = 236), law (n = 220), biotechnology (n = 45), pharmacy (n = 394) and engineering (n = 413). These represented, respectively, 88, 89, 82, 94, 88 and 90% of the total number of students enrolled in each department at the end of the first semester. In the Indonesian system, undergraduate students are enrolled in specific academic programmes and generally do not attend subjects outside of them. This means that GPA reflects academic performance related to subjects within each student's study programme/department, as opposed to generic (cross-department) subjects. Participants' demographic information is displayed in Table 1.

Instruments

Three epistemic beliefs were measured using an Indonesian version of Aditomo's (2014) scales. The translated items were trialled by interviewing six undergraduate students who had just completed the scales. Minor adjustments in wording were made. The scales measured the belief that (a) knowledge is subjective (subjectivity belief), (b) knowledge is uncertain (uncertainty belief), and (c) authority verification is a good way to justify knowledge claims (authority belief). Because the purpose was to measure epistemic beliefs at a discipline-specific level (Muis, Bendixen, and Haerle 2006; Palmer and Marra 2004), participants were asked to identify their study programme/department before responding to the epistemic belief questionnaire. They then were asked to think about knowledge in their study programme/department when responding to the items. Participants rated the items along a 7-point agreement scale from 1 (strongly disagree) to 7 (strongly agree). Sample items include 'Knowledge in my field of study is constantly changing' (uncertainty belief), 'In my field of study, what's a fact depends upon a person's point of view' (subjectivity belief) and 'Things written in textbooks in my field of study are true' (authority belief).

Analysis

All psychological scales were checked for internal consistency (the results are presented in Table 2). One 'subjectivity belief' item ('Knowledge in my field of study is objective and does not involve personal opinion') was removed due to its weak correlation (r = 0.1) with other items in the scale. Mean scores were computed from the remaining items, and linear regression was used to examine the relationships

Table 2. Descriptive statistics and internal consistency of the epistemic belief scales.

Variables	Cronbach's alpha	Total sample (N = 1366)		Soft disciplines (n = 514)		Hard disciplines (n = 852)	
		Mean	SD	Mean	SD	Mean	SD
Prior academic achievement	–	44.65	7.55	45.49	6.54	44.14	8.07
GPA	–	2.62	0.92	2.76	0.79	2.53	0.98
Subjectivity belief	0.66	4.93	1.21	5.41	0.98	4.64	1.25
Uncertainty belief	0.63	4.08	1.15	4.31	1.09	3.94	1.17
Authority belief	0.81	5.42	1.02	5.38	1.02	5.45	1.01

Note: Possible ranges: 0–60 for prior academic achievement, 0–4 for GPA and 1–7 for epistemic beliefs.

between epistemic beliefs, discipline type and GPA, while controlling for prior achievement (high school examination score) and demographic variables (age, gender and parental education). Two approaches were employed. The first approach used a three-step hierarchical regression with the total sample. Prior academic achievement, demographic variables and epistemic beliefs were entered in the first step to predict GPA. A dummy variable for discipline type (soft = 0 versus hard = 1) was entered in the second step, and interaction terms between each epistemic belief and discipline type were entered in the third step. The epistemic belief scores were centred on their respective means to facilitate interpretation of possible interaction effects (Keith 2006). In the second approach, simple linear regressions were performed separately for the soft and hard disciplines.

Results

Descriptive statistics for the achievement variables and epistemic beliefs are presented in Table 2.

The results of the three-step hierarchical regression predicting first-semester GPA for the total sample are displayed in Table 3. The Durbin–Watson statistic (1.97) indicates that the assumption of independent errors was met. None of the variables had a variance inflation factor (VIF) statistic above 10, indicating also that no multi-collinearity assumption was met. The histogram and normal probability plot of the residuals indicate that the errors are normally distributed. A graph plotting standardised residuals against standardised predicted values of the regression model indicates that the relationships between the predictors and criterion are linear. The graph also indicates that the homoscedasticity assumption was met.

