Indirect Evidence for an Effect of Studying Introductory Psychology on Epistemic Cognition in Other Domains.

Abstract

Does studying pre-degree Psychology develop students as critical thinkers? Two studies examined epistemic cognition in 17-year-old female pre-degree students. A twenty-week longitudinal comparison of scores on the Epistemic and Ontological Cognition Questionnaire found no evidence of divergence in the developmental course of Science epistemic cognition between Psychology students and controls. Contrary to expectation, Psychology students held less sophisticated conceptions of scientific knowledge throughout the study. This is attributable to a contrast effect of considering Biology/Science the light of their epistemic conception of Psychology. A qualitative exploration using grounded theory research process suggested that students' epistemic cognition in Psychology is informed by distinct ontological beliefs about Science and Psychology. Belief justification in Psychology depends on congruence between formal concepts and personal narratives. Psychology teachers may develop critical thinking by challenging naive assumptions about Science and by using personal narratives to motivate meaningful engagement with epistemic issues.

1. Introduction

Those who teach Psychology to pre-degree students do so in the knowledge that most of them will not become psychologists or enter an allied profession (Prospects, 2011). It is their habit to console themselves with the belief that by teaching Psychology they develop students as critical thinkers, an aspiration shared with their colleagues in Higher Education (Quality Assurance Agency, 2008). This investigation addresses whether this belief, and the consolation they draw from it, is justified.

Definitions of critical thinking abound (see Petress, 2004, for a review), but that put forward by Halonen (1995) is representative of themes most share. Critical thinking is:

> "the propensity and skills to engage in activity with reflective skepticism focused on deciding what to believe or do." (Halonen, 1995; p.76)

Critical thinkers engage in effortful, principled thought in order to arrive at justifiable conclusions about knowledge claims or possible courses of action. They care about "getting it right" and "presenting positions honestly and clearly" (Ennis, 2001; p. 44). Such capacities and dispositions are clearly important in those who study Psychology or work in Psychological Science or professional practice and their significance to employers and professions is rarely if ever disputed. Some commentators go so far as to place critical thinking at the heart of a viable democracy (Brookfield, 1987; Bowell & Kemp, 2002; Ennis, 1996). For Psychology teaching to contribute to such a valuable capacity would more than justify its place in the pre-degree curriculum.

Critical thinking is an epistemic activity in that it is chiefly concerned with knowledge and its validation. It seems reasonable that the development of learners as critical thinkers is linked to the development of their epistemic cognition more generally. Epistemic cognition is a type of metacognition which provides a basis for reasoning (Moshman, 2011). In academic contexts it is usually addressed under the rubric of Personal Epistemology (Hofer, 2002). The term 'epistemic cognition' (EC) is preferred here since 'personal epistemology' invites confusion about what is being addressed: a person's theory of knowledge or their theory of epistemology

(Kitchener, 2002) and may lead to the mistaken assumption that knowing something entails holding a corresponding epistemological theory (Alston, 1980).

1.1 Theoretical accounts of epistemic cognition

The study of EC development is widely agreed to have begun with Perry's (1970) work with US undergraduates in the 1950s and 1960s (Hofer & Pintrich, 1997). A number of theories have subsequently been advanced. They differ in respect of their conception of EC, age-norms and grounding assumptions but agree that learners' epistemic thinking increases in sophistication over time from naive realism to subjective relativism, with some eventually advancing to a principled relativist view of knowledge. The theories fall roughly into three groups. Perry's original work is Piagetian in character and many of its successors follow suit in conceptualising EC development as being the linear and hierarchical structural development of a domain-independent capacity (Baxter-Magolda, 1992; 2004; Belenky, Clinchy, Goldberger & Tarule, 1986; King & Kitchener, 1994; 2002; 2004; Kuhn, 1999). A second group describes EC development in terms of systems of more-or-less independent beliefs about the nature of knowledge and knowing which may advance asynchronously and in a domain specific manner (Jehng, Johnson & Anderson, 1993; Schommer, 1994; Schommer-Aikens, 2004; Schraw, Bendixen & Dunkle, 2002). A third and more recent group attempts to synthesise the structural and belief-systems approaches (Bendixen and Rule, 2004; Greene, Azavedo & Torney-Purta, 2008).

1.1.1 Structural developmental theories

Of the 'Piagetian' theories, King and Kitchener's (1994; 2002; 2004) Reflective Judgment Model is the most rigorously formulated and thoroughly researched (Pascarella & Terenzini, 1991). King and Kitchener view EC as developing through seven stages organised into three developmental levels. Like Perry, they present a complex stage theory (Rest, 1979) in which development is somewhat more fluid and recursive than a Piagetian stage model would allow. The foci of King and Kitchener's model and the basis for the distinctions they draw between stages and levels are (1) the individual's conceptions of the nature of knowledge and (2) the ways in which they justify belief. The first level of EC development is *pre-reflective reasoning* (stages 1 to 3). At this level knowledge is viewed as absolutely correct (or not) and in need of little or no justification since what is believed is assumed to correspond directly with what is. The second level is termed *quasi-reflective reasoning* (stages 4 and 5). At this level, knowledge is understood to be constructed. There is a decreased emphasis on the role of authority and a correspondingly increased understanding of the role of context and evidence in justifying knowledge claims. However, justification tends to be idiosyncratic and use of evidence unprincipled. At the highest level of development, *reflective reasoning* (stages 6 and 7), it is recognised that whilst all knowledge claims are somewhat tentative it is nonetheless possible to evaluate them in relation to evidence and the context in which they were generated to arrive at defensible judgements about their validity. Reflective reasoners maintain the ability to re-evaluate and alter their beliefs as they encounter new data or methodologies. Baxter-Magolda (1992; 2004) and Belencky et al (1986) bring a gender perspective to EC development but in its essentials their work adds little to the structural scheme developed by Kitchener and King (Moore, 2002).

There is impressive support for King and Kitchener's model, not least from their (1994) longitudinal study in which some 1700 participants, over the course of 10 years, completed the Reflective Judgment Interview (RJI), a one-hour long structured discussion of four ill-structured problems with protocol analysis by trained raters. RJI studies have shown that the Reflective Judgement stages form a developmental sequence (Brabeck & Wood, 1990; King, Kitchener & Wood, 1994; Wood, 1997). Individuals typically show reasoning at adjacent levels and the pace of development is slow. Students generally start Higher Education at stage 3 (pre-reflective) with most leaving undergraduate study at level 4 (King & Kitchener 2004).

There are arguments, however, that by conceptualising EC as domain independent structural developmental theories give a somewhat distorted view of its development. Specifically, there is a tendency for individuals to be characterised by their least sophisticated beliefs about academic knowledge (Greene, Torney-Purta, Azavedo & Robertson, 2010a). Consequently it tends not to be recognised that the same individual may reason in different ways across different domains. A number of findings conflict with the staple claim of the Perry tradition that school-age children are limited to naive-realist/absolutist beliefs about knowledge. In familiar knowledge domains of high personal relevance only a third of high-school students (Grades 8-

12) consistently show absolutist reasoning with over half demonstrating a clear appreciation of the relative nature of knowledge claims (Chandler, Hallet & Sokol, 2002). Furthermore, by focusing on reasoning about ill-structured problems to the exclusion of almost all else, structural theorists have tended to overlook that different types of epistemic reasoning may be appropriate to different types of knowledge domain (Chandler & Proulx, 2010).

1.1.2 Belief-system theories

These observations are accommodated more easily by belief-system theories of EC development than by structural developmental theories. These models posit an interconnected system of beliefs about knowledge and knowing which may develop relatively independently (Greene et al 2008; Jehng et al, 1993; Schommer, 1994; Schommer-Aikens, 2004; Schraw et al, 2002). Schommer-Aikens's (2004) Embedded Systemic Model (ESM) is the best known of these theories. Five beliefs are described, each of which may be held on a continuum of sophistication. As its name implies, the ESM proposes that epistemic beliefs are embedded in a network of wider intra- and inter-individual systems including cognitive, social, classroom and family ones such that "at any moment a thought or action is the culminating effect of multiple systems" (Schommer-Aikens, Bird & Bakken, 2010; p.34). The three most important epistemic beliefs concern (1) the *stability* of knowledge, from unchanging to tentative; (2) the *structure* of knowledge, from fragmented to interconnected; and (3) the *source* of knowledge, from authority to reason/evidence. Two further beliefs concern (4) *speed* of learning and the individual's (5) *capacity* to learn. Importantly, the relative independence of these beliefs and their potential to vary across knowledge domains supports far greater intra-individual variation in EC than structural theories allow.

There is some empirical support for the impact of separable epistemic beliefs on knowledge and reasoning including self-judgements of understanding (Schommer-Aikens, 2004), text comprehension, study strategy (Hofer & Pintrich, 1997; Klaczynski, 2000) and the use of deep processing and metacognition in learning (Paulsen & Feldman, 2007). However, concerns have repeatedly been expressed about the psychometric properties of the instruments used to measure ESM constructs (Buehl, 2008; Clareabout, Elen, Luyten & Bamps, 2001; Hofer & Pintrich,

1997) and a number of studies with school age participants have found only *speed* beliefs to have a significant relationship with learning (Greene et al, 2010a).

