Examination of student learning approaches, reflective thinking, and epistemological beliefs: A latent variables approach

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Abstract

Introduction. The work of reflective thinking (Mezirow, 1991, 1998) and epistemological beliefs (Schommer, 1990, 1993; Schommer-Aikins, Duell & Hutter, 2005) is increasingly recognized as playing an important role in students' academic learning. Furthermore, students' approaches to their learning are also considered as contributing factors in the prediction of students' academic performance. Very few studies to date have combined these three theoretical frameworks within the one study. This article discusses two separate studies conducted over a 12-month period in mathematics and curriculum studies examining the relationships between students' epistemological beliefs, learning approaches, reflective thinking, and academic performance.

Method. Study 1 examined first-year mathematics (N = 352: 152 females, 200 males) students' learning approaches – deep and surface -, the four stages of reflective thinking, and academic performance. Study 2 involved third-year curriculum studies (N = 332: 146 females, 185 males) students and used path analysis to show that deep learning approaches, epistemological beliefs, and reflective thinking predicted academic performance.

Results. For Study 1, linear structural analysis indicated that a surface learning approach predicted habitual action, and a deep learning approach predicted understanding and critical reflection. Deep learning approach, habitual action, and critical reflection also predicted academic performance. Results for Study 2 indicated that deep learning approaches also predicted habitual action and reflection. Furthermore, epistemological beliefs influenced learning approaches as well as the four stages of reflective thinking.

Discussion or **Conclusion.** The findings of the two studies are significant as they add theoretical contribution to the existing literature as well as provide practical implications for educators concerning the relations between epistemological beliefs, learning approaches, reflective thinking, and academic performance.

Keywords: Reflective thinking; epistemological beliefs; learning approaches; structural analyses

Introduction

The teaching and learning processes are influenced by different cognitive variables, important amongst them include student learning approaches, epistemological beliefs and reflective thinking. The two major learning approaches (Biggs, 1987a; Marton & Säljö, 1976) and Schommer's (1988) original work pertaining to epistemological beliefs during the past two decades have resulted in a substantial body of research evidence. Recently, however, an emerging interest has involved the study of students' approaches to learning and their epistemological beliefs within the one framework (Cano, 2005). Further research interest into learning stemming from the work of Leung and Kember (2003) has focused on Mezirow's (1977, 1991, 1998) conceptualisation of reflective thinking within the framework of student learning approaches. Reflective thinking, in particular, has been influential in the teaching and learning profession and is evidenced by the coining of terms such as 'reflective practice', 'reflective practitioner', and 'critical thinking'. Most notably, at present, there is an absence of research in examinations of the three theoretical frameworks within the one study (Cano, 2005; Schommer-Aikins, Duell & Hutter, 2005). This article presents two separate studies that examined the relations amongst epistemological beliefs, student learning approaches, reflective thinking, and academic performance from the perspectives of first-year mathematics and third-year curriculum studies students.

Students' epistemological beliefs about knowledge and learning

The focus of epistemological beliefs in learning and academic development originates from the work of Perry (1970) but has emerged as an active research topic during the past 10 to 15 years (Muis, 2004; Schraw & Sinatra, 2004). Epistemology is a branch of philosophy that is concerned with the nature of knowledge and justification of beliefs. There are many methodological examinations of epistemological beliefs depending on which theoretical orientations are given emphasis (for example, Baxter Magolda, 1987; Hofer & Pintrich, 1997; Kitchener & King, 1981; Ryan, 1984; Schommer, 1990). A full discussion of these methodological examinations and different orientations is beyond the scope of this article, and focus is made instead towards the theoretical perspective of Marlene Schommer. The work of most authors concerning epistemology involves exploring late adolescents and young adults using complex, time-consuming instruments such as production tasks and/or interviews, and trained observers to evaluate those beliefs (Cano, 2005). In contrast, Schommer suggests a quick, simple self-report questionnaire that may enable researchers to study individuals in less time.

Furthermore, Schommer, differing from other theoretical perspectives, offers a more simplistic quantified view of epistemology by contending to the view that individuals possess multiple beliefs about the nature of knowledge and learning, and that these beliefs exist as a multidimensional system or more or less independent beliefs. The argumentative premise is that, in contrast to the work of Perry, Kitchener and Ryan, personal epistemology is too complex for it to be captured on a unidimensional dimension. The term system according to Schommer refers to the notion of more than one systems composed personal epistemology, and more or less independent suggests that these beliefs could, but not necessarily would, develop in synchrony.

The theoretical lens of Schommer's perspective posits four dimensions of epistemological beliefs, ranging from naïve to sophisticated: (a) structure of knowledge (ranging from isolated bits to integrated concepts), (b) stability of knowledge (ranging from certain to evolving), (c) speed of learning (from quick or not at all to gradual), and (d) ability to learn (ranging from fixed at birth to improvable)(Schommer, 1994a, 1994b; Schommer-Aikins & Hutter, 2002). The Epistemological Questionnaire, developed by Schommer (1990), has provided evidence to support the multidimensionality of epistemological beliefs. Examinations of subsequent research indicate that epistemological beliefs predict numerous aspects of academic performance, important amongst them include comprehension, metacomprehension, interpretation of information, higher-order thinking, persistence in working on difficult academic tasks, and problem-solving approaches (Muis, 2004; Schommer, 1993, 1998; Schommer, Crouse & Rhodes, 1992; Schommer-Aikins *et al*., 2005). For example, beliefs about structures and certainty of knowledge predict comprehension, metacomprehension, and interpretation of information. Beliefs about the speed of learning and the ability to learn predict comprehension, valuing of education and overall performance. Other research studies have also examined students' epistemological beliefs in relation to domain-specificity that involves study strategies and problem solving in accounting, history, mathematics, and hypermedia learning (Buehl & Alexander, 2005; Peng & Fitzgerald, 2006; Phillips, 2001; Schommer-Aikins *et al*., 2005).

Students' approaches to learning

The origins of student learning approaches (SAL) are credited to the work of Marton and Säljö (1976) where two major categories of approaches to learning were identified: deep and surface. According to this theoretical perspective, students may adopt a deep approach to learning with an intention to understand the authors' meaning and linking it to their prior

knowledge and personal experience. In contrast, students may also adopt a surface learning approach where the main emphasis is on studying merely for the intention of reproducing information without any further analysis (Murphy & Tyler, 2005). Examinations of John Biggs' (1987a) theoretical orientation suggest an additional learning approach – achieving- wherein it is based on achieving motivation and involves strategies that lead to high marks; for example, "study skills" techniques (e.g., good organization, speed reading, effective note-taking) and "cue-conscious" strategies that depend on the learning environment and the extent of teacher involvement (Akande, 1998). The achieving approach is therefore context dependent and the surface and deep approaches relate to rehearsal and the general cognitive processes of coding, respectively (Akande, 1998). Importantly, however, Biggs' (1987a) theoretical conception of study approaches differs from other theorists in its two components: how students approach a task (strategy); and why they want to approach it in the first place (motive).

