

# **Epistemic match: A pedagogical concept for understanding how students fit in to the chosen subject.**

## **Abstract**

Previous studies have suggested that a student's personal epistemological beliefs can be a predictor of their academic performance (Cano, 2005; Hofer, 2000; Schommer, 1993; Stathopoulou and Vosniadou, 2007). The current research aimed to extend this work by exploring whether the disciplinary epistemological beliefs presented to students in their classes and assessments might mediate the relationship between students' personal epistemological beliefs and performance. A comparison of a student's personal epistemological beliefs with the epistemological beliefs presented in their classes and assignments was carried out, establishing the level of '**epistemic match**' between student and discipline. It was expected that epistemic match would be a predictor of a student's performance. 362 first year students from 8 subject disciplines at a UK university completed O'Siochru's (2006) questionnaire measure of personal epistemological beliefs. 38 staff from the same disciplines also completed a questionnaire which was adapted from the original student version to represent a measure of the presented epistemological beliefs in their discipline. The results showed a significant relationship between performance and levels of epistemic match. Closer epistemic match was associated with higher performance. The conclusion is that epistemic match is a reliable predictor of students' performance in their first year.

## **Introduction**

The concept of epistemological beliefs refers to an individual's beliefs regarding knowledge. This would include such things as their beliefs about where knowledge can be found and how to evaluate it. Early research on the concept of epistemology, such as Perry (1970), presented us with a model of epistemological development. This development occurred in stages with each stage comprised of a set of beliefs that were characteristic to that stage. The overall trend of the changes in belief found in these stage theories was from relatively naive beliefs to sophisticated ones; from a simplistic view of knowledge to a complex view, from certainty to relativism and from an unquestioning acceptance of authority to exercising personal judgement (Perry, 1970; King and Kitchener, 1994). Later research by Hofer and Pintrich (1997) and Schommer (1990) challenged this view of epistemology as a developmental process. Instead, they saw an individual's epistemology existing as a set of separate dimensions with each dimension representing a specific epistemological belief. For example, in Hofer and Pintrich's (1997) model they propose four dimensions. The first dimension, 'Certainty', represents the degree to which we believe knowledge to be either fixed and unchanging or fluid and changeable. The second dimension, 'Source', represents the degree to which we believe knowledge to originate either inside ourselves or outside from authority sources. The third dimension, 'Simplicity', represents the degree to which we believe knowledge to be either a collection of separate facts or a series of interconnected concepts. Finally the fourth dimension, 'Justification', represents the degree to which we believe that knowledge can be evaluated either by direct experience and authority or by some form of rules of evaluation. In contrast to the stages proposed by the developmental theorists

the beliefs theorists proposed that while an individual's epistemological beliefs does change, this development does not follow any pre-determined path.

Another area of debate in the research on epistemology concerns the domain-specificity of an individual's epistemology. Early studies presented the image that an individual's epistemology is domain-general and does not vary depending on the domain of knowledge those beliefs were being applied to (Perry, 1970). Other researchers (e.g. Hofer and Pintrich, 1997) have suggested that the epistemological beliefs being utilized by an individual might be related to the domain of knowledge to which those beliefs were being applied. This theory would suggest that there will be a similarity between the epistemological beliefs of two individuals dealing with knowledge from the same knowledge domain. Consequently, a group of students that are all studying the same subject might be expected to have similar epistemological beliefs regarding knowledge in that subject.

### ***Epistemological beliefs and performance***

It has been argued that the level of sophistication of a student's epistemological beliefs can be a reliable predictor of their academic abilities. This view of 'sophistication' in epistemological beliefs originated with the stage theories which saw beliefs as developing from naive to sophisticated (Perry, 1970). The dimensional theories retained the concept of sophistication typically viewing one end of each belief dimension as more sophisticated than the other. For example, in Hofer and Pintrich's (1997) 'certainty' dimension the belief that knowledge is fixed would be seen as less sophisticated than the belief that knowledge is changeable. Researchers have found links between a student's