1.1.3 Syntheses of the structural and belief-systems approaches

In recent years theories have been proposed that hope to marry the sound empirical research base of the structural approach to the more nuanced understanding of EC afforded by the belief-systems approaches (Bendixen, & Rule, 2004). One such is the epistemic and ontological cognition (EOC) model advanced by Greene et al (2008), which informs the rationale for the studies presented below. The EOC model distinguishes between learners' *ontological beliefs* about the nature of knowledge (simple and certain or complex and dynamic) and their *epistemic beliefs* about the process of knowing. One ontological and two epistemic dimensions of cognition are proposed. The ontological dimension describes the extent of belief in simple and certain knowledge (SC). The epistemic dimensions capture two independent justifications for knowledge claims: justification by authority (JA) and personal justification (PJ). The former relates to how firmly an individual believes that knowledge claims are warranted by knowledge from teachers, scientists and other experts; the latter to how far they believe that personal experience, opinion and reasoning can warrant knowledge claims. The EOC model integrates structural and systems approaches by suggesting that the three belief dimensions vary systematically to produce four developmental positions similar to those described by the structural models (see Table 1).

Greene et al regard EC development as a domain specific process but do not use 'domain' conterminously with 'academic discipline'. Their key distinction is between ill-structured and well-structured knowledge domains. Well-structured domains are those in which knowledge is viewed as objective and clear, logical justification rules obtain. Ill-structured domains allow greater subjectivity in both the nature of knowledge and the rules for its justification (Donald, 1990). Green et al propose that advances in epistemic cognition occur earlier in ill-structured than well-structured domains so whilst a shift from realism to either dogmatism or scepticism is expected towards the end of school or beginning of university education in ill-structured subjects like History, the same shift does not occur in well-structured subjects like Biology until the middle to later years of university education.

Table 1: Developmental positions in the EOC (based on Greene et al, 2010a)

		Belief in...		
Position	**SC**	**JA**	**PJ**	
Realism	Strong	Strong	Strong	Knowledge is objective and warranted either by self or authority.
Dogmatism	Weak	Strong	Weak	Knowledge is complex and either warranted by authority (dogmatism) or self (scepticism).
OR				
Scepticism	Weak	Weak	Strong	
Rationalism	Weak	Moderate	Moderate	Knowledge is complex but how it is warranted depends on the context of knowledge claims

1.2 Mechanisms of EC development

There is agreement that EC advances through disequilibriating experiences that challenge learners' naive epistemic schemas and require their adaptation to accommodate (Bendixen, 2002; Hofer, 2004a, 2004b; King & Kitchener, 2004; Perry, 1970). This is best understood as a recursive process in which change initially occurs in isolated areas of understanding which are revisited, extended and eventually integrated over extended periods of time (Chandler et al, 2002). This process is embedded in a system of social-environmental variables including teacher behaviour and the epistemic climate of the learning environment (Rule & Bendixen, 2010; Feucht, 2010).

The lack of a strong relationship between age and epistemic developmental level (Hofer & Pintrich, 1997; King & Kitchener, 1994) suggests that EC development is not purely a maturational process and the finding that those with a university education develop faster and further than those without (even when IQ and socioeconomic status are controlled) lends support to the ‘disequilibrium’ view (King & Kitchener, 2002; Edman, 2008). More direct confirmation comes from Bendixen (2002) who also highlights the impact of affect and epistemic doubt and Hofer (2004b), who discusses how variations in teaching practices can facilitate or hinder EC development.

If advances in EC depend on exposure to disequilibriating experiences there is the possibility that different academic disciplines may foster different rates of development, depending on the numbers and types of challenge they present to students’ epistemic assumptions. Claims regarding Psychology’s contribution to the development of critical thinking rest on this possibility. Psychology is an epistemologically self-conscious discipline, even when taught at pre-degree level. The subject matter draws attention to the lack of both certainty and simplicity inherent in issues that novice Psychology students are likely previously to have taken for granted and the critical skills routinely taught in introductory courses require explicit consideration of the source and justification for knowledge claims. Judging how far this affects development is difficult as in the classroom a number of epistemic influences intersect including (at least) the (1) structure of the discipline being taught, (2) the content of a given course, (3) the purpose for which it is taught and (4) its mode of assessment, along with (5) the pedagogical traditions of the discipline, (6) the epistemic beliefs of the teacher and (7) their repertoire of teaching methods. Nonetheless, there are indications of subject/discipline effects on EC development. King, Wood and Mines (1990) found that studying Social Sciences was associated with higher RJI scores than studying Maths and Science but only in graduate students. Palmer & Marra (2004) found in Science and Engineering students that aspects of EC development relating to the adoption of multiple perspectives were facilitated by exposure to learning in the Social Sciences. This conclusion is broadly supported by Lonka and Lindblom-Ylanne (1996) with Medical and Psychology students. Liu and Tsai (2008) found that students studying only Sciences held significantly more naive Science epistemic beliefs than those studying a variety of disciplines and attributed this difference to prolonged exposure of the Science students to “an epistemic environment that describes scientific knowledge as objective and universal” (p. 1055).

So far, discipline effects have only been isolated in Higher Education students, usually ones engaged in advanced study. This may be because intensive and prolonged immersion in a discipline is necessary for epistemic cognition significantly to be affected. However, it may also be because the models used to frame the phenomenon do not lead researchers to suspect discipline effects in pre-degree students and the instruments commonly used to measure EC are not suitable for use with younger learners. This investigation extends the previous work by assessing whether studying Psychology influences EC about Science generally and Biology specifically, using a model and instrument (Greene et al's EOC model and questionnaire) suitable for use with pre-degree students.

1.3 Context of this investigation

The majority of learners who enter Higher Education in England and Wales study the General Certificate of Education Advanced Supplementary and Advanced Level qualifications (GCE AS/A-Levels). A combination of subjects is studied over two years, usually immediately following the end of compulsory education (currently at 16 years). Typically, four subjects are studied for a year at AS-Level with three of these being carried on to A-Level for a further year of study. The majority of assessment at AS and A-Level is through written exams. In principle, students may select any combination from a wide variety of subjects but in practice their choices are constrained by what their institution makes available, what they have studied previously and what they intend to study at university. A-Levels are the *de facto* university entrance exam for England and Wales. Undergraduate places are typically offered to applicants conditionally on their achieving specified grades, often in specified subjects.

For the vast majority of students in England and Wales, their A-Level course represents their first opportunity to study Psychology. It is a popular choice, with 54,940 candidates taking the A Level qualification in 2010 (Joint Council for Qualifications, 2010). Since 2008 Psychology at AS and A Level has been classified as a science by the examinations and curriculum regulatory bodies for England and Wales. As a result the Psychology AS/A-Level curriculum specifications are structured with reference to a 'How Science Works' (HSW) rubric shared with Physics, Chemistry, Biology, Geology, Electronics and Environmental Science

(Qualifications and Curriculum Authority, 2006). The HSW rubric explicitly requires the teaching and examination of scientific subjects to address epistemic issues including the requirement to “evaluate methodology, evidence and data, and resolve conflicting evidence” and “appreciate the tentative nature of scientific knowledge.” (QCA, 2006; p. 4). It is argued above that the epistemic character of Psychology creates more opportunities for learners to address these concerns than may be the case in the physical sciences. The HSW rubric, however, offers Psychology students a route by which to connect their Psychology-derived epistemic insights with their learning in other Sciences. If so, it might be expected that EC about Science will develop differently in students who study physical sciences and Psychology compared with those who study physical sciences without Psychology

Two studies were conducted to investigate this proposition. The first was a longitudinal, quantitative study of EC development in Biology students, half of whom were also studying Psychology. It was found that whilst EC about Science was different in the Psychology students the course of EC development was not. A second, qualitative, study investigated Psychology students’ conceptions of the epistemic nature of the discipline in order to understand why this was the case.

2. Study One

A longitudinal study examined whether studying Psychology influences epistemic cognition in Biology and Science. Two groups were compared: students who were studying introductory (AS Level) Psychology and students who were not. Changes in participants' EC in the domains of Biology and Science were measured over a period of 20 weeks. It was predicted that EC in the domains of Science and Biology would develop differently between those students who studied Psychology and those who did not.

2.1 Material and methods

2.1.1 Participants

A sample of 58 female volunteer participants was recruited from Year 12 of a single-sex, selective, state-funded school in a large city in the West Midlands of the United Kingdom through a general appeal to the student body. None received any inducement for participating. Their ages at the start of the study ranged from 16 years 6 months to 17 years 6 months with a mean age of 17 years 1 month. The participants had prior educational attainment substantially above national norms for England and Wales. All had between 8 and 13 GCSEs (General Certificate of Secondary Education, the predominant school-leaving qualification in England and Wales) at grades A* to C (mode: 11 GCSEs) with a modal grade of A. All participants were full-time students enrolled on a course of four AS Level qualifications. All were studying Biology and 29 were taking Psychology. They were studying a range of other subjects: Chemistry (n=52), Mathematics (n=44), Physics (n=11), Geography (n=8), Economics (n=6), Religious Studies (n=5), History (n=5), English (n=4), Further Mathematics (n=3), French (n=2), Business Studies (n=2), Government & Politics (n=1), Art (n=1) and Drama (n=1). At the beginning of the study they had been pursuing these courses for 18 weeks (not including school holidays), receiving 4.5 teaching contact hours each week. Twenty-four were studying Critical Thinking as an additional subject, receiving 1 contact hour each week.

2.1.2 Measures

There were two IVs. One was *time*. Data were gathered at 0, 10 and 20 weeks from the start of the study. The other was *elected study content*. Participants were either studying *Biology and Psychology* or *Biology only*.