Focusing on the LPQ and SPQ (Biggs, 1987b, 1987c), the review of literature indicates two main areas of research: an examination of the psychometric properties of the LPQ and SPQ by means of confirmatory factor analysis (*CFA*) and exploratory factor analysis (*EFA*); and the study of student learning behaviours. Analysis of research studies indicates anomalous results with some investigations confirming a three-factor structure (Kember & Gow, 1991; Watkins, Regmi & Astilla, 1991) while other studies confirm only two factors – deep approach combined with achievement approach, and surface approach. For example, Kember and Leung (1998) tested a number of *a priori* first and second-order factor models and found a two-factor model as the best fitted model. The two major factors, which are indicative of students' study approaches, labelled as 'reproducing' and 'meaning' lend support to the conclusion that Richardson (1994) drew, namely: "there is little unambiguous support for any *separate*, 'strategic' approach to academic assessment of the sort that was originally postulated by Ramsden (1979), based upon an 'achieving' orientation towards studying" (p. 463).

Biggs, Kember, and Leung (2001) extended this line of inquiry by suggesting that students, in general, adjust their styles of learning based upon the demands of the course that they are enrolling in. The authors revised the original SPQ to form the revised two-factor Study Process Questionnaire (R-SPQ-2F). This instrument is designed to evaluate how students approach learning topics or courses that are most important to them. Furthermore, the changing of wordings of instruction enables the R-SPQ-2F to be used as evaluation of students' approaches to specific topics or courses. Fox, McManus, and Winder (2001), for ex-

ample, found with medical students that the R-SPQ-2F shared similar characteristics in terms of structure to those of the original SPQ. The R-SPQ-2F as demonstrated also enabled prediction of medical students' academic performance.

Research investigations have also provided evidence attesting to the relations between approaches to learning and the quality of learning outcomes (Trigwell & Prosser, 1991; Watkins, 1983) and academic performance. Evidence suggests that that deep approach to learning is associated with high-quality outcomes. Results focusing on university students have also indicated that, in many cases, all or some of the approaches to learning are related to academic performance (Drew & Watkins, 1998; Watkins *et al*., 1991; Wong & Watkins, 1998). In contrast, studies centred on high school students show that students' poor performances were related to their use of a surface approach (Watkins, 2001; Wong & Watkins, 1998), whereas higher grades were obtained by those who aligned their learning to a deep approach (Watkins, 2001; Wong & Watkins, 1998) and those who displayed achievement motivation (Eklund-Myrskog & Wenestam, 1999). In general, based on this analysis, the evidence seems to suggest that deep and achieving approaches to learning relate positively to academic success, and surface approaches relate negatively with academic performance.

Reflective thinking and students' learning

The notion of reflective thinking, or what is commonly referred to as 'reflective practice', 'reflection', and 'reflective practitioner', is not a new idea but originates from the work of John Dewey (1933). He defined it as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the conclusion to which it tends." (p. 9). Reflective thinking, according to Dewey, emphasises the consequences of ideas and suggests future physical action to confront and to solve a variety of personal and professional obstacles (Norton, 1997). In the teaching and learning processes, reflective thinking cultivates meaningful learning and helps students and educators alike to develop specific skills that may assist them to be more vocal and critical, and to develop expertise in their areas of professionalism.

Research investigations into reflective thinking employing quantitative and qualitative methodological approaches have sought to explore how critical reflective practice fits in with the teaching and learning processes, as well as the development of specific skills that required in reflection itself. A full discussion of these researches is beyond the scope of this article, and efforts are focused instead on a recent important line of research inquiry, namely Mezirow's (1981) theories of learning and the sources of reflective thinking. Mezirow's theoretical orien-

tation of reflective thinking suggests that as adults gauge and expand into their personal learning, they become more adaptive and are able to benefit from their experiences. Reflective thinking involves not only cognitive processes, but also affective, social, cultural, and political reasoning (Jensen & Joy, 2005; Mezirow, 1981). Furthermore, in his theoretical perspective Mezirow advocates four stages of reflective thinking: habitual action, understanding, reflection and critical reflection. Habitual action is a mechanical and automatic activity that is performed with little conscious thought. Understanding is learning and reading without relating to other situations. Reflection concerns active, persistent and careful considerations of any assumptions or beliefs grounded in our consciousness. Finally, critical reflection is considered as a higher level of reflective thinking that involves us becoming more aware of why we perceive things, the way we feel, act and do (Mezirow, 1991, 1998).

Mezirow's (1981, 1991, 1998) theoretical orientation has been used to study reflection within nursing as well as in adult education (Jensen & Joy, 2005; Wong, Kember, Chung & Yan, 1995). More recently, research investigations have extended to the study of how the four stages of reflective thinking relate to student learning approaches (e.g., Kember, Leung, Jones, Loke, McKay, Sinclair, Tse, Webb, Wong, Wong, & Yeung, 2000; Leung & Kember, 2003). In particular, the quantitative approach of latent variables (Bollen, 1989; Byrne, 1998; Mueller, 1996) used in these studies has provided evidence attesting to the important positive associations between students' approaches to their learning and reflective thinking. This amalgamation of reflective thinking in SAL research (e.g., Biggs *et al*., 2001; Bernardo, 2003; Kember, Biggs, & Leung, 2004; Kember & Leung, 1998) has resulted in the study of different learning styles as possible sources of reflective thinking. Leung and Kember's (2003) study on learning styles indicates that the four stages of reflective thinking are related to the two main learning styles. Confirmatory factor analysis (*CFA*) in this case indicated a positive correlation between habitual action and surface approach to learning, and understanding, reflection, and critical reflection and that of deep study approach. Accordingly a surface approach to learning is in line with habitual action, whereas a deep approach to learning is more reflective of the other three types of reflective thinking.

Relationships between Epistemology, Learning approaches, Reflective thinking and Academic performance

The amalgamation of research investigations into students' epistemological beliefs and learning approaches (Cano, 2005), and learning approaches and reflective thinking (Leung & Kember, 2003) has been advanced separately by researchers. It is considered of value to theo-

ries and practice to examine within the one study whether the three theoretical frameworks influence academic performance and, if so, how. From a theoretical perspective, for example, specific learning orientations of students may help to explain the reflective thinking practice that takes place in classroom settings. Similarly, personal beliefs pertaining to the nature of knowledge play an important role in students' specific learning orientations.