epistemological sophistication and their study strategies (Hofer and Pintrich, 1997), their study orchestrations (Rodriquez and Cano, 2006) and their cognitive strategies (Kardash and Howell, 2000). The more sophisticated the student's epistemological beliefs the more sophisticated their capability in the associated academic ability. However, the relationship between epistemological sophistication and educational performance is not always so clear cut. A number of studies have proposed a link between epistemology and grade performance, typically suggesting that higher levels of sophistication in the student's epistemological beliefs are associated with higher grades (Cano, 2005; Hofer, 2000; Schommer, 1993; Stathopoulou and Vosniadou, 2007). And yet, this relationship does not appear to be a reliable one. Most of these studies have only found evidence of a relationship between certain specific epistemological beliefs and performance. Furthermore, there is disagreement between the studies as to which of the dimensions of epistemological beliefs it is that predicts performance. Cano (2005) found that beliefs regarding the speed of learning and the simplicity of knowledge both predicted performance. Schommer (1993) also found a significant relationship between performance and beliefs regarding the speed of learning but not beliefs about the simplicity of knowledge. By contrast, Hofer (2000) and Stathopoulou and Vosniadou (2007) both agree with Cano that beliefs in the simplicity of knowledge predict performance but they add that beliefs in the certainty of knowledge also predict performance. However, Trautwein & Ludtke (2006) found no significant relationship between beliefs regarding the certainty of knowledge and performance.

One possible reason for these inconsistencies in establishing a clear relationship between beliefs and performance is that the previous studies in this area have not taken

into account the full impact of domain-specificity in epistemological beliefs. In the same way that disciplines differ in terms of their epistemological beliefs they may also differ in terms of what they consider to be a sophisticated belief. Schommer-Atkins (2002) made this point when she suggested that the sophistication of an epistemological belief may be context dependent. In her view no single set of epistemological beliefs could be said to be sophisticated in all contexts. Her alternative was to suggest that the sophisticated learner was the one who maintained balance between changing some beliefs and maintaining others depending on what the context demanded. In an academic setting the different contexts are likely to translate as different disciplines each with their own demands in terms of the knowledge and skills a student of that discipline is expected to demonstrate. If we want to identify the epistemological beliefs that are likely to succeed in any given discipline we first need to know what that discipline is demanding. In other words, if we wish to link epistemological beliefs to performance we need to look at how those beliefs match the demands of the discipline being studied.

***Presented epistemological beliefs***

This raises the question of how to quantify the demands of a discipline. Neumann (2001) suggested that the demands of a discipline might be determined by the epistemological beliefs of academic staff responsible for selecting the content and setting the assignments in that discipline. Unfortunately, the research linking staff epistemological beliefs to their approach to teaching and classroom practices is somewhat equivocal. Several studies have supported the view that a teacher's personal epistemological beliefs will have an impact on their approach to teaching that discipline (Kang and Wallace,

2005; Lawson, Fazez and Clancy, 2006). Other research has found that in some cases teachers' personal epistemological beliefs were not being reflected, or even contradicted by their classroom practices (Hofer & Pintrich, 1997; Olafson & Schraw, 2006). One explanation for this is that contextual constraints, such as curriculum, policy and traditions in teaching might cause teachers to use methods not in alignment with their epistemological beliefs (Kang, 2007; Norton, Aiyegbayo, Harrington, Elander and Reddy, 2010).

Consequently, we might be better off looking for evidence of a discipline's demands and expectations by looking at the epistemological beliefs built into the assessments and delivery of that discipline. As Entwistle and Smith (2002 ) put it, the teaching and assessment methods used in the classroom often present explicit and implicit cues about the "target understanding" that the teachers require of their students. One example of this are "threshold concepts" (Meyer and Land, 2005), key theoretical concepts within a discipline that a student needs to grasp before they can fully understand the discipline. In other words, how the teachers deliver and assess a discipline will tell the students what kind of epistemological beliefs are appropriate to that discipline. A number of researchers have been interested in looking at the presented epistemological beliefs found in lectures or assessments (Hofer, 2004; Kang, 2007; Langer, 1994). Hofer (2004) found evidence of what she considered to be implicit epistemological beliefs present in the materials of a first year university course. She suggests that these presented beliefs might influence the beliefs of the students themselves as well as influencing their learning strategies, motivation and achievement in the discipline.