Epistemic cognition was measured using the Epistemic and Ontological Cognition Questionnaire (EOCQ; Greene et al, 2010a). This measure has acceptable psychometric properties (Greene, Torney-Purta & Azavedo, 2010b) and consists of 13 Likert-type scale items with response scales ranging from 1 to 6 (see Appendix A). The scale is labelled as follows: 1='completely disagree'; 2='mostly disagree', 3='somewhat disagree', '4='somewhat agree', 5='mostly agree', 6='strongly agree'. Five scale items measure belief in simple and certain knowledge (SC; e.g. "In science, what is a fact today will be a fact tomorrow"), four measure belief in justification by authority (JA; e.g. "Things written in science textbooks are true") and four measure belief in personal justification (PJ; e.g. "In science, what's a fact depends on a person's point of view"). Ten of the items are phrased so that higher ratings indicate stronger belief; three are phrased so that higher ratings indicate weaker belief. Three versions of the scale were prepared, one in which scale items referred to "Biology", one in which they referred to "Psychology" and one in which they referred to "Science". *Biology and Psychology* participants completed a questionnaire comprising all three scales. *Biology only* participants completed a questionnaire comprising the "Biology" and "Science" versions. In both cases, the item order of the combined scales was randomised to produce the final questionnaires.

2.1.3 Procedure

Three, week-long, series of data gathering sessions were held, at intervals of ten weeks. They took place in a school classroom at lunchtimes during the school day. Participants were notified of sessions in advance. On arrival, groups of 5-15 participants were conducted into the classroom, seated and asked not to talk to each other for the duration of the session. Participants completed a front-sheet on which they listed their AS Level subject choices. Before completing the questionnaire they were told, "This questionnaire is to investigate your beliefs about the subjects you study. This is not a test and there are no correct answers to any of the questions.

Just tick the box that reflects your own view". Clarification questions about questionnaire items were not answered. The participants completed an identical questionnaire at each session. An additional sheet was appended to the final questionnaire on which participants reported their date of birth and their previous examination results. EOCQ responses were scored by calculating the mean response for items in each subscale for each domain.

2.2 Results and discussion

2.2.1 Preliminary analysis

A grounding assumption of this investigation is that what a learner studies can affect the development of their epistemic cognition. Therefore, a chi-squared test of independence was used to ensure that, besides Psychology, participants' subject choices did not differ significantly between the *Biology and Psychology* and *Biology only* groups. Because the frequency of some subject choices was very low, Art, Business Studies, Drama, Economics, English, French, Geography, German, Government and Politics and Religious Studies were combined as 'Humanities, Arts and Languages' for the purpose of analysis (see table 2). The subject combinations of the two groups did not display asymmetry in distribution $\chi^2(4) = 5.003$; $p = .287$.

Table 2. Subjects studied besides Biology (n=58) and Psychology (n=29).

	Chemistry	Mathematics	Critical Thinking	Humanities, Arts & Languages	Physics
Biology and Psychology	23	19	10	15	1
Biology only	29	28	14	19	10

To ensure that prior academic achievement did not confound the main analysis the GCSE results of the groups were compared. GCSE grades were assigned a numerical value: A* = 10, A = 9, B = 8, C = 7 etc. Mean GCSE scores were then calculated for each participant and the groups were compared using an independent t-test. Mean GCSE score for *Biology only* was 9.365 (SD = .47) and for *Biology and Psychology* it was 9.206 (SD = .348). The groups did not differ significantly t(56) =

1.467; p = .148. It is unlikely that either current subject combination or prior academic attainment exerted a confounding influence on the results.

2.2.2 Multivariate repeated measures ANOVA

It was predicted that EOCQ epistemic cognition measures (*SC*, *JA*, *PJ*) for the domains *Biology* and *Science* would develop differently in *Biology and Psychology* and *Biology only* participants. If so, divergence in EC development should be reflected in a significant interaction between *time* and *elected study content* in respect of the EOCQ subscale scores. The data were analysed using a doubly multivariate repeated measures ANOVA with *time* (0, 10 and 20 weeks) as a within-participants factor and *elected study content* (*Biology and Psychology* and *Biology only*) as a between-participants factor. DVs were the EOCQ subscale measures (*SC*, *JA* and *PJ*) for the two domains (*Science*, *Biology*). There was a significant main effect of *time* $F(12,45) = 3.259$; $p = .002$; and *elected study content* $F(6, 51) = 3.766$; $p = .004$. The interaction effect *time* x *elected study content* was not significant $F(12, 45)=1.103$; $p = .381$[1]. Although epistemic cognition about Biology and Science changed longitudinally and differed between students who studied Psychology and those who did not, the lack of a significant interaction effect suggests that studying Psychology did not affect the course of development of EC in the domains measured.

Tables 3 and 4 summarise follow-up univariate analyses of the main and interaction effects. Mauchly's test indicated that the assumption of sphericity was violated for the main effect of *time* on *SC Science* $\chi^2(2) = 11.184$; $p = .004$ and *JA Biology* $\chi^2(2) = 8.581$; $p = .014$. Consequently degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε=.845 for *PJ Science* and .874 for *JA Biology*).

[1] Pillai's trace F is reported as it is the most robust test statistic to violations of assumptions when sample sizes are equal (Bray & Maxwell, 1985).

Table 3 – Main and interaction effects of time and elected study content on EOCQ subscales in the Science domain

	SC Science			*JA Science*			*PJ Science*		
	df	*MS*	*F*	*df*	*MS*	*F*	*Df*	*MS*	*F*
Time	1.992, 111.582[a]	.909	6.114**	2, 112	.479	1.903	2, 112	.143	.720
Elected study content	1, 56	4.082	3.766	1, 56	0.061	.023	1, 56	7.141	9.631**
Time x Elected study content	1.992[a]	.050	.338	1.930[a]	.816	3.128[b]	2	.053	.266

[a]Corrected for violation of sphericity assumption.

[b]Although p<.05, treated as a Type 1 Error because multivariate analysis was not significant.

*p<.05. **p<.01. ***p<.001

Table 4 – Main and interaction effects of time and elected study content on EOCQ subscales in the Biology domain

	SC Biology			*JA Biology*			*PJ Biology*		
	df	*MS*	*F*	*df*	*MS*	*F*	*df*	*MS*	*F*
Time	2,112	.030	.163	1.992, 97.862[a]	1.374	3.578*	2,112	.387	1.973
Elected study content	1, 56	5.294	4.882*	1, 56	1.862	.660	1, 56	11.126	11.429***
Time x Elected study content	2	.090	.485	1.748[a]	.100	.260	2	.033	.171

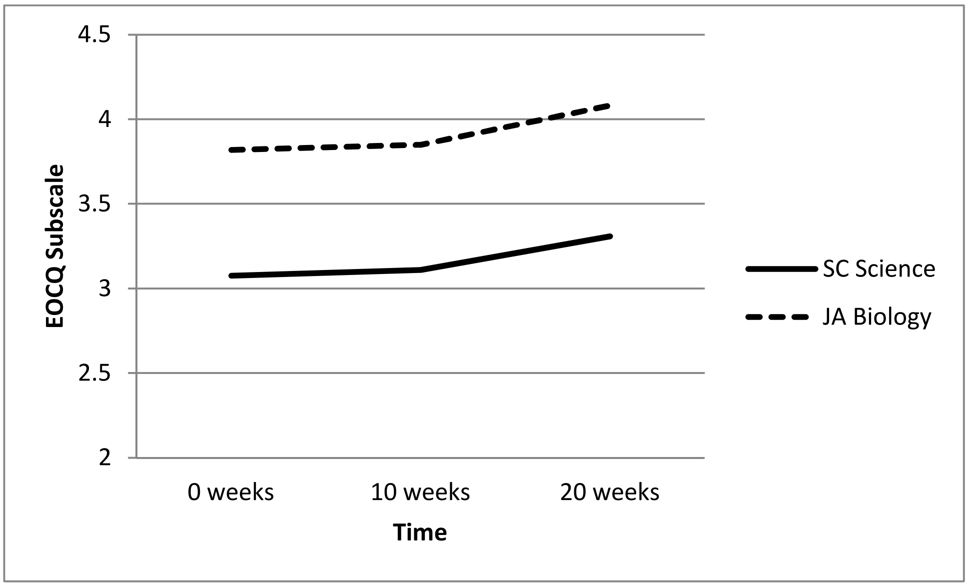
[a]Corrected for violation of sphericity assumption.

*p<.05. **p<.01. ***p<.001

2.2.3 Longitudinal changes in epistemic cognition

Over the course of the study participants became more likely to agree that knowledge in Science is simple and certain F(1.992, 111.582) = 6.114; p = .003 although mean scores remained on the side of disagreement. Participants also became more likely to endorse the view that Biological knowledge is warranted by authority F(1.992,97.862) = 3.578; p = .037 (see Figure 1).

Figure 1 – Longitudinal changes in 'Simple & Certain Knowledge' scores in Science and 'Justification by Authority' scores in Biology.