As described previously, the work of Schommer and colleagues (Schommer, 1993, 1998; Schommer *et al*., 1992; Schommer-Aikins *et al*., 2005) has indicated that epistemological beliefs predict academic performance. In a recent study involving both epistemological beliefs and student learning approaches, Cano found with secondary European students that their epistemological beliefs and learning approaches change as they advance in their studies. Furthermore, with the exception of the factor certain knowledge, both quick learning and simple knowledge epistemological beliefs influenced academic performance directly. Epistemological beliefs also indirectly influenced academic performance via the effects of the two learning approaches. Zhang and Watkins (2001) in their study of Perry's (1970) scheme of intellectual and ethical development found similar findings between ideas about knowledge and learning and academic performance. This important evidence then, albeit limited at present, substantiates the view that epistemological beliefs influence academic performance directly and indirectly via the mediating influences of learning approaches.

Despite the extensive research into epistemological beliefs (Schommer, 1993; Schommer *et al*, 2002; Schommer-Aikins *et al*., 2005; Schraw & Sinatra, 2004) and that the recent work by Cano (2005) is a developing area, there are still many unknown factors that need to be explored further. Extending Cano's study, in particular, we feel that it is important to advance this premise with the inclusion of Mezirow's (1977, 1991, 1998) work. In addition to student learning approaches, the study of epistemological beliefs within the framework of reflective thinking has theoretical and practical implications as these beliefs may play a role in influencing the four stages of reflective thinking directly and indirectly via the major learning approaches (Cano, 2005; Schommer-Aikins *et al*., 2005). There is a gap at present in our theoretical understanding of how epistemological beliefs relate to student learning approaches and reflective thinking. For example, students' beliefs about knowledge in a subject domain (e.g., mathematics) may influence their adoption of a particular learning approach as well their understanding and development of reflective thinking. One might argue then that students who adopt a deep approach to learning are more likely to critically reflect on their learning with a view to improve; this pursue of reflection enables them to be more successful in their academic learning.

Research into the relations between student learning approaches and the four stages of reflective thinking (Mezirow, 1977, 1991, 1998) is still in its infancy and requires further investigation. The *CFA* work of Leung and Kember (2003) has established an important theoretical foundation that may indicate the possibility of the two learning approaches – deep and surface – acting as causal determinants of reflective thinking. In particular, the structural analysis performed in the Leung and Kember study suggests the precedence of causality between the approaches to learning and the stages of reflective thinking. Empirical evidence is needed to clarify whether students who adopt a surface learning approach may then be influenced to see learning as something that is automatic and mechanical. Similarly, the theory of SAL (Kember & Leung, 1998; Leung & Kember, 2003) has posited that students who align to deep approaches to learning are more motivated and interested in using different strategies to search for meaning and understanding, as well as to theorise and to form new hypothesis. This theoretical postulation relates to the three stages of reflective thinking. There is a need, however, as Leung and Kember recognized, to advance the causal relations between these two frameworks. Furthermore, we feel that it is important to extend this line of research inquiry concerning the interrelations between the three theoretical frameworks with the inclusion of academic performance.

Overall, based on existing research evidence cited, we explored the relationships between the three theoretical frameworks outlined in two separate studies involving studen enrolled in mathematics and curriculum studies. We examined the three theoretical frameworks in two different subject domains as there are reasons to indicate, for example, that subject disciplines influence students' learning approaches (Skogsberg & Clump, 2003; Smith & Miller, 2005). Furthermore, as students progress in learning the experiences acquired at university may help them form and develop their reflective thinking and, in particular, personal beliefs about knowledge differently as opposed to first-year students who have very little university learning experiences. In this analysis, we feel that it is important to provide a comparison of students in different years and subject disciplines. Evidence obtained from the present research may shed additional insight into students' epistemological beliefs arising from their acquired experiences at university.

Study 1: An approach to learning, reflective thinking, and academic performance

This study explored the relationships between student learning approaches, the four stages of reflective thinking, and academic performance over a period of 12 months of first year mathematics students in the Pacific. The focus of this study, developed from previous

research evidence (Drew & Watkins, 1998; Leung & Kember, 2003; Mezirow, 1991, 1998; Watkins, 2001; Wong & Watkins, 1998), attempts to explore the causal effects of student learning approaches and reflective thinking on academic performance over time. Furthermore, according to Mezirow (1991, 1998), the four stages of reflective thinking are structured from simplicity to complexity. We advocate, given this simple-complex structure, that each stage of reflective thinking determines the next; for example, habitual action determines understanding, understanding determines reflection, and reflection determines critical reflection. The sequence of this theoretical contention here suggests that having understood the true meaning of a subject content may enable students then to reflect on their learning (Leung & Kember, 2003). Specifically, the research questions under investigation include: (a) Do deep and surface approaches contribute to the prediction of the four stages of reflective thinking?; (b) Do deep and surface approaches predict academic performance directly, and indirectly via reflective thinking?; (c) Do the four stages of reflective thinking predict academic performance directly?; and (d) Do the four stages of reflective thinking exist in a sequence as indicated? These four questions are answered by means of linear structural equation.

Participants

Participants (N = 352: 152 females, 200 males) in this study were all Science major with the exception of some students who were Arts and Education majors. The age range of the students ranged from 18-47 (M = 23; SD = 1.95).

Instrumentation

Study Process Questionnaire (R-SPQ-2F)

Existing research studies using Biggs' (1987c) Study Process Questionnaire (SPQ) have indicated the recurrent theme that the major learning approaches are best described by a two-factor structure (Kember *et al*., 2004; Kember & Leung, 1998; Leung & Kember, 2003; Richardson, 1994). The revised SPQ, developed recently by Biggs *et al*. (2001), offers an alternative with consistent research evidence supporting for its use (Biggs *et al*.; Fox *et al*. 2001; Leung & Kember, 2003). The R-SPQ-2F consists of 20 items grouped into two approaches – deep and surface. Each subscale (e.g., deep motive (DM)) comprised of 5 items answered on a 5-point Likert scale ranging from 1 (always true of me) to 5 (only rarely true of me); for example, "I find that at times studying gives me a feeling of deep personal satisfaction" (deep motive), "I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied" (deep strategy), "My aim is to pass the course while

doing as little work as possible" (surface motive), and "I only study seriously what's given out in class or in the course outlines" (surface strategy). A full version of the 20 items may be obtained from Biggs *et al.*. Researchers using this instrument have reported reliability estimates ranging from .57 to .72 for the four subscales (Biggs *et al.*; Leung & Kember, 2003).

Reflective Thinking Questionnaire (RTQ)

The Reflective Thinking Questionnaire (RTQ) developed by Kember *et al.*, 2000) contains 16 items descriptive of the four types of reflective thinking advocated (Mezirow, 1977, 1991). The items on a five-point scale ((1) definitely agree, (3) only to be used if a definite answer is not possible, (5) definitely disagree) include, for example: "In this course we do things so many times that I started doing them without thinking about it" (Habitual action); "To pass this course you need to understand the content" (Understanding); "I often reappraise my experience so I can learn from it and improve for my next performance (Reflection); and "This course has challenged some of my firmly held ideas" (Critical reflection). Using the same instrument, Leung and Kember (2003) reported reliability estimates ranging from .58 to .74 for the four subscales of the RTQ.