### ***Epistemic match***

Using these presented epistemological beliefs found in the delivery and assessment of a discipline it would be possible to look at the level of compatibility between student beliefs and those presented beliefs, a concept we can refer to as epistemic match. A student's personal epistemological beliefs guide their study strategies enabling them to locate and process the knowledge they need to complete their assessments (Hofer and Pintrich, 1997). Therefore, a student whose beliefs closely match the beliefs implicitly underpinning their assessments will be able to locate the knowledge that best suits the requirements of the assessment resulting in higher grades. Consequently, it is predicted that compatibility between student personal epistemological beliefs and the presented epistemological beliefs of a discipline will predict that student's performance in the discipline.

A secondary aim of the current research was to compare epistemic match and epistemological sophistication as predictors of academic performance. Based on the findings of studies such as Cano (2005), Hofer (2000), Schommer (1993) and Stathopoulou and Vosniadou (2007), the expectation would be to find a significant positive relationship between a student's performance and their scores on one or more of the belief dimensions. However, this approach of focusing on an individual's belief scores directly does not take into account the compatibility of those beliefs with the discipline being studied. Consequently, it is expected that the relationship between performance and epistemic match will be stronger than that of the relationship between performance and epistemological beliefs.





## **Method**

### ***Participants***

A total of 362 university students recruited from eight academic disciplines participated in the study. All were in the first year of their university degree in the same university. Their ages ranged from 17 – 46 ( $M = 20.8$ ;  $SD = 2.54$ ) with 137 men and 225 women making up the sample. Students were initially recruited through opportunity sampling by being approached at the beginning of one of their lectures in the relevant discipline. Ultimately, only those students who received final grades of 40 and above in their discipline were retained as participants in this study. This decision was based on the research of Kember and Harper (1987) who suggested that the factors which explain the difference between passing and failing students are not the same as the factors which explain the variation in grades of pass and above.

A total of 38 staff participated in the study. All staff participants came from the same university and from the same disciplines as the students. The sample was comprised only of those members of staff in each discipline that were responsible for teaching the first-year classes in that discipline. Although this approach limited the number of staff that were eligible to participate in some disciplines this was a necessary limitation. It was not the intention of the current research to establish the wider epistemological beliefs in each of the disciplines participating in the study. Only the epistemological beliefs that were presented to the first-year students in their classes and assessments were of interest. Consequently, only those staff directly involved in teaching and assessing the first-year students were included. The breakdown of staff and students participants from each discipline is summarised in Table 1.

Table 1. Number of students and staff participating organised by academic discipline

Discipline	Students			Staff		
	Total <sup>a</sup>	Participated	Response Rate	Total <sup>b</sup>	Participated	Response Rate
Psychology	194	74	38%	6	6	100%
Sociology	126	49	37%	10	10	100%
Health studies	54	29	54%	4	4	100%
English language	72	42	58%	4	4	100%
English literature	104	62	60%	2	2	100%
Law	66	23	35%	3	2	66%
Theology	54	31	57%	4	4	100%
Sports studies	240	52	22%	8	6	75%
<b>Total</b>	<b>910</b>	<b>362</b>	<b>40%</b>	<b>41</b>	<b>38</b>	<b>93%</b>

<sup>a</sup> Numbers of students enrolled on the first year of that course. <sup>b</sup> Numbers of staff involved in delivering the first year course.

### ***Materials***

The Personal epistemological beliefs measure (PerEB) used was O'Siochru's (2006) domain-specific epistemological beliefs measure which contained eighteen statement items. Each item was represented by a statement and a five-point Likert scale, ranging from 'Strongly Agree' scoring 5 to 'Strongly Disagree' scoring 1. The 18 items produce three dimensions; (1) "certainty", (2) "justification: personal", and (3) "source: authority". An example of an item from the certainty belief dimension is, "In assessments in this subject, most questions have only one right answer". The scores for all of the items belonging to the same belief dimension were summed to produce a total for that dimension. A high score indicated that the student held the positive form of that

belief. Thus, a high score in the 'source: authority' dimension would indicate that the student believed that knowledge in their discipline was determined by external authority sources. A high score in the 'certainty' dimension would indicate that the student believed that knowledge in their discipline was certain and rarely changes. A high score in the 'justification: personal dimension would indicate that the student believed that judging the authenticity of knowledge is the personal responsibility of each individual. In terms of the psychometric properties of this measure the Cronbach's alpha coefficients for the three dimensions were 0.66, 0.57 and 0.52 respectively, which are low but comparable to other measures of this type (see Hofer 2000). A confirmatory factor analysis showed that goodness-of-fit scores for the measure as a whole were as follows; RMSEA = 0.068, GFI = 0.92, CFI = 0.93 (O'Siochru, 2006).