In the first step of the regression, the predictors explained 16.1% of the students' first-semester GPA (see Table 3). Stronger belief in the uncertainty of knowledge was associated with higher GPA, while stronger belief in the subjectivity of knowledge was associated with lower GPA. Authority belief was not found to be associated with GPA. The addition of discipline type, in the second step, slightly increased the model's predictive power, by 1%, reflecting the fact that GPA was somewhat higher in soft disciplines. The third step added the interaction terms between epistemic beliefs and discipline type. The results show that subjectivity belief negatively predicts GPA in hard, but not soft, disciplines (see Figure 1).

Simple regressions predicting GPA were performed separately for the soft and hard disciplines (Table 4). The results also show that stronger uncertainty belief was associated with higher GPA in both soft and hard disciplines. Stronger subjectivity belief was associated with lower GPA only in hard disciplines.

Discussion

This study explores the relationships between beliefs about knowledge and academic performance in soft and hard disciplines. The findings provide support for the claim that the epistemic beliefs that facilitate performance differ between soft and hard disciplines, at least during the first semester of college. In the following, findings pertaining to each of the three epistemic beliefs are discussed.

Table3. Hierarchical regression predicting first-semester GPA (total sample, $N = 1366$).

Variables	b	SE	β	t	R^2 change (%)	F	VIF
Step 1					16.10	37.21**	
Constant	0.65	0.15		4.23**			
Prior academic achievement	0.04	0.00	0.32	12.67**			1.05
Gender	0.27	0.05	0.14	5.74**			1.02
Father's education	−0.04	0.02	−0.06	−1.87			1.41
Mother's education	0.06	0.02	0.08	2.62**			1.41
Subjectivity belief	−0.10	0.02	−0.14	−4.97**			1.36
Uncertainty belief	0.13	0.02	0.16	5.74**			1.24
Authority belief	0.01	0.03	0.01	0.34			1.24
Step 2					1.00	16.81**	
Constant	0.88	0.16		5.42**			
Prior academic achievement	0.04	0.00	0.31	12.36**			1.05
Gender	0.25	0.05	0.13	5.30**			1.02
Father's education	−0.05	0.02	−0.07	−2.28*			1.41
Mother's education	0.05	0.02	0.07	2.45*			1.41
Subjectivity belief	−0.13	0.02	−0.17	−5.98**			1.36
Uncertainty belief	0.12	0.02	0.16	5.62**			1.24
Authority belief	0.02	0.03	0.02	0.72			1.24
Discipline type	−0.21	0.05	−0.11	−4.10**			1.17
Step 3					0.80	4.16**	
Constant	0.87	0.16		5.31**			
Prior academic achievement	0.04	0.00	0.31	12.26**			1.05
Gender	0.25	0.05	0.13	5.27**			1.02
Father's education	−0.05	0.02	−0.07	−2.31*			1.41
Mother's education	0.05	0.02	0.07	2.42*			1.41
Subjectivity belief	−0.04	0.05	−0.05	−0.87			5.84
Uncertainty belief	0.12	0.04	0.15	3.23**			3.75
Authority belief	0.05	0.04	0.05	1.15			3.60
Discipline type	−0.18	0.05	−0.09	−3.36**			1.26
Discipline X Subjectivity	−0.12	0.05	−0.13	−2.36*			5.13
Discipline X Uncertainty	−0.01	0.05	−0.01	−0.21			3.65
Discipline X Authority	−0.07	0.05	−0.06	−1.29			3.43

Notes: $^{**}p < 0.01$; $^{*}p < 0.05$; Durbin–Watson statistic = 1.97.

Subjectivity of knowledge

The findings indicate that, without taking into account disciplinary differences, stronger belief in the subjectivity of knowledge is moderately associated with lower GPA ($\beta = 0.14$). This finding contradicts the assumption that a mature personal epistemology is marked by the belief that knowledge is subjective. Interestingly, previous studies have also failed to support this assumption. For example, a study of high school students in the US reported by Schommer (1993) found that GPA was weakly related to the belief that knowledge is simple (factual, objective), but this relationship became non-significant when cognitive ability was controlled. Two other studies, one with Spanish secondary school students (Cano and Cardelle-Elawar 2008) and one with US college students (Hofer 2000), also found that belief about the subjectivity of knowledge was unrelated to GPA.