Academic performance in Mathematics

Academic performance in mathematics was measured in terms of collecting the students' overall performance mark at the end of the second semester. This overall performance mark consisted of 50% course work (i.e., involving 10% tutorial participation, 20% mid-semester test, and 20% written assignments) and 50% final examination.

Procedures

Instruments were administered in tutorial classes with the assistance of two tutors. Participation by the students was voluntary and no remuneration was provided. Students were also instructed to write down their student numbers for the purpose of collecting their overall performance marks in mathematics. Students were assured of anonymity and were explained why their overall performance marks in mathematics were needed. The Study Process Questionnaire was administered during the first week of the academic calendar year (first semester in the first week of February), whereas the Reflective Thinking Questionnaire was administered during the first week of the second semester (mid July). Finally, academic performance grades were collected at the end of the academic year (mid December).

Data Analysis

The present study, similar to previous SAL and reflective thinking research (e.g., Kember & Leung, 1998; Leung & Kember, 2003; Sachs & Gao, 2000), involved two types of analyses: descriptive and linear structural relations (LISREL). In particular, structural equation modelling (SEM) is more superior than any other statistical methodologies as it enables examination of both direct and indirect causal effects between latent variables, as well as taking into account both structural and measurement errors (Bollen, 1989; Byrne, 1998; Kline, 2005). Furthermore, SEM techniques are based on theoretical and empirical support and warrant the testing of competing models. We used LISREL-8 with the covariance matrices and maximum likelihood procedures (ML) to test the structural equations (Jöreskog & Sörbom, 2001). We analysed covariance matrices because analysing correlation matrices is known to have potential problems, such producing incorrect goodness-of-fit measures and standard errors (Byrne, 1998; Jöreskog & Sörbom, 2001). Furthermore, the ML procedure was chosen as it has shown to perform reasonably well with multivariate normally distributed data (Chou & Bentler, 1995). The three goodness of fit indexes provided by LISREL and reported in this section are the Comparative Fit Index (CFI), the Non-Normed Fit Index (NNFI), and the Root Mean square of Approximation (RMSEA). Models with CFI and NNFI values close to .95 and RMSEA values less than .05 are normally considered as an indication of acceptable fit.

Our structural model, based on existing research evidence (Drew & Watkins, 1998; Leung & Kember, 2003; Mezirow, 1991, 1998; Watkins, 2001; Wong & Watkins, 1998), involved examination of causal relations as follows: the four stages of reflective thinking were hypothesized to mediate the influence of surface and deep learning approaches and influence academic performance directly (in particular, a surface learning approach was hypothesized to influence habitual action only, and a deep learning approach was hypothesized to influence all four stages of reflection); and deep and learning approaches to learning were hypothesised to influence academic performance directly.

Results

The means and standard deviations of the scales for the sample are presented in Table 1. Cronbach alpha values for the RTQ and R-SPQ-2F, are also given in Table 1. The alpha values ranged from .79 to .91 for the subscales of the RTQ, and .70 to .86 for the subscales of the R-SPQ-2F. Compared with previous findings (Biggs *et al*., 2001; Leung & Kember, 2003) the alpha values for the subscales of the RTQ and R-SPQ-2F appear acceptable.

Table 1. Means, standard deviation and Cronbach alpha for scales and subscales of the R-SPQ-2F and RTQ.

	Mean	SD	Alpha
SPQ			
• Deep motive	16.94	4.32	.70
• Deep strategy	17.38	4.11	.76
• Surface motive	16.20	4.73	.81
• Surface strategy	16.29	5.01	.86
RTQ			
• Habitual action	21.30	6.34	.91
• Understanding	22.46	5.52	.79
• Reflection	18.99	6.41	.80
• Critical reflection	21.18	6.98	.85

The covariance matrix of the measured variables which were used as database for the analyses is presented in Table 2. Estimation of the initial structural analysis indicated relatively good support for the hypothesised model, $\chi^2(195, N = 352) = 447.90$, $p < .001$, CFI = .94, NNFI = .93. Post hoc model modifications were performed in an attempt to develop a better fitting, more parsimonious model. On the basis of the MI recommendations and theoretical relevance, three error terms were added and three paths were deleted. Two measurement errors between items descriptive of the understanding scale and one measurement error between items descriptive of the reflection scale were added in the respecified model. Furthermore, paths between the reflection and understanding scales to academic performance, and from a surface approach to academic performance were subsequently deleted in the post-hoc analyses. Table 3 presents the models tested with the various goodness of fit indexes. Although the estimation of the final model resulted in an overall $\chi^2_{(192)}$ value of 403.48 that was statistically significant, $p < .01$, all other measures of goodness of fit, CFI = .95, NNFI = .94, provided support for this model. A schematic representation of this final structural model that includes the standardised path coefficients is displayed in Figure 1. The final model accounted for 25% of the variance observed in academic performance.

Table 2: Covariance matrix used in the structural equation models.

	Hb1	Hb2	Hb3	Hb4	Un1	Un2	Un3	Un4	Re1	Re2	Re3	Re4	Cr1	Cr2	Cr3	Cr4	A1	A2	SS	SM	DS	DM
Hb1	3.04																					
Hb2	2.11	3.41																				
Hb3	1.97	2.30	3.59																			
Hb4	2.13	2.59	2.61	2.85																		
Un1	0.23	0.48	0.66	0.47	3.01																	
Un2	0.35	0.64	0.63	0.54	1.25	2.35																
Un3	-0.29	-0.11	-0.16	-0.26	1.42	0.92	4.64															
Un4	0.16	0.25	0.43	0.27	1.65	1.47	2.28	2.55														
Re1	0.52	0.82	0.83	0.62	0.73	0.67	1.22	0.83	3.89													
Re2	1.28	1.32	1.33	1.18	0.39	0.41	0.32	0.27	1.34	4.09												
Re3	0.65	0.70	0.70	0.62	0.55	0.47	1.20	0.83	2.09	1.65	4.87											
Re4	0.30	0.36	0.39	0.33	0.16	0.19	0.33	0.30	0.94	0.87	1.23	1.04										
Cr1	0.90	0.86	0.69	0.61	0.04	-0.18	-0.60	-0.09	-0.28	0.03	-0.63	-0.09	5.19									
Cr2	1.04	0.82	0.99	0.88	0.08	0.01	-0.46	0.08	0.12	0.06	-0.32	0.06	2.68	4.52								
Cr3	0.51	0.60	0.63	0.59	0.05	0.23	-0.39	-0.01	0.04	0.05	-0.45	-0.13	2.19	2.04	4.46							
Cr4	0.77	0.61	0.57	0.57	-0.02	0.11	-0.38	-0.02	-0.15	0.02	-0.56	-0.10	2.72	2.90	2.96	3.64						
A1	0.95	0.88	0.97	0.62	0.46	0.59	1.23	0.21	0.18	0.19	-0.26	0.12	1.32	1.65	2.61	2.55	30.93					
A2	0.75	0.87	0.51	0.50	0.06	-0.03	0.28	-0.16	0.07	0.92	-0.32	0.15	1.96	1.49	2.78	2.09	15.05	20.17				
SS	2.85	3.10	2.45	2.56	1.95	1.59	1.08	1.46	1.53	2.00	0.70	0.33	1.28	0.02	1.47	0.46	6.42	6.41	25.13			
SM	2.79	2.60	2.28	2.21	2.13	1.55	0.69	1.51	0.98	1.81	-0.18	-0.04	1.75	0.88	1.19	0.87	5.71	5.09	16.48	22.42		
DS	2.49	2.71	2.52	2.43	1.63	1.16	0.21	0.99	0.85	1.49	0.13	0.08	1.38	0.81	1.66	0.99	5.88	6.36	15.45	13.61	16.95	
DM	2.29	2.81	2.69	2.24	1.47	1.17	0.58	0.79	1.18	2.09	0.44	0.41	1.13	0.42	1.31	0.60	5.67	6.19	17.18	14.38	13.55	18.68