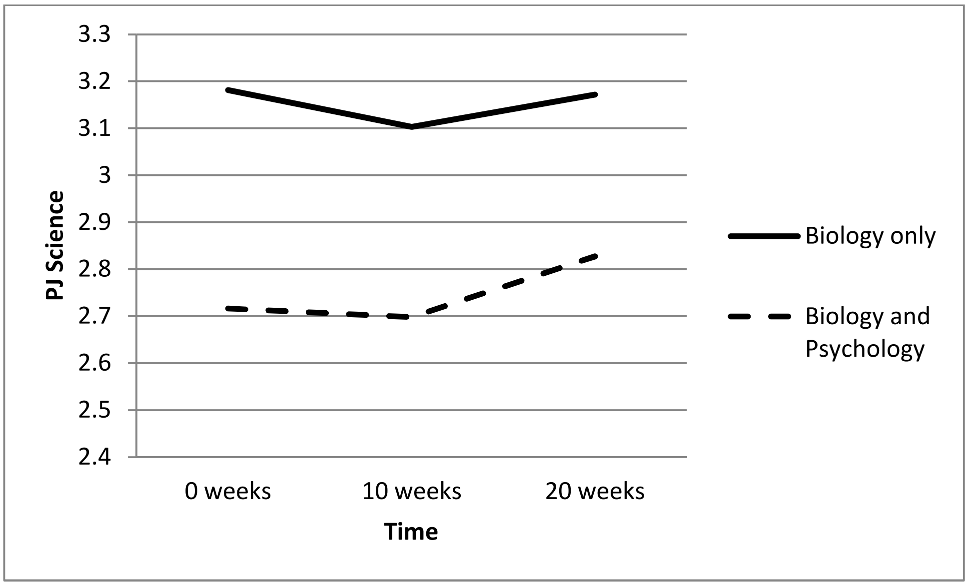


The change in students' cognitions about Science run counter to what Green et al's (2008; 2010a; 2010b) theory would predict. In their scheme the transition to post compulsory education is marked by a decrease in the belief in the simplicity and certainty of knowledge. It may be significant that between the second and third data points participants in this study underwent an intense period of high-stakes testing (the Summer AS-Level examinations) in all the subjects they studied. Although the effects of high stakes testing on teaching and learning remain controversial there exists some evidence that they can result in a narrowing of the curriculum and an excessive focus on exam technique in teaching, an increase in direct instruction and a corresponding decrease in enquiry and problem solving in the classroom (Harlen, 2006). This can shift learners from a mastery to a performance orientation resulting in poor quality learning which does not transfer and is quickly forgotten (Grolnick & Ryan, 1987; Harlen & James, 1997). Such changes in teaching and learning seem likely to militate against the development of EC, which is acknowledged by Perry (1970) and Kitchener and King (2004) to retreat under adverse circumstances. This could be investigated by comparing EC development between students studying equivalent modular and linear courses of study. It might be expected that the more frequent high-stakes testing associated with modular courses would result in slower epistemic development.

2.2.4 Group differences in epistemic cognition

In Science, *Biology and Psychology* students disagreed more strongly than *Biology only* students that knowledge claims could be warranted by personal justification $F(1,56) = 9.631$; $p = .003$ (see Figure 2).

Figure 2 – Group differences in 'Personal Justification for Knowledge' scores in Science.



There was a corresponding difference in belief in Personal Justification in Biology. Once again, *Biology and Psychology* students expressed stronger disagreement that knowledge claims can be warranted by personal justification $F(1, 56) = 11.429$; $p = .001$ (see Figure 3).

Biology only students disagreed more strongly than *Biology and Psychology* students that knowledge in Biology is simple and certain although the difference between the groups was smaller than for personal justification $F(1,56) = 4.882$; $p = .032$ (see Figure 4).

Figure 3 – Group differences in 'Personal Justification for Knowledge' scores in Biology.

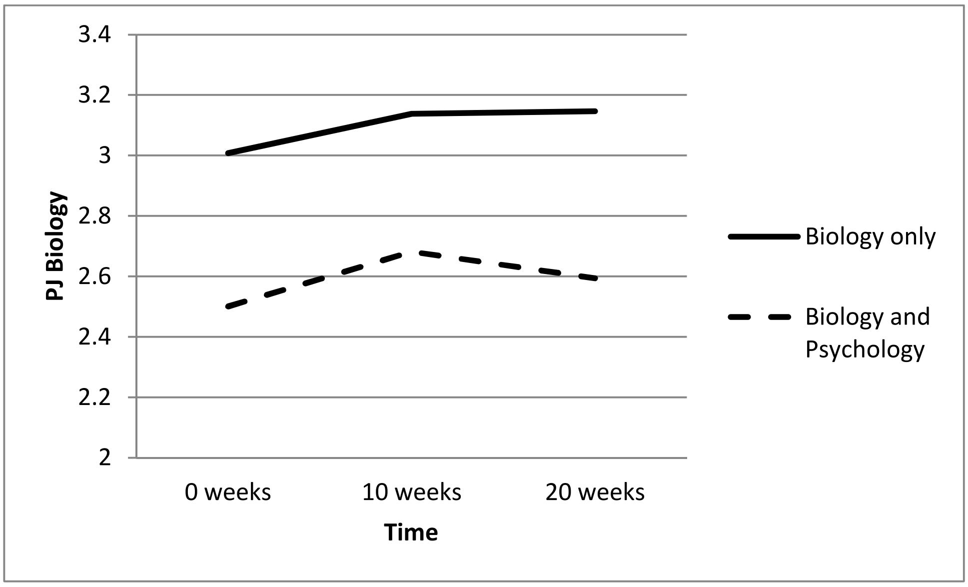
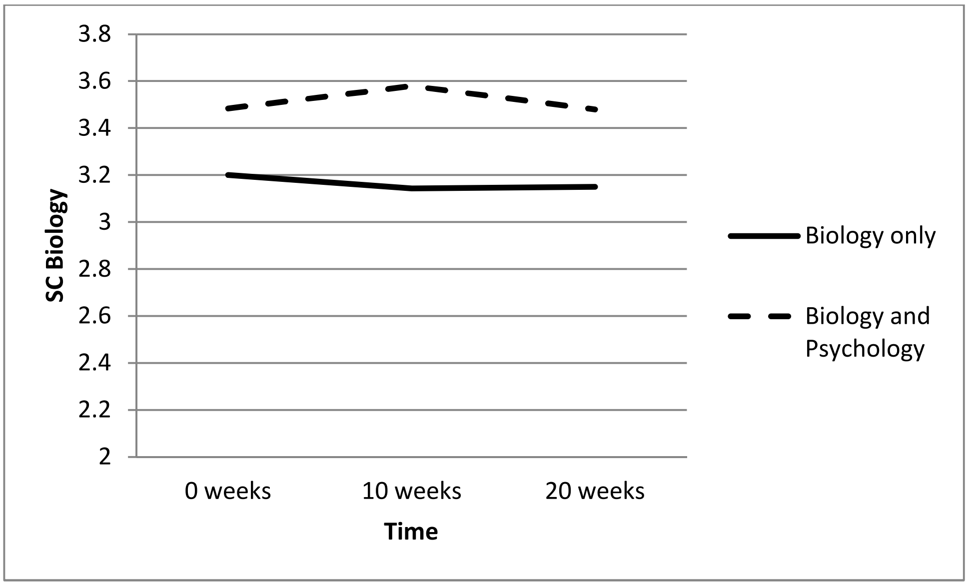


Figure 4 – Group differences in 'Simple & Certain Knowledge' scores in Biology.



It is possible that answering questions about Psychology and Biology simultaneously caused participants to exaggerate the differences between them in their responses. If so, group differences in the main analysis might be due to the confounding effect of the *Biology and Psychology* participants completing a questionnaire with the additional "Psychology" subscale. To assess the likelihood of this, a follow up study was conducted in which 41 Year 12 Psychology students were randomly assigned to complete one of three EOCQ questionnaires: (1) the "Biology" subscale only (n=13);

(2) the "Psychology" subscale only (n=13); or (3) both subscales combined (n=15). One-way ANOVAs were used to compare groups (1) and (3) on their responses to the "Biology" subscale and groups (2) and (3) on their responses to the "Psychology" subscale. All differences were non-significant ($p>.05$). It therefore seems that the differences between *Biology only* and *Biology and Psychology* participants' EOCQ scores indicate genuine differences in the epistemic beliefs of the two groups rather than a confounding effect of questionnaire construction.

These are not the expected results. If transfer of epistemic beliefs between Psychology and Biology had occurred the result should be that, compared with *Biology only* students, *Biology and Psychology* students would regard Biological knowledge as *less* sure and certain with a correspondingly *greater* role for personal justification. In EOC terms, *Psychology and Psychology* students appear to hold somewhat more naive beliefs about Biology than their *Biology only* counterparts. Two questions must therefore be addressed: what is the source of these differences and why do they run counter to expectation?

One possibility is that introductory Psychology courses attract individuals with naive beliefs about Biology or that students who do not hold such beliefs drop out early on in the course. The latter seems unlikely: in the cohort from which the participants were drawn, only two students dropped Psychology prior to the study and only one of these was also studying Biology. It is, plausible, however, that Psychology is attractive to students with a particular epistemic outlook. A study of epistemic beliefs as predictors of post-compulsory subject choice would shed light on this. A third possibility is that learning about Psychology did affect participants' epistemic cognition but this happened before the beginning of this study. No firm conclusion can be drawn about this, but some salient points emerge from an analysis of the differences between the *Biology and Psychology* group's epistemic beliefs about the two disciplines.