By comparing across soft and hard disciplines, the current study provides further clarification on the nature of the relationship between subjectivity belief and academic performance. Subjectivity belief is found to be associated with GPA in hard, but not soft, disciplines. With a β value of 0.20, subjectivity belief could be considered as having a moderate effect on GPA in hard disciplines (Keith 2006, 62). In this study, its influence on GPA was roughly half as strong as the influence of prior academic achievement (see Table 4). Again, the negative association raises the issue of what counts as a mature epistemic belief with regards to subjectivity of knowledge. This finding suggests that, in hard disciplines, at least in the first semester of college, it is more beneficial to assume that knowledge depends little on one's subjective or personal opinion about an issue. It may be revealing to compare this with the findings of Karimi (2014), who investigated the influence of epistemic beliefs on grammar learning. The author found that, after 20 sessions of an online English course, students with naïve epistemic beliefs became

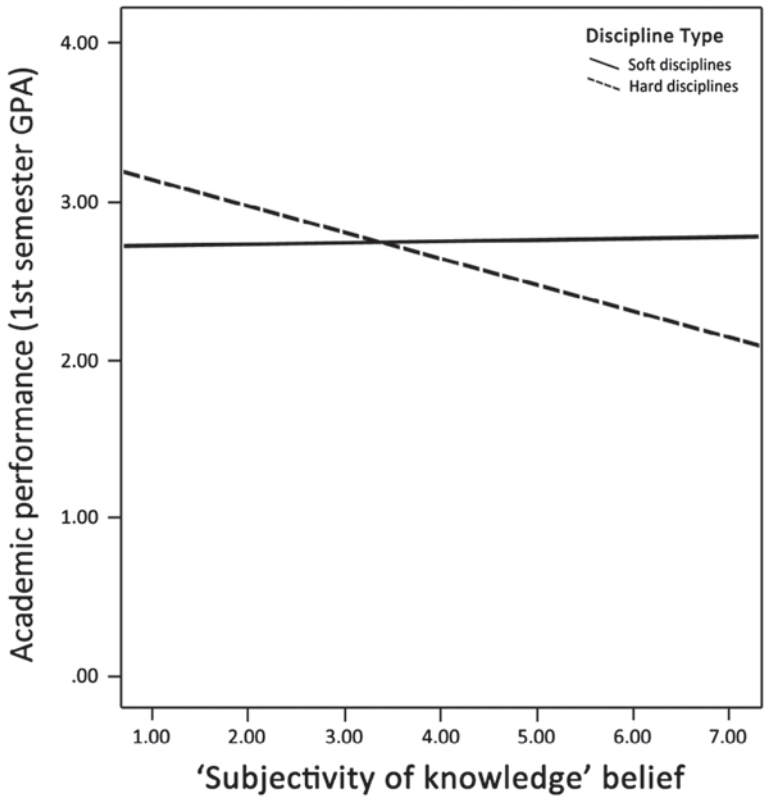

Figure 1. Interaction between subjectivity belief and discipline type in predicting academic performance**.**

Table 4. Regressions predicting first-semester GPA for soft ($n = 514$) and hard ($n = 852$) disciplines.

Variable	b	SE	β	t	R^2 (%)	F	VIF
Soft disciplines					7.3	5.67**	
Constant	1.86	0.26		7.21**			
Prior academic achievement	0.01	0.01	0.09	2.12*			1.03
Gender	0.29	0.07	0.18	4.08**			1.01
Father's education	0.01	0.03	0.02	0.38			1.45
Mother's education	0.04	0.03	0.07	1.27			1.45
Subjectivity belief	−0.04	0.04	−0.05	−1.02			1.44
Uncertainty belief	0.12	0.04	0.17	3.54**			1.25
Authority belief	0.04	0.04	0.05	0.98			1.38
Hard disciplines					21.10	56.79**	
Constant	0.34	0.19		1.78			
Prior academic achievement	0.05	0.00	0.40	12.81**			1.05
Gender	0.23	0.06	0.12	3.78**			1.02
Father's education	−0.08	0.03	−0.11	−3.04**			1.33
Mother's education	0.06	0.03	0.07	2.12*			1.35
Subjectivity belief	−0.16	0.03	−0.20	−6.09**			1.17
Uncertainty belief	0.11	0.03	0.13	3.99**			1.22
Authority belief	−0.01	0.03	−0.01	−0.35			1.21

Note: $^{**}p < 0.01$; $^{*}p < 0.05$; Durbin–Watson statistic was 1.88 for soft disciplines and 2.01 for hard disciplines.

more proficient compared to those with sophisticated beliefs. One can speculate that the nature of the knowledge that is being tested (i.e. grammatical rules) requires students to believe that knowledge is objective and certain. Believing otherwise would not be beneficial for students and may even be counter-productive for their academic performance.