Table 3: Comparison of nested models.

Models	Descriptions	χ^2	df	CFI	NNFI	RMSEA	χ^2 diff
1	Hypothesised [(1)]	447.90	195	.94	.93	.060	-
2	Added: a measurement error b/w understanding items	418.50	194	.95	.94	.060	M1-M2 = 29.40*
3	Added: a measurement error b/w critical reflection items	404.57	193	.95	.94	.05	M2-M3 = 13.90*
4	Added: a measurement error b/w understanding items	396.85	192	.95	.94	.05	M3-M4 = 7.72**
5	Paths dropped: reflection → academic performance; understanding → academic performance surface approach → academic performance	403.48	196	.95	.94	.05	M4-M5 = 6.63

Note: [(1)] Hypothesised model involved: direct paths from the two learning approaches to academic performance, a direct path from a surface approach to habitual action and direct paths from a deep approach to understanding, reflection, and critical reflection; and direct paths from the four stages of reflective thinking to academic performance; covariances specified freely between latent factors. * $p < .01$, ** $p < .05$.

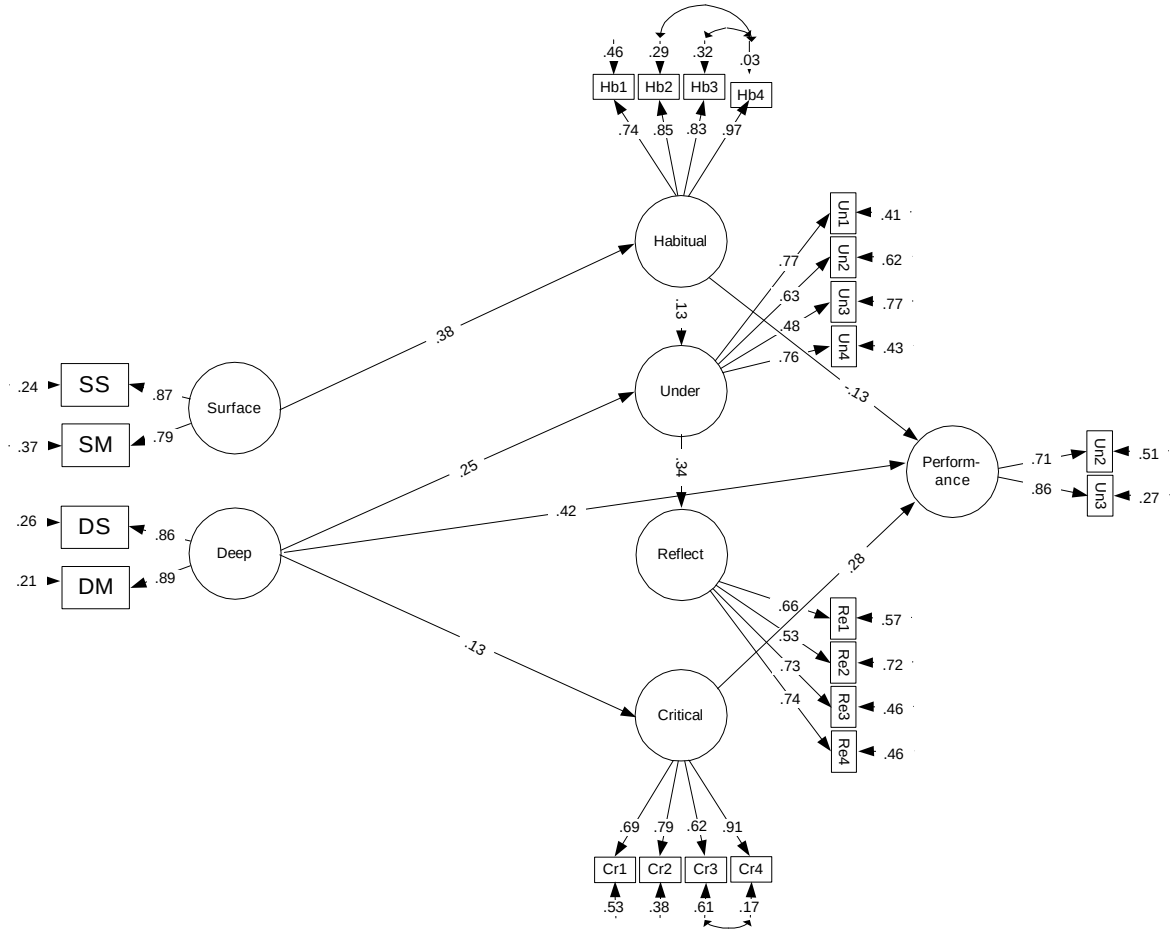


Figure 1: Final model of causal structure related to learning approaches, reflective thinking, and academic performance. All paths are statistically significant at p < .05.

Table 4 presents the direct, indirect, and total effects on academic performance in mathematics. Of all the independent variables a deep approach to learning (β = .42), critical reflection (β = .28), and habitual action (β = -.13) made an independent contribution to the prediction of performance in mathematics. A surface approach to learning made an independent contribution to the prediction of habitual action (β = .38), whereas a deep approach to learning made an independent to the prediction of understanding (β = .25) and critical reflection (β = .13). The results indicated that a deep approach had a stronger effect on academic performance than did any other variables. Both its direct and total effects were significantly stronger than those of critical reflection, habitual action, or a surface approach. Finally, a surface approach to learning had a stronger direct effect on habitual action than the direct effects of deep approach to learning on understanding and critical reflection. Finally, the causal effect of understanding on reflection (β = .34) is stronger than that of habitual action on understanding (β = .13).