An additional two questions were included as measures of two control variables. The first question asked the student to indicate the number of places where they had studied this discipline prior to taking it in this university. The second question asked the student to estimate how many hours of study they completed in that discipline on an average week.

In order to measure the presented epistemological beliefs found in assignments and classes the Presented epistemological beliefs measure (PresEB) was completed by the staff in each discipline. To create this measure the 18 items of the personal epistemological beliefs measure (PerEB) were reworded with the new wording asking each staff member if they felt that a particular belief had been reflected in the first-year lectures and assessments for that discipline. The items in the presented epistemological beliefs measure (PresEB) were scored and totalled in the same way as those in the

personal epistemological beliefs measure (PerEB) in order to produce the same three dimensions in both measures.

### ***Procedure***

Prior to data collection the research was first reviewed and cleared by the ethics review board of the participating university. This ensured that the ethical principles of informed consent, confidentiality, protection from harm and the right to withdraw were all adhered to.

With regard to the student personal epistemological beliefs data, the researcher (first author) approached the students in the sixth week of term in their first year. The Personal epistemological beliefs measure (PerEB) was completed by the students at the start of their weekly lecture. Student performance data was collected at the end of the academic year. A section on the personal epistemological beliefs measure asked the students for permission to access this data for the purposes of the study.

Around the same time the presented beliefs of each discipline were measured by approaching each staff participant separately and asking them to complete the presented epistemological beliefs measure (PresEB). It was made clear that they should respond to each item with regard to the epistemological beliefs that were present in the delivery and assessment of their discipline and not to their own personal epistemological beliefs. They were also asked to focus exclusively on their own teaching and not to try to factor in any estimates of what was being reflected in the teaching of any other staff.

### *Design*

A within-participants design was employed. The predictor variables were the student's epistemological beliefs and epistemic match on the three dimensions of epistemological belief; (1) "certainty", (2) "justification: personal" and (3) "source: authority". The 'certainty' dimension represents the degree to which the student believes knowledge is certain and unchanging. The 'justification: personal' dimension represents the degree to which the student believes they must decide for themselves on what qualifies as valid knowledge. The 'source: authority' dimension represents the degree to which the student believes that the validity of knowledge is determined by external authorities.

The outcome variable was the student's academic performance. This variable was represented by their final grade in the discipline, a weighted average of all the individual assignment grades that the student had achieved in that discipline that year. In the participating university the final grades of each student are standardised into grade bands. All actual grades that fall within the same grade band are converted into a single standardised grade, represented by a letter grade and standardised percentage score. These bands can be seen in Table 2.

Table 2. Grade bands with their associated letter grade and standardised percentage score.

Grade Band	Standardised Letter Grade	Standardised Grade Score
73-85	A+	85
69-72	A-	72
63-68	B+	68
59-62	B-	62
53-58	C+	58
49-52	C-	52
43-48	D+	48
40-42	E	42

In addition to the experimental variables two control variables were included. These were the "number of prior study occasions" and the "hours of study". The selection of these control variables was based on previous research looking at factors that influence academic performance (Cacioppo, Petty, Feinstein and Jarvis, 1996; Wood and Kardesh, 2002).

## Results

Before the analyses could be carried out it was first necessary to calculate the epistemic match scores for each student. The scores for each staff member within a given discipline were averaged to create a mean score for that discipline on each of the three belief dimensions. These mean scores represented the epistemological beliefs that had been presented in the classes and assessments of that discipline. The belief scores for

each student were compared to their discipline's mean scores. The difference between the two scores, represented as an absolute value, was calculated for each of the three belief dimensions. A high score here indicated a low level of match signifying that the student's beliefs had been very different from the presented beliefs in the discipline.

***Performance and Epistemic Match***

In order to study the relationship between students' epistemic match, epistemological belief and performance a multiple linear regression was used. Each of the student's epistemic match scores and personal epistemological belief scores were entered as separate predictor variables. "Number of prior study occasions" and "hours of study" were also included as predictors. The outcome variable was the performance score. The results of the regression are summarised in Table 3.