2.2.5 Differences in Psychology students' epistemic beliefs about Psychology and Biology

If Psychology and Biology are understood by students to be as epistemically similar as the shared 'How Science Works' rubric implies, then it would be expected that *Biology and Psychology* participants' EOCQ scores for the two domains would not differ markedly. To test this, scores on the EOQC *Biology* and *Psychology* subscales for the group studying both subjects were analysed using a multivariate repeated measures ANOVA with *time* (0, 10 and 20 weeks) and *domain* (biology, psychology) as within-participants factors. DVs were the EOCQ subscale measures (*SC*, *JA* and *PJ*). Mauchly's test indicated that the assumption of sphericity was violated for the main effect of *time* on *JA* $\chi^2(2) = 11.242$; $p = .003$. Consequently degrees of freedom were corrected using the Greenhouse-Geisser estimate of sphericity (ε=.744). There was a significant main effect of *domain* $F(3, 26) = 28.298$; $p <.001$. Neither the main effect of *time* was significant $F(6,23) = .975$; $p= .464$ nor the interaction effect *domain* x *time* $F(6, 23) = .929$; $p=.493$. Participants' epistemic cognition differed significantly between the domains of Biology and Psychology. However, EC did not change significantly over time across or within domains. See Table 5 for a summary of follow-up univariate analyses.

Table 5 – Main and interaction effects of Domain and Time on EOCQ subscale scores.

	Simple & Certain			*Justification by Authority*			*Personal Justification*		
	df	*MS*	*F*	*Df*	*MS*	*F*	*df*	*MS*	*F*
Domain	1, 28	26.967	39.242***	1,28	29.381	16.586***	1,28	69.857	86.184***
Time	2,56	.019	.083	1.487, 41.636[a]	1.377	1.677	2,56	.173	.516
Domain x Time	2,56	.304	2.086	2,56	.168	.786	2,56	.176	.570

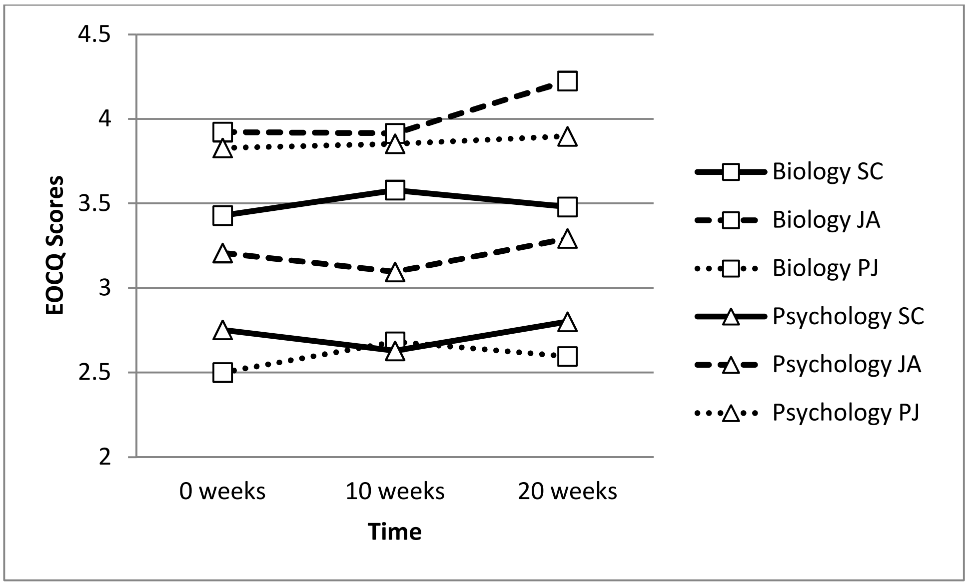
[a]Corrected for violation of sphericity assumption.

*p<.05. **p<.01. ***p<.001

Throughout the study, *Psychology and Biology* students regarded Biological knowledge as simpler and more certain than Psychological $F(1,28) = 39.242$; $p < .001$. For knowledge claims, authority was given a higher justificatory importance for

Biology than Psychology $F(1, 28) = 16.586$; $p < .001$ and personal justification a lower one $F(1, 28) = 86.184$; $p < .001$ (see Figure 5).

Figure 5 – Psychology students' EOCQ subscale scores for Biology and Psychology over 20 weeks



There are very marked differences between EOCQ subscale scores between the two domains. These findings are consistent with those of Estes, Chandler, Horvath and Backus (2003) who found that UK and US undergraduates differed significantly in their appraisal of truth claims in Biology and Psychology. It is possible that the underlying similarity between the disciplines caused the divergence in epistemic judgements. Psychology may be similar enough to Biology to provide a salient point of reference for intra-individual comparisons about certainty and justification. Psychology students, who frequently encounter uncertain knowledge claims in Psychology, may judge Biological knowledge claims to be correspondingly more certain than do Biology students, who have no similarly salient point of contrast. Contrast effects are well documented in Social Psychology (Wood, 1989). If, as Study two implies, Psychology students place the discipline outside the semantic category boundary of Science then the same processes may be at work here.

It would be possible to investigate contrast effects further by modifying the study design to include comparisons between several different subject combinations. However, it is a more pressing matter to address the question of whether these group differences in Biology/Science EC are caused by early experiences with

Psychology or predate the beginning of study. Retaining the design of this investigation but starting when the students commence their AS Level courses would be one way of addressing this question, but given that the putative changes in Biology/Science EC are more rapid than is usually assumed it would be more appropriate to adopt a microgenetic methodology to capitalise on the superior granularity in the data so collected (cf. Kuhn & Pearsall, 1998).

Caution should be exercised extrapolating from these results because of the sample of female high-achievers. There is no obvious reason to suspect that epistemic cognition amongst an academically equivalent male sample would be different but reckless generalisations are discouraged in the light of Woods and Kardash's (2002) discovery of interactions between gender and some scales of EC measurement. Further, since epistemic cognition varies with both academic level and academic achievement within level, it would be unwise to assume that similar findings would be obtained in samples with a different academic profile.

3. Study Two

A qualitative study was conducted to explore Psychology students' epistemic cognition around Psychology and Science. The aim was to produce a model, grounded in participants' talk about Psychology, Science and other school subjects, of how they formed epistemic judgements. Besides shedding light on the findings of study one, the study could also inform comment on the construct validity of Greene et al's (2008) EOC model.

3.1 Material and Methods

3.1.1 Participants

Eight volunteer participants were recruited, through a general appeal, from the cohort of AS Level Psychology students in Year 12 of the same school as study 1, with the same age and academic profiles. All were studying at least three subjects in addition to Psychology: Biology (n=4), Maths (n=4), Economics (n=1), French (n=1), History (n=2), Religious Studies (n=3), Art (n=1), Drama (n=2), English (n=2), Chemistry (n=2), Business Studies (n=1). Five were studying Critical Thinking as an additional subject.

3.1.2 Materials

Two interview schedules were used (Appendix B). The first was based on Greene et al's (2010a; 2010b) EOCQ. Three questions addressed the constructs of the EOCQ (SC, JA, PJ) in a general way. A set of optional follow up questions was prepared to elicit more information. The second interview schedule was drawn up around themes that emerged from the early stages of analysis of the data obtained using schedule one. The questions centred on issues of certainty in knowledge and the similarities and differences between knowledge in different subject areas. Some questions were included for the purposes of 'member checking' (Charmaz, 2006) of the constructs emerging in the initial stages of analysis. In addition to the interview schedule, a set of 2cm x 3cm white cards was prepared, each bearing the name of a different subject on the curriculum of the respondents' school. These were used as prompts to help respondents make comparisons between different subjects in the schedule two interviews.

3.1.3 Procedure

Semi-structured interviewing was used to elicit respondents' talk about knowledge in Psychology and other domains. Twelve interviews were conducted at agreed times in the school day, in classrooms and offices, by a researcher who also taught Psychology to all the respondents. Six interviews used interview schedule one. Four of these were conducted one-to-one, two with pairs of respondents. Six further one-to one interviews were conducted using schedule two. Two respondents were interviewed once (schedule one only), six twice. All interviews were audio recorded. Before each interview began it was explained to respondents that the purpose was to understand how they thought about knowledge in Psychology and that the interviewer was neither testing them nor expecting particular answers from them.

In the first part of the schedule two interviews, respondents were invited to make comparisons between different academic subjects they had studied. To facilitate this they were presented with a set of cards bearing the names of different subjects and asked to remove any that they had never studied or felt unable to talk about. They were then asked to divide the remainder into two groups and asked about the similarities and differences between the subjects implied by the division they had made. This was repeated two or three times with each respondent, until they reported that they had run out of ways to make distinctions. The interviewer then followed the remainder of the interview schedule, asking follow up questions where relevant.

Twelve interviews yielded 401 minutes of audio recording. The interviews were transcribed using a simple notation to produce approximately 57,000 words of typed dialogue. The transcripts were used as the primary data for analysis.

3.1.4 Analytical strategy

The transcript data were analysed using a grounded theory research process (GTRP) described by Charmaz (2006). The aim of this approach is to produce theoretical accounts of phenomena that are directly grounded in data. GTRP was used because its systematic nature allows for the principled generation of ideas in ways that can be followed by people other than the researcher, which enhances transparency in qualitative research (Yardley, 2008). At the same time, its iterative, flexible nature allows for the focus of research to change in response to insights as they occur during the research process. This makes it ideal for exploratory investigations.