Table 4: Direct, indirect, and total effects of the final structural model.

Effect	Direct	Indirect	Total
On performance:			
• Of habitual action	-.13*	-.00	-.13*
• Of understanding	.00	-.01	-.01
• Of reflection	.00	-.03	-.03
• Of critical reflection	.28*	.00	.28*
• Of surface approach	.00	-.05*	-.05*
• Of deep approach	.42*	.03	.45*
On habitual action:			
• Of surface approach	.38*	.00	.38*
• Of deep approach	.00	.00	.20
On understanding:			
• Of surface approach	.00	.05	.05
• Of deep approach	.25*	.00	.25*
• Of habitual action	.13*	.00	.13*
On reflection:			
• Of surface approach	.00	.02	.02
• Of deep approach	.00	.09*	.09*
• Of habitual action	.00	.04	.04
• Of understanding	.34*	.00	.34*
On critical reflection:			
• Of surface approach	.00	-.00	-.00
• Of deep approach	.13*	-.01	.12*
• Of habitual action	.00	-.01	-.01
• Of understanding	.00	-.04	-.04
• Of reflection	-.11	.00	-.11

Note: * $p < .05$.

Summary of results from Study 1

The results from structural equation analyses provide moderate support for the hypothesised relations described previously (Leung & Kember, 2003). In particular, our findings are significant as they establish a causal relationship between the SAL and reflective thinking frameworks. As Leung and Kember recognise, although existing researches associated with each framework have been extensive, there has been very few evidence, if any, concerning the relationships between the two theoretical frameworks within the one study. A possible explanation, as the authors argued, may lie in the fact that the SAL and reflective thinking contentions have to date been applied in different contexts. The structural analysis derived in the Leung and Kember study establishes the precedence that learning approaches may causally determine the stages of reflective thinking.

The results of Study 1 provide moderate support for both the structural and measurement parts of the hypothesised model. The evidence indicates that a surface approach to learning is predictive of habitual action, whereas both understanding and critical reflection are determined mainly by a deep approach to learning. Furthermore, the findings support our hypothesis concerning the causal influence of one stage of reflective thinking onto another. Previously, we hypothesised that the earlier stages of reflective thinking (for example, habitual action) would influence the latter stages of reflective thinking (for example, reflection). The evidence as such confirms this hypothesis wherein habitual action was shown to influence understanding which, in turn, affected reflection. This pattern of causal influence reflects the theoretical contentions by Mezirow (1977, 1991, 1998) where he advocates that the four stages are developed in a structured manner over time mainly through knowledge and experience. The development of reflection in a structured manner suggests that the stages range in complexity and not all of us progress through these four stages. Moreover, knowledge and experiences acquired in one stage help students develop their next of reflective thinking.

Examining the total effects only, both deep and surface approaches to learning were significantly predictive of the four types of reflective thinking. The causal effect of surface approach to learning on habitual action is consistent with previous findings (Leung & Kember, 2003). Habitual action, an automatic mechanical routine and procedure, is in line with a surface approach to learning as no attempt is being made in understanding the contents acquired. Students who adopt a surface learning approach tend to engage in rote learning and memorisation and as a result, are able to recall facts automatically and routinely without really having any real knowledge of the facts imparted.

In contrast, the total effects also indicate that a deep approach to learning is predictive of understanding, reflection, and critical reflection. Students who adopt a deep learning approach show more tendency than those who adopt a surface approach, to read and to acquire knowledge with an attempt to understand and absorb meaning into personal knowledge structure and experience (Leung & Kember, 2003). Furthermore, the evidence also suggests that students' alignment with deep approaches to learning play an important role in the development of critical reflection. Critical reflection, according to Leung and Kember, involves the process of transformation where we question presuppositions from our conscious and unconscious prior learning. It also concerns our willingness and ability to question conventional wisdom and ingrained assumptions that are bounded in our consciousness and unconsciousness and to offer alternatives. Students who adopt a deep approach to learning genuinely search for understanding, and to critically theorise and to form hypotheses (Kember & Leung,

1998). It is with this practice and experience of learning for understanding that students over time develop and nurture their skills in critical reflection. These three stages of reflective thinking then, differing from the initial stage of habitual action, concern the notion of acquiring and understanding knowledge, as well as to consolidate and to reflect upon practice and experiences. The latter and complex stage of critical reflection involves a perspective transformation and requires us to question why we perceive, think, feel, or act the way we do.

Our results also confirm previous studies (Cano, 2005; Wong & Watkins, 1998) indicating that students who adopt a deep approach to learning are more successful in their academic learning. Furthermore, our study brings to light a finding that supports the hypothesis made earlier. Both habitual action and critical reflection directly predicted academic performance in mathematics. Students who see learning as daily routines and who make very little attempt to understand the concepts acquired, are more likely to be less successful in their academic learning. On the contrary, students who acquire knowledge and make genuine attempts to reflect and to critique conventional wisdom and ingrained assumptions are more likely to perform academically better. This finding does not come as a surprise, in fact, given that both habitual action and critical reflection exist in the initial and final stages of reflective thinking, respectively. Students who strive to learn as well as to engage in perspective transformations are more successful in their academic learning.

Study 2: A path analysis of students' epistemological beliefs, learning approaches, reflective thinking, and academic performance

This path analysis study examined third year students' epistemological beliefs in curriculum studies, learning approaches, reflective thinking, and academic performance over a period of 12 months. The focus of this study, developed in particular from the work of Cano (2005) and Leung and Kember (2003), attempts to integrate the three theoretical frameworks within the one study. Specifically, besides the questions pertaining to student learning approaches and reflective thinking, we also put forth the research question concerning the effects of epistemological beliefs on learning approaches, reflective thinking, and academic performance in curriculum studies.

We feel that it is important to investigate this question as this may add theoretical and practical contributions to the existing literature on the three theoretical frameworks and how they combine to influence academic performance outcomes. Recent emphasis has suggested that epistemological beliefs may relate to student learning approaches and reflective thinking (Phillips, 2001; Schommer-Aikins *et al*., 2005). Furthermore, it is also of particular interest to

compare the findings of this study with those obtained from Study 2 to gauge additional insight into students' learning approaches, epistemological beliefs, and reflective thinking of students enrolled in curriculum studies. Curriculum studies, as an Education course, may be considered as "soft applied" when compared to mathematics, which may be considered as a "hard pure" subject (Becher, 1989, 1994).

Participants

The ages of the students (N = 332: 146 females, 185 males) ranged from 20-35 (M = 22; SD = 1.12) in this study were all Education major with the exception of a few students who were Arts major.