Table 3. Summary of the regression analysis for variables predicting final grade in first year university students (N=362).

Variable	B	SE B	$\beta$
Certainty Match Score	-1.548	.474	-.393**
Justification Match Score	-.239	.280	-.056
Source Authority Match Score	-.557	.311	-.148
Certainty Factor Total	.766	.422	.248
Justification Personal Factor Total	.185	.253	.049
Source Authority Factor Total	.168	.265	.059
Previous study occasions	-.858	.628	-.077
Number of hours personal study per week	.180	.086	.118*

Note: \*  $p < .05$ ; \*\*  $p < .01$

The model explained a significant amount of variance in the students' final grade,  $F(8; 302) = 4.818, p < .001 (R^2 = .09)$ . Only two of the predictors, the certainty match score

and number of hours study significantly predicted the outcome variable of performance. There was a negative relationship between certainty match and performance ( $\beta = -.393$ ,  $p = .001$ ) indicating that lower scores in epistemic match are associated with higher scores performance and vice versa. Since lower scores in epistemic match indicate a better match this result would appear to confirm that a good epistemic match with a discipline is associated with higher levels of performance in that discipline. Conversely, the relationship between hours studied and performance was positive ( $\beta = .118$ ,  $p = .037$ ) indicating that higher numbers of hours studied are associated with higher performance scores. We can see these relationships in Figure 1.

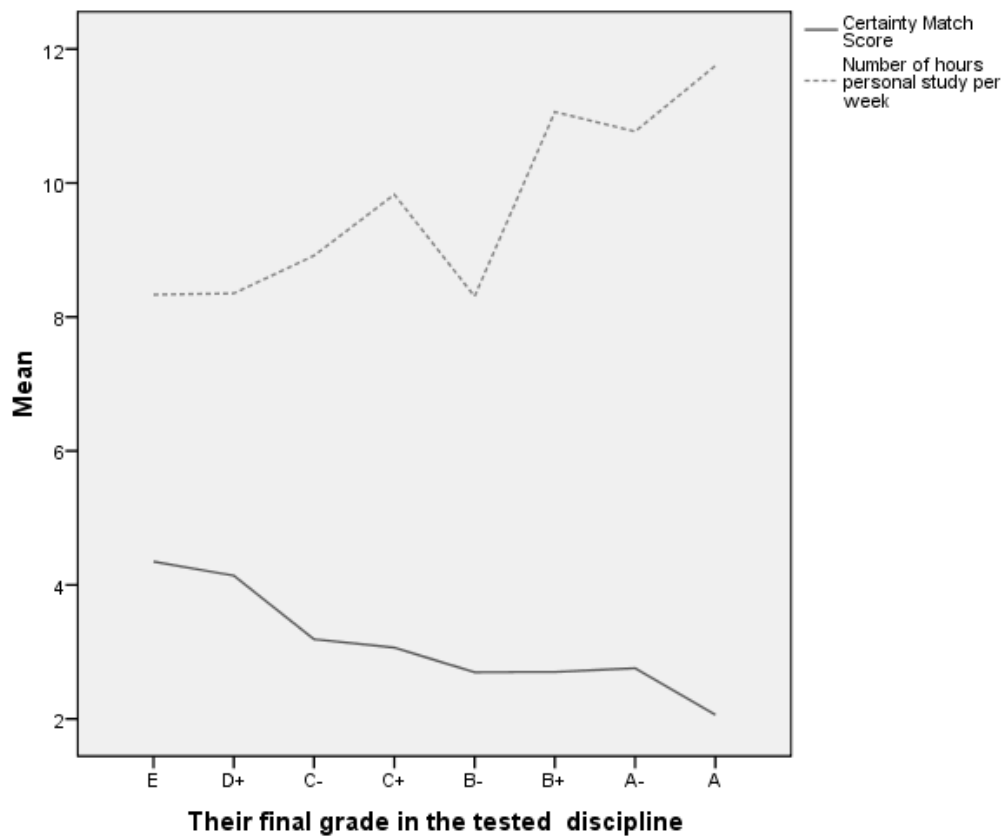


Fig 1. Mean certainty match scores and number of hours studied per week presented across standardised module grade Bands



The results also show that there was no significant relationship between a student's scores on the three dimensions of epistemological beliefs and performance. This would suggest that the level of sophistication of a student's epistemological beliefs is not a reliable predictor of their performance in that discipline.