It should be noted that the present finding pertains to academic performance in the first semester. It could be that curricula in the hard disciplines in the current study place more emphasis on 'hard facts' and objective answers, postponing more complex knowledge and open-ended problems for later semesters. Hence, the negative association between subjectivity belief and academic performance may be weakened or altered in later semesters. This is a possibility worthy of further investigation.

Uncertainty/changeability of knowledge

With respect to uncertainty belief, the findings indicate that students who believed that knowledge continues to change tended to obtain higher GPAs. The association was of moderate effect (Keith 2006, 62) in both the hard and soft disciplines ($\beta = 0.16$). This is in line with the theoretical assumption that students who believe that scientific knowledge evolves are also more aware that a given phenomenon could be explained by different concepts and theories. Hence, they should also be more willing to explore different explanations and obtain more comprehensive understanding.

The findings are consistent with those of Hofer (2000), but not with those of Schommer (1993), who found that the belief in 'certain knowledge' did not predict high school GPA when prior ability was taken into account. This inconsistency likely stems from differences in the meaning of the constructs. In Schommer's (1993) study, 'certain knowledge' refers to the belief that scientists can eventually find true knowledge. In contrast, Hofer (2000, 390) conceptualised 'uncertainty belief' in the same way as the current study, i.e. pertaining to whether scientific knowledge changes. This highlights the importance of distinguishing between different facets of what previous studies have referred to as the certainty of knowledge. In this case, beliefs about whether scientific knowledge changes may be more important for learning, compared to beliefs about the attainability of truth.

The relationship between uncertainty belief and GPA was slightly stronger in soft compared to hard disciplines (Table 4), but this interaction was not statistically significant. This interaction hypothesis was based on the reasoning that, because hard disciplines possess a unifying paradigm, the fundamental tenets of those disciplines remain relatively constant except during periods of major paradigm shift (Kuhn 1996). This is consistent with the observation that hard disciplines place a greater emphasis on mastery of facts, concepts and principles (Braxton 1995), and more frequently use tests, with relatively clear-cut boundaries between right and wrong answers (Neumann, 2001, 409). Nonetheless, in those disciplines the body of facts does expand through the application of new methods/tools and the accumulation of new findings. New concepts may also be proposed to shed different light on established 'facts'. Hence, even for hard disciplines, it seems that academic performance would be enhanced by an awareness that scientific knowledge changes.

While the interaction between uncertainty belief and discipline type was not significant, it is worth noting that, in the soft disciplines, uncertainty belief had a larger effect on GPA compared to high school performance. This is noteworthy given that prior academic performance is typically found to be a stronger predictor of future performance compared to many psychological factors, including cognitive ability (Richardson, Abraham, and Bond 2012). This means that students who believe that knowledge is fixed might be disadvantaged and would benefit from interventions targeted at changing their beliefs.

Authority belief

The present study's findings did not support the hypothesis that students who are critical of authority would tend to examine the logic and empirical basis of knowledge claims. The assumption was that students who are critical of authority would also engage in deeper cognitive processes and, as a result, obtain better understanding of curriculum materials. Despite its plausibility, this line of reasoning receives little support from prior studies. For example, in Schommer's studies, the scales under her 'omniscient authority' dimension failed to be identified as a distinct factor (Schommer 1990, 1993; Schommer et al. 1992, 1997; Schommer-Aikins and Easter 2006; Schommer-Aikins, Duell, and Hutter 2005). Hofer's (2000) study, which did identify a distinct 'authority belief' dimension, found that it predicted grades in neither science nor psychology.