Instrumentation

Epistemological Beliefs Questionnaire

Epistemological beliefs in this study were assessed with the Schommer Epistemological Questionnaire (Schommer, 1990). This 63-item questionnaire has been widely used in previous research (Peng & Fitzgerald, 2006; Schommer, 1993; Schommer-Aikins & Hutter, 2002) and taps students' preferences to statements about knowledge and learning. Individuals respond on a Likert-type scale ranging from strongly disagree (1) to strongly agree (5) to statements, such as "You never know what a book means unless you know the intent of the author" and "It's a waste of time to work on problems which have no possibility of coming out with clear-cut and unambiguous answers." These ratings provide an indication of a participant's range of beliefs along a continuum from a higher score (naïve belief) to a lower score (sophisticated belief). A number of studies have reported that the EQ has good psychometric properties in terms of reliability and content validity. Duell and Schommer-Aikins (2001), for example, reported a .74 test-retest and .63 to a .85 inter-item correlations for items within each belief factor. Furthermore, studies using EFA and CFA have shown that students' responses to the EQ exist as a four-factor structure (Peng & Fitzgerald, 2006; Phillips, 2001; Schommer, 1990, 1993; Schommer *et al*., 1992; Schommer-Aikins & Hutter, 2002).

Similarly, to ensure the appropriateness of the EQ to our sample, we performed two types of factor analyses – exploratory and confirmatory – that are similar to those performed in previous studies (Cano, 2005; Schommer, 1990, 1993; Schommer *et al*., 1992; Schommer-Aikins *et al*., 2005). In the initial phase we performed EFA with the SPSS default of a 1.0 eigenvalue as the cutoff for factors. The EFA, using the principal components method and varimax rotation, revealed the presence of four factors with eigenvalues greater than 1. To

confirm this four-factor structure, we performed Horn's (1965) parallel analysis as recommended by Pallant (2005). The four factors with eigenvalues greater than 1 together explained 65.04 percent of the variance in responses and accounted for more variance than the components derived from random data. Factor 1 is labeled Simple Knowledge (beliefs in simple knowledge); Factor 2 is labeled as Fixed Ability (beliefs that the ability to learn in unchangeable); Factor 3 is labeled as Certain Knowledge (beliefs in certain knowledge); and Factor 4 is labeled as Quick Learning (beliefs in quick, effortless learning). This finding is in contrast to Cano's (2003) study whether the author found only three factors. However, other studies have also confirmed the existence of four factors (Phillips, 2001; Schommer, 1993; Schommer *et al*., 2005; Schommer & Hutter, 2002). Inter-item reliabilities for items defining each factor, measured by Cronbach's α, were .94 for Factor 1, .93 for Factor 2, .89 for Factor 3, and .86 for Factor 4. We next carried out CFA based on the EFA findings and previous research findings. The goodness of fit index values for the four-factor model indicated a reasonably fitted model, χ^2 (48, N = 332) = 757.93, $p < .01$, NNFI = .91, CFI = .92, RMSEA = .09. Finally, similar to Study 1, the R-SPQ-2F (Biggs *et al*., 2001) and RTQ (Kember *et al*., 2000) were administered to students.

Academic performance in Curriculum Studies

Academic performance in curriculum studies was measured in terms of collecting the students' overall performance mark at the end of the second semester. This overall performance mark consisted of 50% course work (i.e., involving 10% tutorial participation, 20% mid-semester test, and 20% written assignments) and 50% final examination.

Procedures

Instruments were administered in tutorial classes with the assistance of four tutors. Participation by the students was voluntary and no remuneration was provided. Students were also instructed to write down their student numbers for the purpose of collecting their overall performance marks in curriculum studies. Students were assured of anonymity and were explained why their overall performance marks in curriculum studies were needed. The Epistemological Beliefs Questionnaire and the Study Process Questionnaire were administered during the first week of the academic school year (first semester in the first week of February), whereas the Reflective Thinking Questionnaire was administered during the first week of the second semester (mid July). Finally, academic performance grades in curriculum studies were collected at the end of the academic year (mid December).

Data Analysis

This study, similar to previous epistemology, reflective thinking and learning approaches research (Cano, 2005; Leung & Kember, 2003; Schommer *et al*., 1992; Schommer-Aikins *et al*., 2005), used path analysis with LISREL-8 (Jöreskog & Sörbom, 2001) to explore the structural relations between the three theoretical frameworks. Path analysis involved examination of direct and indirect effects between learning approaches, epistemological beliefs, reflective thinking and academic performance in curriculum studies. Although criticisms have not gone unnoticed, path analysis techniques are still significant as they allow the testing of relations between variables when theoretical and empirical support is present (Cook & Campbell, 1979). Theoretical and empirical evidence involved the testing of a path model in this study as follows: epistemological beliefs were hypothesised to influence all variables; deep and surface learning approaches would mediate the influence of epistemological beliefs and influence the remaining variables directly (in particular, a surface learning approach was hypothesised to influence habitual action only, and a deep learning approach was hypothesised to influence all four stages of reflection); and the four stages of reflective thinking were hypothesised to influence academic performance and would mediate the influence of learning approaches and epistemological beliefs on academic performance.

Results

The means and standard deviations of the scales for the sample are presented in Table 5. Cronbach alpha values for the EQ, RTQ and R-SPQ-2F are also given in Table 5. The alpha values ranged from .83 to .95 for the subscales of the RTQ, .89 to .94 for the subscales of the EQ, and .82 to .87 for the subscales of the R-SPQ-2F.

Table 5: Means, standard deviation and Cronbach alpha for scales and subscales of the R-SPQ-2F and RTQ.