### **Discussion**

The first part of the analysis looked at the relationship between epistemic match and performance. Epistemic match was measured by comparing the students' personal epistemological beliefs with the presented epistemological beliefs found in their classes and assessments. The results showed that higher levels of performance corresponded with a better epistemic match between the student's personal epistemological beliefs and the presented epistemological beliefs in that discipline. This result supports the view that epistemic match is an indicator of the 'fit' between student and discipline and a reliable predictor of performance.

The analysis also found that while epistemic match was a predictor of performance, epistemological sophistication was not. This failed to support previous research which suggested that there would be a significant relationship between a student's score on at least one of the dimensions of their personal epistemological beliefs in a discipline and their performance in that discipline (Cano, 2005; Hofer, 2000; Schommer, 1993; Stathopoulou and Vosniadou, 2007). The most likely explanation for this result from the perspective of the current research is that the attempts to link epistemological beliefs directly to performance do not take into account the compatibility between the beliefs and the discipline. As Schommer-Atkins (2002) pointed out, it is unlikely that one set of beliefs could be well suited to the requirements

of all disciplines. Future research exploring the link between student epistemological beliefs and performance needs to take into account the suitability of those beliefs by comparing them with the presented beliefs of the discipline that student is studying.

### ***Revising the presented beliefs measure***

The presented epistemological beliefs (PresEB) measure was developed from the existing personal epistemological beliefs measure (PerEB) in O'Siochru (2006). However, a number of potential issues relating to this measure emerged during the current research. There may have been some uncertainty among the staff regarding how to respond to the items in the presented beliefs measure. Some staff may have responded based on their perception of what beliefs were reflected in their classes whereas others may have responded based on their perception of what beliefs were actually adopted by the students as a result of those classes. A possible alternative to this staff measure would be to ask the students what epistemological beliefs had been presented in their lectures and assessments as well as asking them what their personal epistemological beliefs were (d'Appolonia and Ambrami, 1997). In future, it may also be interesting to investigate any similarities in the presented beliefs for the same discipline taught in different universities and whether they represented a form of "epistemic philosophy" for that discipline in general.

### ***Practical applications and future research***

It is important to remember that it cannot be determined from these results if a student's level of epistemic match was the cause of their level of performance. However, the

student's epistemological belief scores which are the basis for the epistemic match scores were measured well before the end of the first semester. This means that these scores were taken before the majority of assessments took place in all of the disciplines that participated. What this tells us is that epistemic match measured near the start of the year appears to be a good predictor of a student's later performance in their first year of higher education.

In order to establish if there is a causal relationship between epistemic match and performance we would need to be able to experimentally manipulate the beliefs held by students. Student beliefs are notoriously difficult to change, even when those beliefs are negatively influencing their studies. Nevertheless, Meyer, Ward and Latreill (2009) charted a change in the meta-learning beliefs of 354 economics students in response to a programme of targeted reflection. It is possible that the same method could be used to change epistemological beliefs (Gill, Ashton and Algina, 2004). If a causal relationship between epistemic match and performance does exist then the potential benefits of being able to encourage students to adopt more compatible beliefs would be considerable. If a causal relationship cannot be established then the value of epistemic match as a predictor of performance could still be put to good use in advising students on subject selection in higher education. Either way, epistemic match can make a valuable contribution towards helping students achieve their potential in terms of performance in higher education.

Overall, this study has concluded that epistemic match offers a new pedagogical concept for understanding how students fit in to their chosen discipline when taking a degree. Predicting performance represents only one element of the epistemic match's potential.

Previous studies have found links between a student's epistemological sophistication and a number of other pedagogical concepts such as study strategies (Hofer and Pintrich, 1997). The relationship between epistemology and these concepts could be re-examined and better understood using epistemic match. Other areas of potential development include refining the method of measurement of both personal epistemological beliefs and presented epistemological beliefs. Future development and research of this concept is clearly worthwhile.

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