There are a number of plausible explanations for the lack of a relationship between authority belief and academic performance. In the context of university study, epistemic authorities (textbook authors and lecturers) generally possess relevant expertise regarding the claims they make. Hence, the claims they make in the context of instruction are generally also trustworthy, at least compared to claims made in public discourse on contentious issues (think, for example, of issues such as climate change or genetically modified food). Moreover, in academic settings, learning outcomes are assessed in terms of how well students' views and understanding align with canonical knowledge that is taught by the lecturers. An overly sceptical stance may be detrimental to performance in formal assessments.

This invites a re-examination of what should count as mature epistemic belief regarding authority justification. To this end, the notion of a 'division of cognitive labour' could be useful (Bromme and Goldman 2014). In modern societies, the complexity and vastness of knowledge means that expertise is necessarily narrow. Consequently, claims to epistemic authority need to be examined contextually. In some special cases, including instructional contexts in university classrooms, the authorities do typically possess the relevant expertise and thus are generally reliable sources of knowledge. But even university lecturers make claims that are beyond their area of expertise. Hence, both overly dogmatic and overly sceptical attitudes toward authority would be detrimental to effective achievement of goals in many contexts. What is important may not be the strength of one's belief about authority as a source of knowledge justification, but rather the ability to distinguish between the expertise of sources of authority and their relevance to particular claims. In other words, epistemic sophistication has less to do with a general sceptical stance towards authority, and more to do with the ability to evaluate the relevance of a source's expertise and the knowledge claim that they are justifying or criticising (Bromme and Thomm 2015).

Conclusions and limitations

Based on the findings discussed above, it can be concluded that epistemic beliefs influence academic performance during the first year of college across many disciplines. This influence, however, depends on the specific belief dimensions under consideration, as well as on the nature of the discipline itself. This suggests some important implications for practice. First, university students and instructors should be aware that epistemic beliefs are a possible source of learning difficulty (or, seen from the opposite point of view, an important resource for learning). For some students, difficulties and setbacks in academic performance may partly stem from a misguided view of knowledge (e.g. that scientific knowledge does not change) rather than simply from deficiencies in ability and/or motivation. This awareness can be empowering for both students and teachers, because beliefs are commonly seen to be a product of socialisation or education, and hence should be easier to change than traits such as cognitive ability.

Second, the findings suggest epistemic beliefs are worthy targets of pedagogical interventions. Previous research shows that epistemic beliefs may predispose students to adopt more productive motives for learning, deeper approaches to studying and better cognitive as well as metacognitive strategies. Hence, reflections on the nature of knowledge and knowing should be an essential part of pedagogical interventions to promote learning and achievement. Such interventions, however, need to be tailored to the epistemological characteristics of particular disciplines. Thus, broadly speaking, it is important for students in hard disciplines to see that scientific knowledge is largely objective. Furthermore, the findings also suggest that students need to understand that knowledge evolves/changes and the implications of this view for study strategies. While this applies to students in both soft and hard disciplines, the practical impact of this latter kind of epistemic intervention may be particularly beneficial for students in soft disciplines.

The current study also has theoretical implications regarding what counts as a 'mature' personal epistemology. The findings contradict the assumption held by most models of personal epistemology, which is that epistemic beliefs exist as polar dimensions, with one pole being more mature than the other. Instead, as some authors have argued (Chinn, Buckland, and Samarapungavan 2011; Louca et al. 2004), it is more likely that what counts as mature epistemic beliefs depends upon context (in this

case, the discipline or programme of study). Thus, stronger belief that knowledge is subjective (i.e. influenced by personal/cultural views and values) is not always more mature, especially for students who are studying in hard disciplines. In addition, overly strong scepticism towards authority may not always be a mature epistemic stance. Further studies are needed to investigate the conditions under which belief in (or scepticism toward) authority is germane for learning and academic performance.