GTRP has three phases: initial coding, focused coding and the generation of conceptual categories. These are not sequential; the researcher may move back and forth between them as analysis proceeds, especially since analysis occurs alongside, and informs, the collection of further data. Initial coding is “a process of defining what data are about” (Charmaz, 2008; p.92). This involved examining interview transcripts line by line and defining the epistemic processes and ideas occurring or being represented. This was followed by focused coding, a more selective process during which the most frequent or significant initial codes were used as the basis for creating more inclusive concepts by which large amounts of the data corpus could be sorted and categorised. In the third phase the natures of the concepts emerging from the analysis were clarified, as were the relationships between them. The process was an iterative one in which initial ideas were reassessed in the light of later insights and in which the development of concepts informed the gathering of further data from respondents. Throughout the analysis, memos were written to analyse codes and categories, prompt comparisons between categories and data and to document the research process for transparency purposes.

Although obtained using GTRP, the resulting analysis is not presented as a grounded *theory* of students’ epistemic cognition. The original interview schedule was based on EOC constructs and there would therefore be a risk of circularity in claiming that themes around certainty and justification of knowledge had emerged spontaneously from respondents’ talk. Additionally, the analysis reported here falls short of the exhaustive requirements of grounded theory proper. In particular, no claim is made that the point of category saturation (Charmaz, 2006) was reached, when the gathering of further data no longer leads to new theoretical insights. Consequently, the analysis below should be regarded at most as an exploratory sketch or a grounded description of epistemic cognition in pre-degree Psychology students. It is organised according to the principal concerns of this investigation but it should be noted that the sections are strongly interrelated and no such clear divisions were present in the respondents’ talk.

3.2 Analysis and discussion

3.2.1 Conceptions of Science and Psychology

Unexpectedly, respondents construed Science as a descriptive rather than an explanatory activity: the purpose of Science is to provide facts, which are incontrovertible, descriptive statements about observable entities. To make inferences from or interpretations of data was taken to be a deviation from ideal Science, in which a description of the evidence *constitutes*, because it obviates, an explanation:

> Olivia[2]: [...] there's [.] grey areas where people's knowledge [.] not necessarily individuals' but knowledge of humanity [.] as a whole leaves a few gaps and <u>then</u> you might have to make an inference but when we find everything about Science that there is to know [.] if that ever happens there will be no inferences.
>
> *Interview 12; 284-289.*

Psychology was broadly positioned in contrast to the realist right/wrong dualism of this conception of Science. The requirement of making inferences from behavioural data was viewed as undermining the certainty science requires. The existence of competing psychological perspectives was also construed as problematic for its scientific status either on grounds of a lack of sufficient certainty or because alternative psychological perspectives were regarded as interpretations of behaviour amongst which it is possible to choose. Choosing one's beliefs is incompatible with a realist notion of Science although a scientific status was allowed for some topics in Psychology (e.g. Bio-psychology, constituted principally as descriptive brain anatomy). This was justified in terms of the visible concreteness of its objects of study and the concomitant certainty of the statements to which they could give rise. Further objections to Psychology as a Science were grounded in respondents' ontological assumptions. Science was presented as dealing with uniform entities whereas people were characterised by their uniqueness:

[2] All names have been changed.

> Katie: [...]there's a limitation to how much you can generalise from them because even the facts that you gain are specific to your sample that you get [.] so even if other people are similar then it's still not going to be the same whereas in Biology [.] if it says that your lungs do this then that's the same for everyone because everyone has the same pair of lungs
>
> *Interview 1; 38-43.*

The lack of certainty inherent in Psychological knowledge was rarely construed as problematic since respondents' purpose in studying it was at least in part to equip them with sense-making tools for use in everyday life. Psychological knowledge was positioned for this purpose as a realm of epistemic freedom giving rise to multiple possibilities for understanding.

The absolutist conception of Science apparent here is unexpected in the light of a number of findings that indicate subjectivist/relativist understandings of scientific knowledge in substantially younger samples (Yang & Tsai, 2010). This may reflect differences in research strategy. Most studies infer epistemic conceptions of knowledge from performance on problem solving tasks whereas these respondents were articulating their ideas about knowledge directly. The indirect approach may bring to light implicit epistemic understandings that individuals do not articulate explicitly until substantially later. There is little work against which to situate the respondents' conceptions of Psychology but the account given here is consistent with Greene et al's (2010b) general outline of EC in ill-structured domains and Wallwork, Mahoney and Mason's (2007) findings with beginning Psychology undergraduates.

3.2.2 Justification of knowledge claims in Psychology

Pre-degree students do not hold psychological ideas (concepts, models, theories, perspectives) on a simple continuum of belief. Rather, three distinct epistemic statuses were discernable in respondents' talk: *accepted*, where an idea gives rise to viable ways of explaining behaviour, *rejected*, where it does not, and *sidelined*, where it is held as a formal proposition and no commitment is made to its explanatory viability, truth or falsehood. Whether an idea is *sidelined* or not depends largely on how far it coincides with areas of importance or interest to the student. *Sidelined* knowledge is understood to be acquired for the purposes of mastering the syllabus in order to pass the examination. *Accepted* and *rejected* knowledge has, in addition, a degree of personal importance to the student apparently derived from its relationship with their pre-existing folk psychological notions (Bruner, 1990) and their narratives of everyday experience. If it is *accepted* then a formal Psychological construct may meaningfully be used as a way of making sense of people, although *accepting* did not entail believing for all respondents. A student's repertoire of Psychological ideas is dynamic, and notions that originally were *sidelined* appeared to travel in the direction of being *accepted*, sometimes by way of being *rejected* in between:

> Olivia: Well at the time I remember we all hated Cog[nitive Psychology] it used to be like <u>oh</u> it's a Cog lesson but I think it's kind of Social Psychology is more evident that you can see it happening around you [.] like evaluation apprehension you can see it someone stands up in front of an audience you <u>know</u> it's happening but then I think really when you think about it what's more interesting is Cognitive Psychology because you <u>can't</u> see it and yet it makes sense you can't see it but you think about it and you're like [.] that could happen that <u>does</u> happen I feel like that does happen [.] inside of me

Interview 12; 589-601.

A range of justificatory resources may be mobilised in respect of knowledge claims, depending on their status. *Sidelined* knowledge claims tend to be evaluated formally, in terms of their theoretical coherence, internal and/or external validity and so on. Whilst this superficially resembles sophisticated epistemic activity, from the student's viewpoint it has more the character of a performance or an *evaluation game* played out for the benefit of their examiner and entailing no personal epistemic commitment:

> Susan: [...] there is some knowledge [.] OK I'm not that bothered by it I just learn it for the exam [.] like Freud's structure of the personality [.] you think my gosh it's <u>such</u> a waste of time and I just learned it for the exam
>
> *Interview 10; 400-404.*

The justification for *accepting* a Psychological construct is generally expressed in terms its capacity for *making sense*. This entails more than straightforward comprehensibility. An idea *makes sense* if a clear connection can be drawn between it and one or more episodes of experience. Respondents explained the process of learning introductory Psychology as learning to recognise the familiar as their everyday understandings became colonised with new terms for known (but not always noticed) experiences:

> Amy: Yeah like with perceptual processes and we were saying about size constancy and you look at [.] you look at a bus and it's far away and you don't think oh that's a really small bus you think oh it's coming towards me it's getting bigger and when you were talking about that we were all sitting there thinking yeah yeah it's true
>
> *Interview 6; 400-406.*

This is consistent with the extant literature on individuals' preference for explanations versus evidence as justification for knowledge. In general, a preference for explanations that give a coherent narrative account of a phenomenon gives way only gradually to a preference for evidence-based justification, which appears fully only in high-performing undergraduates (Kuhn, 2001). If Psychology is understood as ill-structured, the disparity between justificatory processes in Science and Psychology is consistent with Greene et al's (2010b) contention that epistemic cognition develops earlier in ill-structured knowledge domains.