In interpreting these findings, a number of limitations need to be kept in mind. First, academic performance is influenced by many factors, only a few of which were controlled for in the current study. Cognitive ability, for instance, is one factor that is arguably important but not included as a control variable in this study. Furthermore, the current study did not include any variables that may have mediated the influence of epistemic beliefs on achievement (e.g. goal orientation, self-efficacy). Second, readers should also keep in mind that GPA may sometimes be a less than ideal indicator of actual learning, in the sense of mastery/acquisition of new knowledge and skills. Often, GPA may also be reflective of other things such as students' social adjustment and study strategies. Furthermore, university teachers may also employ assessments that fail to measure meaningful learning. Hence, care should be taken when making inferences about the influence of epistemic beliefs on learning from this study. Third, the operationalisation of 'discipline type' in this study was rather coarse and may have masked important epistemological differences between, say, psychology and law, or between biotechnology and engineering. Future studies should attempt to operationalise disciplinary epistemology at a more sophisticated level. Fourth, the current study was conducted with participants from cultural backgrounds not typically studied in relation to epistemic beliefs. Cultural values (e.g. power distance and uncertainty avoidance; see Hofstede 1983) may suppress or promote certain epistemic beliefs and perhaps moderate their influence on academic achievement. Unfortunately, this study was not designed to explore these interesting questions. Despite these limitations, the current findings signal that the study of epistemic beliefs in disciplinary contexts is a worthy endeavour.

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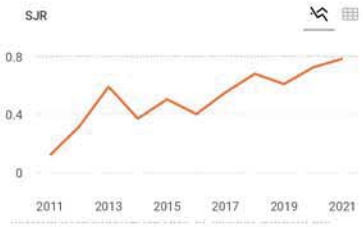
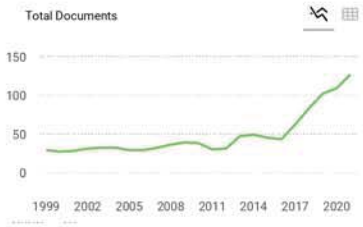
How to publish in this journal

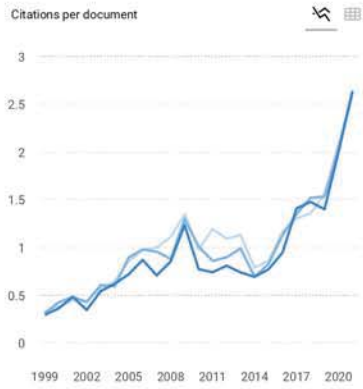
j.rowley@mmu.ac.uk

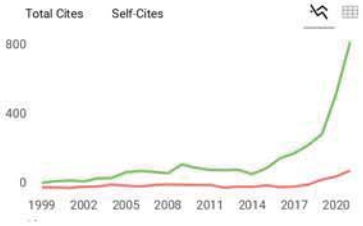
SCOPE

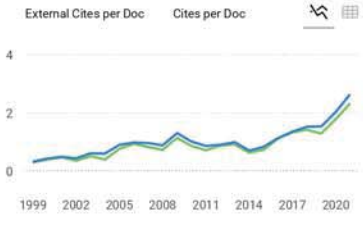
Journal of Further and Higher Education is an international, peer-reviewed journal publishing scholarly work that represents the whole field of post-16 education and training. The journal engages with a diverse range of topics within the field including management and administration, teacher education and training, curriculum, staff and institutional development, and teaching and learning strategies and processes. Through encouraging engagement with and around policy, contemporary pedagogic issues and professional concerns within different educational systems around the globe, Journal of Further and Higher Education is committed to promoting excellence by providing a forum for scholarly debate and evaluation. Articles that are accepted for publication probe and offer original insights in an accessible, succinct style, and debate and critique practice, research, theory. They offer informed perspectives on contextual and professional matters and critically examine the relationship between theory and practice across the spectrum of further and higher education.

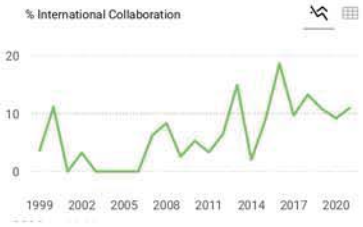


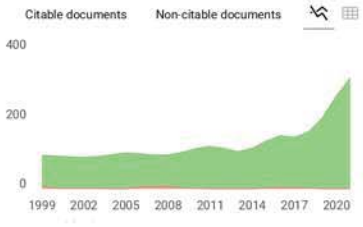


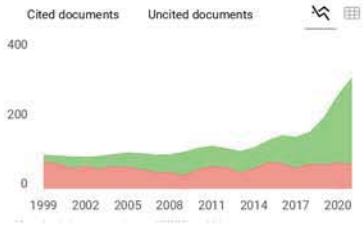












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