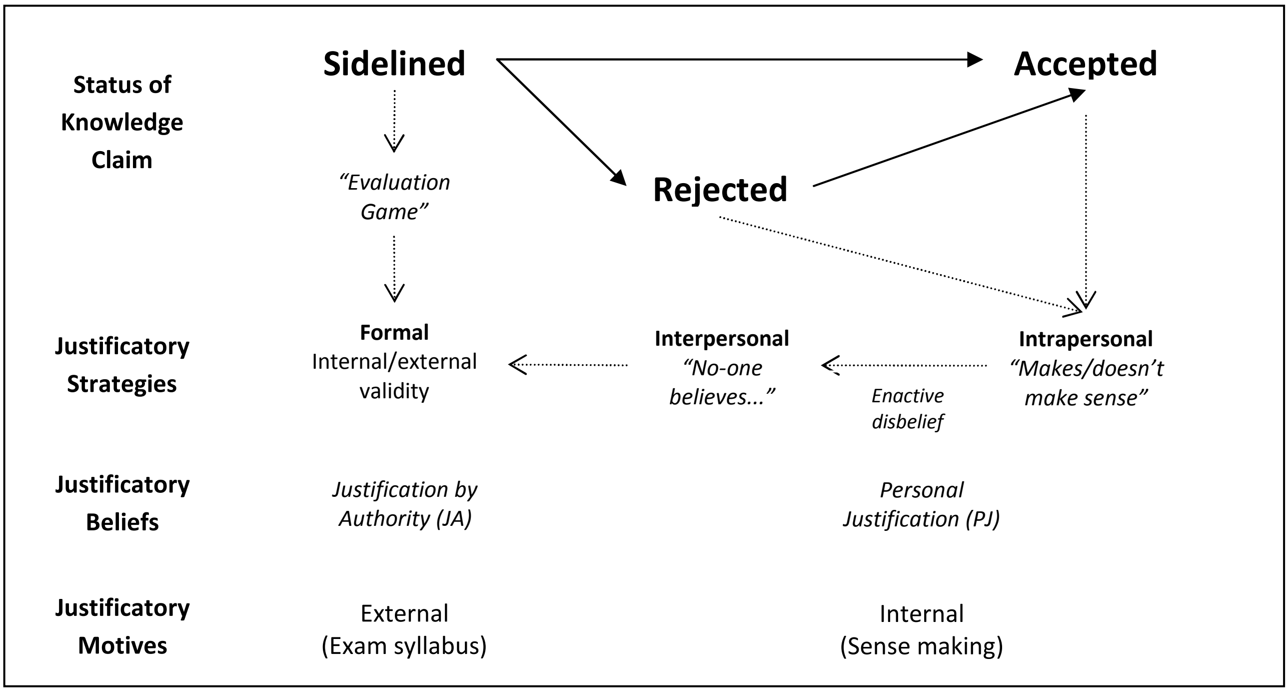
Making sense was presented by respondents as the ultimate arbiter of truth for the kinds of undecidable questions in which Psychology deals, although truths in this context were understood as personal, not necessary. The failure of a construct to *make sense* in relation to a personally important area, however, was a sufficient reason for its being *rejected*. Although *accepted* notions may or may not be regarded as true, *rejected* notions are categorically regarded as false. With *rejected* ideas the epistemic focus shifts to justification for not believing. Frequently this gives rise to a form of *enactive disbelief,* an interpersonal process of nullifying putative justifications for *accepting* the idea. The principal strategy appeals to a notional consensus of disbelief. This may be strengthened by rhetorical deployment of formal evaluation criteria in barrage form:

> Anna: [...] the whole Oedipus and Elektra complex [.] that really doesn't make sense to me because I can't really comprehend with it [.] it might be true but from what I can remember it's not really and I think as I sort of discussed it with other people in the group as well they kind of find it difficult [.] weird [.] strange and I think maybe because Freud only [.] he based that assumption on a very limited case study that he didn't even see the child he just read letters from the parent [.] he based the whole study on one person that I don't think it's very reliable because it doesn't mean that just because one person's going through a certain experience that everybody's having that
>
> *Interview 5; 468-481.*

There is a broad relationship between the justificatory strategies in this sketch and the two sources of justification in Greene et al's (2008) EOC model (JA and PJ). In the respondents' talk about knowledge these seemed to correspond, in turn, to two categories of underlying motives for knowing: those imposed externally (the requirement to pass an exam) and those understood as internal (the desire to make sense of experience). A diagrammatic sketch of the relationships between grounded concepts is given in Figure 6.

The above grounded description of epistemic cognition agrees broadly with Greene et al's (2008) EOC model. It refines their account by going some way to clarifying the character of personal justification, in Psychology at least. It differs from the EOC model in one important respect. The EOC model treats all justification as a matter of belief and there is an assumption that individuals evaluate all knowledge claims on an equivalent basis. This reflects a more general tendency within theories of epistemic cognition to construe the prototypical knower as a 'naive scientist' whose principal motivation for acquiring and evaluating knowledge is *to know more*. This may reflect the predominance of undergraduate samples in this area of research. The pre-degree students studied here manifested a strategic approach to knowledge acquisition that had consequences for the way they thought (or did not think) about what they had learned. This is unsurprising given their exam-dominated epistemic landscape and the high stakes at risk in the educational game in which they were caught up. But, as research into epistemic cognition increasingly moves beyond undergraduate populations, greater attention will need to be paid to how the process is influenced by the context in which knowledge claims are evaluated and the individual's motives for doing so.

Figure 6. Relations between concepts in a grounded description of epistemic justificatory processes in pre-degree Psychology students



Through the lens of quantitative research concerns, study two may be viewed with scepticism. However, to dismiss it on grounds of its small sample and apparent lack of objectivity would miss the point of adopting qualitative methods. Since the aim was to explore the nuances in respondents' beliefs about knowledge a statistically viable sample would have been impractical to study and the usual precautions taken to minimise bias (rigid standardisation and statistical analysis of data) would inevitably have removed as error variance exactly the nuances and variations the investigation sought to understand. Using criteria offered by Yardley (2008) as more suitable for the evaluation of qualitative investigations, two principal concerns come to the fore. First, the dual role of the researcher/teacher who gathered the data meant that all the interviews were framed by the teacher-student relationship and its associated power imbalance. There is a strong possibility this affected respondents' willingness to articulate some understandings of epistemic processes. In mitigation it is offered that the same teacher-student relationship frames the exploration of Psychological knowledge in the classroom so the research context actually reproduced very closely the one it aimed to elucidate. A second problem is that the use of a single researcher to collect and interpret the data did not allow for the types of triangulation and cross-validation that enhance the transparency and rigour of analysis in qualitative studies. The use of GTRP, with its strong reflexive focus and self-generating audit trail of analytical decisions, goes some way to addressing this concern but it is accepted that the above analysis should be treated with great caution. It is therefore offered as exploratory work of a preliminary nature. Further research that extends the concepts described here or evaluates them more rigorously is encouraged.

4. Conclusions

The two studies presented above are indirect evidence for an effect of studying Psychology on epistemic cognition in other subject domains. Students who study both Psychology and Biology see Biological knowledge as simpler and less personally justified than students who study Biology only. This may be attributable to a contrast effect that influences the judgements of those who study both subjects and which is rooted in their ontological assumptions about the nature of Science and of people. However, it remains to be established whether these differences actually are consequent upon studying Psychology. It is also unknown how far these differences are caused or mediated by the teaching a student receives, which may be influenced by the teacher's own epistemic outlook. Further research should address the influence of teacher EC within and across subject domains.

For Psychology teachers, these findings raise questions about how introductory courses are taught, especially if the ambition is to develop students with a critical appreciation of the scientific nature of the discipline. This is an important predictor of success for those who subsequently advance to degree courses in the field (Nathanson, Paulhus & Williams, 2004).

One implication of these findings is that introductory courses should address students' epistemic misconceptions about the nature of Science as much as they should promote an understanding of Psychological principles. A second implication is that teachers should seek to bridge the apparent gap between students' externally and internally motivated epistemic cognition. The problem here is twofold: students' most principled epistemic cognition involves little or no personal commitment to ideas whereas their most personally committed understandings tend to be epistemically unprincipled. To meet the the aspiration to develop Psychology students who "care about getting things right" then two things must happen in introductory Psychology learning. Students must first define Psychological ideas as personally relevant, so that meaningful, intrinsically motivated epistemic thinking occurs in relation to them. They should then be encouraged to shift their justificatory arguments away from narrative coherence and towards a preference for evidence. Teaching them to understand the difference is suggested as a useful first step.

A final implication is for the justification of Psychology's place in the pre-degree curriculum. Claims that the subject develops students as critical thinkers do not stand up to the evidence presented here. There may be an impact across domains but it does not make students more sophisticated in their understanding of knowledge in the sciences. If anything, they appear more naive than those who study other subjects. As things stand, then, the consolation of the pre-degree Psychology teacher must be sought elsewhere.

References

Alston, W. P. (1980). Level confusions in epistemology. *Midwest Studies in Philosophy*, 5, 135-150.

Baxter-Magolda, M. B. (1992). *Knowing and reasoning in college: gender related patterns in students' intellectual development*. San Francisco, CA, Jossey-Bass.

Baxter-Magolda, M. B. (2004). Evolution of a constructivist conceptualisation of epistemological reflection. *Educational Psychologist*, 39, 31-42.

Belenky, M. F., Clinchy, B. M., Goldberger, N. & Tarule, J. (1986). *Women's ways of knowing: The development of self, voice and mind*. New York, NY, Basic Books.

Bendixen, L. (2002). A process model of belief change. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Bendixen, L. & Rule, D. (2004). An integrative approach to personal epistemology: A guiding model. *Educational Psychologist*, 39, 69-80.

Bowell, T. & Kemp, G. (2002). *Critical thinking: A concise guide*. London, Routledge.

Brabeck, M. & Wood, P.K. (1990). Cross-sectional and longitudinal evidence for differences between well-structured and ill-structured problem-solving abilities. In M. L. Commons, C. Armon, L. Kohlberg, F. A. Richards, T. A. Grotzer & J. D. Sinnons (Eds.) "*Adult development 2: Models and methods in the study of adolescent and adult thought*". New York, NY, Praeger.

Bray, J. H. & Maxwell, S. E. (1985). *Multivariate analysis of variance*. Sage university paper series on quantitative applications in the social sciences, 07-054. Newbury Park, CA, Sage.

Brookfield, S. (1987). *Developing critical thinking*. Milton Keynes, SRHE/Open University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA, Harvard University Press.

Buehl, M. M. (2008). Assessing the multidimensionality of students' epistemic beliefs across diverse cultures. In M. S. Khine (Ed.) "*Knowing, knowledge and beliefs: Epistemological studies across diverse cultures*". New York, NY, Springer.

Chandler, M. J., Hallett, D. & Sokol, B. W. (2002). Competing claims about competing knowledge claims. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Chandler, M. J. & Proulx, T. (2010). Stalking young persons' changing beliefs about belief. In L. D. Bendixen & F. C. Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London, Sage.

Charmaz, K. (2008). Grounded theory. In J. A. Smith (Ed.) "*Qualitative psychology: A practical guide to research methods*". London, Sage.

Clareabout, G., Elen, J., Luyten, L. & Bamps, H. (2001). Assessing epistemological beliefs: Schommer's questionnaire revisited. *Educational Research and Evaluation*, 7, 53-77.

Donald, J. (1990). University professors' views of knowledge and validation. *Journal of Educational Psychology*, 82, 242-249.

Edman, L. R. O. (2008). Are they ready yet? Developmental issues in teaching thinking. In D. S. Dunn, J. S. Halonen & R. A. Smith (Eds.) "*Teaching critical thinking in Psychology: A handbook of best practices*". Chichester, Wiley-Blackwell.

Ennis, R. (1996). *Critical thinking*. Upper Saddle River, NJ, Prentice-Hall.

Ennis, R. (2001). Goals for a critical thinking curriculum and assessment. In A. Costa (Ed.) "*Developing minds (3rd Ed.)*". Alexandria, VA, ASCD Publications.

Estes, D., Chandler, M., Horvath, K. & Backus, D. W. (2003). American and British college students' epistemological beliefs about research on psychological and biological development. *Journal of Applied Developmental Psychology*, 23, 625-642.

Feucht, F. C. (2010). Epistemic climate in elementary classrooms. In L.D.Bendixen & F.Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Greene, J. A., Azavedo, R. & Torney-Purta, J. (2008). Modelling epistemic and ontological cognition: Philosophical perspectives and methodological directions. *Educational Psychologist*, 43, 142-160.

Greene, J.A., Torney-Purta, J. Azavedo, R. & Robertson, J. (2010a). Using cognitive interviewing to explore elementary and secondary students epistemic and ontological cognition. In L. D. Bendixen & F. C. Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Greene, J.A., Torney-Purta, R. & Azavedo, R. (2010b). Empirical evidence regarding relations among a model of epistemic and ontological cognition, academic performance and educational level. *Journal of Educational Psychology*, 102, 234-255.

Grolnick, W. S. & Ryan, R. M. (1987). Autonomy in children's learning: An experimental and individual differences investigation. *Journal of Personality and Social Psychology*, 52, 890-898

Halonen, J. S. (1995). Demystifying critical thinking. *Teaching of Psychology*, 22, 75-81.

Harlen, W. (2006). The role of assessment in developing motivation for learning. In J. Gardner (Ed.) "*Assessment and learning*". London, Sage.

Harlen, W. & James, M. (1997). Assessment and learning: Differences and relationships between formative and summative assessment. *Assessment in Education*, 4, 365-380.

Hofer, B. K. (2002). Personal epistemology as a psychological and educational construct: An introduction. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Hofer, B. K. (2004a). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist*, 39, 43-55.

Hofer, B. K. (2004b). Exploring the dimensions of personal epistemology in differing classroom contexts: Student interpretations during the first year of college. *Contemporary Educational Psychology*, 29, 129-163.

Hofer, B. K. & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67, 88-140.

Jehng, J. J., Johnson, S. D. & Anderson, R. C. (1993). Schooling and students' epistemological beliefs about learning. *Contemporary Educational Psychology*, 18, 23-35.

Joint Council for Qualifications (2010). Provisional GCE A Level results 2010 (all UK candidates). URL: http://www.jcq.org.uk/attachments/published/1297/JCQ%20GCE%20Results%202010.pdf Retrieved 10th July, 2011.

King, P. M. & Kitchener, K. S. (1994). *Developing reflective judgement: Understanding and promoting reflective growth and critical thinking in children and adolescents*. San Francisco, CA, Jossey-Bass.

King, P. M. & Kitchener, K. S. (2002). The reflective judgment model. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

King, P. M. & Kitchener, K. S. (2004). Reflective judgment: Theory and research on the development of epistemic assumptions through adulthood. *Educational Psychologist*, 39, 5-18.

King, P. M., Kitchener, K. S. & Wood, P. K. (1994). Research on the reflective judgment model. In P. M. King & K. S. Kitchener (Eds.) "*Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*". San Francisco, CA, Jossey-Bass.

King, P. M., Wood, P. K. & Mines, R. A. (1990). Critical thinking among college and graduate students. *The Review of Higher Education*, 13, 167-186.

Kitchener, R. F. (2002). Folk epistemology: An introduction. *New Ideas in Psychology*, 20, 89-105.

Klaczynski, P. A. (2000). Motivated scientific reasoning biases, epistemological beliefs and theory polarization: A two-process approach to adolescent cognition. *Child Development*, 71, 1347-1366.

Kuhn, D. (1999). A developmental model of critical thinking. *Educational Researcher*, 28, 16-25.

Kuhn, D. (2001). How do people know? *Psychological Science*, 12, 1-18.

Kuhn, D. & Pearsall, S. (1998). Relations between metastrategic knowledge and strategic performance. *Cognitive Development*, 13, 227-247.

Lonka, K. & Lindblom-Ylanne, S. (1996). Epistemologies, conceptions of learning and study practices in medicine and psychology. *Higher Education*, 31, 5-24.

Lui, S-Y. & Tsai, C-C. (2008). Scientific epistemological views of undergraduate students. *International Journal of Science Education*, 30, 1055-1073.

Moore, W. S. (2002). Understanding learning in a postmodern world: Reconsidering the Perry scheme of intellectual and ethical development. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Moshman, D. (2011). *Adolescent rationality and development: Cognition, morality and identity (3rd Edition*). Hove, Psychology Press.

Nathanson, C., Paulhus, D. L. & Williams, K. M. (2004). The challenge to cumulative Learning: Do introductory courses actually benefit advanced students? *Teaching of Psychology*, 31, 5-9.

Palmer, B. & Marra, R. (2004). College student epistemological perspectives across knowledge domains: A proposed grounded theory. *Higher Education*, 47, 311-335.

Perry, W. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York, NY, Holt Rinehart.

Pascarella, E. T. & Terenzini, P. T. (1991). *How college affects students*. San Francisco, CA, Jossey-Bass.

Paulsen, M. B. & Feldman, K. A. (2007). The conditional and interaction effects of epistemological beliefs on the self-regulated learning of college students: Cognitive and behavioural strategies. *Research in Higher Education*, 48, 353-401.

Petress, K. (2004). Critical thinking: An extended definition. *Education*, 124, 461-466.

Prospects (2011). Psychology: career area. URL: http://www.prospects.ac.uk/options_psychology_career_areas.htm Retrieved 30th June 2011.

Qualifications and Curriculum Authority (QCA) (2006). GCE AS and A Level subject criteria for science (QCA/06/2864). URL: http://www.ofqual.gov.uk/files/qca-06-2864_science.pdf Retrieved 11th July, 2011.

Quality Assurance Agency (2008). The framework for higher education qualifications in England, Wales and Northern Ireland. URL: http://www.qaa.ac.uk/academicinfrastructure/fheq/ewni08/fheq08.pdf Retrieved: 30th June 2011.

Rest, J. R. (1979). *Development in judging moral issues*. Minneapolis, MI, University of Minnesota Press.

Rule, D. C. & Bendixen, L. D. (2010). The integrative model of personal epistemology development: Theoretical underpinnings and implications for education. In L. D. Bendixen & F. Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Schommer, M. (1994). Synthesising epistemological belief research: Tentative understandings and provocative conclusions. *Educational Psychology Review*, 6, 293-319.

Schommer-Aikens, M. (2004). Explaining the epistemological belief system: Introducing the embedded systemic model and co-ordinated research approach. *Educational Psychologist*, 39, 19-29.

Schommer-Aikens, M., Bird, M. & Bakken, L. (2010). Manifestations of an epistemological belief system in preschool to grade twelve classrooms. In L. D. Bendixen & F. C. Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Schraw, G., Bendixen, L. D. & Dunkle, M. E. (2002). Development and validation of the epistemological belief inventory. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Wallwork, J., Mahoney, B. & Mason, S. (2007). 'Watching people do stuff': An analysis of newly recruited students' accounts of doing a Psychology degree. *Psychology Learning and Teaching*, 6, 139-149.

Wood, J. V. (1989). Theory and research concerning social comparisons of personal attributes. *Psychological Bulletin*, 106, 231-248.

Wood, P. K. (1997). A secondary analysis of claims regarding the reflective judgment interview: Internal consistency, sequentiality and individual differences in ill-structured problem solving. In J. C. Smart (Ed.) "*Higher education: Handbook of theory and research. Volume XII*". Edison, NY, Agathon Press.

Wood, P. K. & Kardash, C. A. (2002). Critical elements in the design and analysis of studies of epistemology. In B. K. Hofer & P. R. Pintrich (Eds.) "*Personal epistemology: The psychology of beliefs about knowledge and knowing*". Mahwah, NJ, Lawrence Earlbaum Associates.

Yang, F-Y & Tsai, C-C. (2010). An epistemic framework for scientific reasoning in informal contexts. In L. D. Bendixen & F. C. Feucht (Eds.) "*Personal epistemology in the classroom: Theory, research and implications for practice*". Cambridge, Cambridge University Press.

Yardley, L. (2008). Demonstrating validity in qualitative Psychology. In J. A. Smith (Ed.) "*Qualitative Psychology: A practical guide to research methods*". London, Sage.