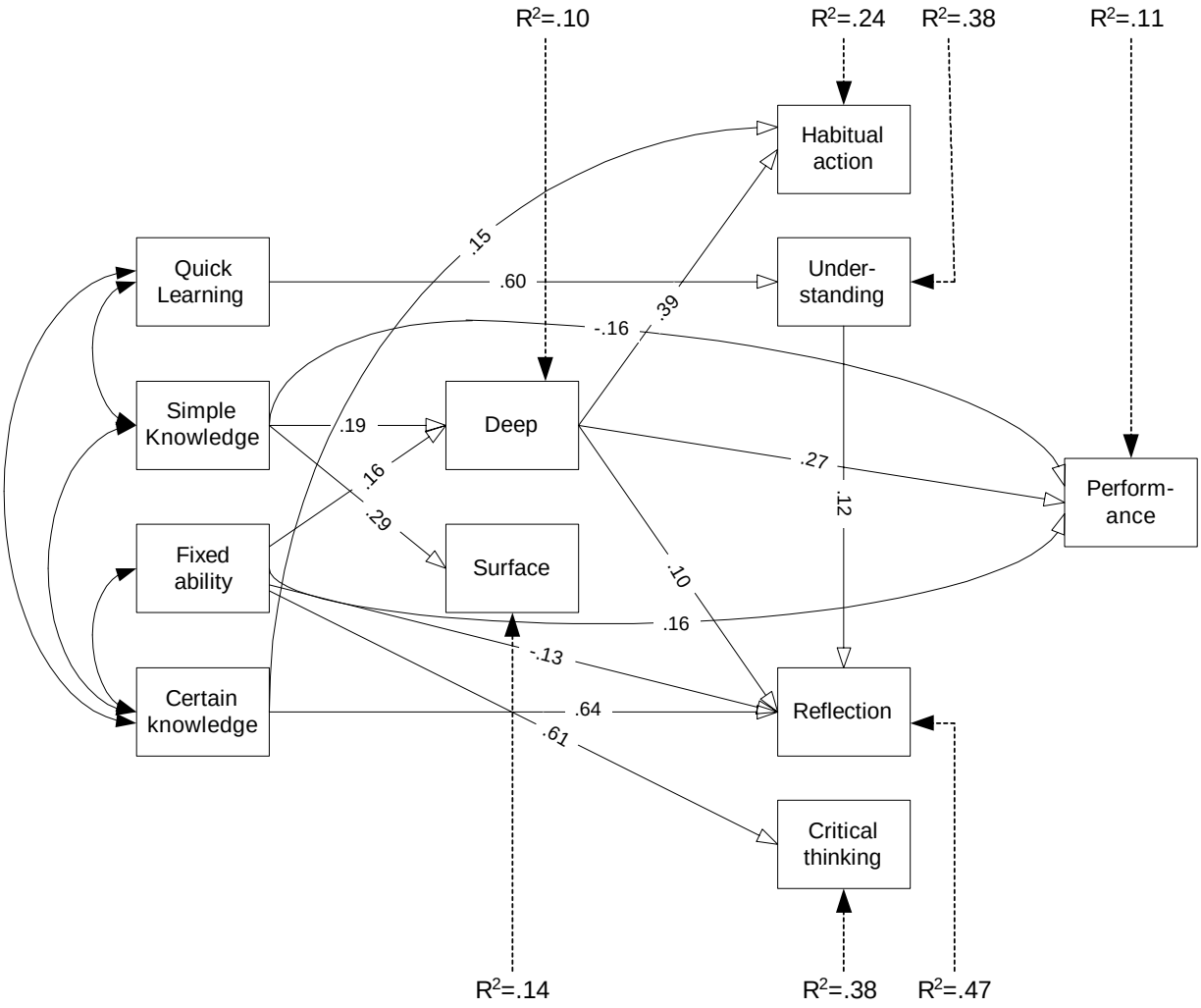
	Mean	SD	Alpha
SPQ			
• Deep motive	4.96	1.41	.82
• Deep strategy	5.51	1.35	.83
• Surface motive	4.85	1.56	.87
• Surface strategy	4.94	1.92	.85
EQ			
• Simple knowledge	4.96	1.41	.94
• Quick learning	5.51	1.34	.86
• Certain knowledge	4.85	1.56	.89
• Fixed ability	4.94	1.92	.93

RTQ			
• Habitual action	5.44	1.53	.95
• Understanding	5.85	1.18	.83
• Reflection	5.00	1.54	.86
• Critical reflection	5.32	5.31	.95

The covariance matrix of the measured variables which were used as database for the analyses is presented in Table 6. Estimation of the initial path analysis indicated relatively good support for the hypothesised model, $\chi^2(7, N = 332) = 44.60$, $p < .001$, CFI = .98, NNFI = .80. Post hoc model modifications were performed in an attempt to develop a better fitting, more parsimonious model. On the basis of the modification fit (MI) recommendations, five paths were deleted: reflection to critical reflection; critical reflection to academic performance; habitual action to academic performance; surface learning approach to academic performance; and reflection to academic performance. Although the estimation of the final model resulted in an overall $\chi^2_{(192)}$ value of 39.64, $df = 12$, that was statistically significant, $p < .01$, all other measures of goodness of fit, CFI = .98, NNFI = .92, RMSEA = .08 provided support for this model. The $\chi^2_{(5)}$ difference between the final model and the initial hypothesised model was 4.96 $p > .05$. A schematic representation of this final structural model that includes the standardised path coefficients is displayed in Figure 2. The final model accounted for 11% of the variance observed in academic performance.

Table 6: Covariance matrix used in the structural equation models.

	Deep	Surf	Hab	Und	Ref	Cri	Per	Quick	Simple	Fixed	Certain
Deep	0.77										
Surf	0.82	1.08									
Hab	0.60	0.68	2.34								
Und	0.19	0.22	0.36	1.40							
Ref	0.26	0.40	0.74	0.57	2.36						
Cri	0.28	0.18	0.65	-0.09	-0.40	3.63					
Per	1.97	2.00	1.00	0.61	0.01	1.87	71.29				
Quick	0.20	0.22	0.39	0.96	0.76	0.09	-0.10	1.81			
Simple	0.33	0.52	0.57	0.23	0.57	0.18	-0.53	0.60	1.98		
Fixed	0.28	0.21	0.24	-0.22	-0.61	2.21	2.91	-0.16	0.28	3.69	
Certain	0.25	0.41	0.64	0.58	1.57	-0.02	0.16	1.10	1.06	-0.37	2.42



<u>Figure 2</u>: Final model of causal structure related to epistemological beliefs, learning approaches, reflective thinking, and academic performance. All paths are statistically significant at p < .05.

Table 7 presents the direct, indirect, and total effects on academic performance in curriculum studies. The significant results include the direct causal effect of deep learning approach on academic performance (β = .27). For epistemology, the more naïve a student's beliefs that knowledge is simple, the poorer his/her academic performance (β = -.16); likewise, as explained by the positive β-weight, students' naïve beliefs of innate learning influenced academic performance (β = .16). Deep approach to learning also influenced habitual action (β = .39) and reflection (β = .10). The findings also confirmed our hypothesis that the less a student believes that knowledge is simple rather than complex, the less he/she is likely to adopt a surface approach (β = .29) and more in a deep approach (β = .19). The less a student believes that the ability to learn is innate, the more he/she is likely to adopt a deep approach to learning

(β = .16). In terms of the four stages of reflective thinking, the more students believe that knowledge is certain rather than tentative, the more they do things routinely and automatically without reflection (β = .15); likewise, students who believe less in innate learning are more likely to engage in reflection (β = -.13). Students who believe in quick, effortless learning are more likely to read and learn for understanding but without any reflection (β = .60).

Table 7: Direct, indirect, and total effects of the final structural model.

Effect	Direct	Indirect	Total
On performance:			
• Of habitual action	.00	.00	.00
• Of understanding	.00	.00	.00
• Of reflection	.00	.00	.00
• Of critical reflection	.00	.00	.00
• Of surface approach	.00	.00	.00
• Of deep approach	.27*	.00	.27*
• Quick learning	-.03	.02	-.01
• Simple knowledge	-.16*	.05*	-.11
• Fixed ability	.16*	.04*	.20*
• Certain knowledge	.07	.02	.09
On habitual action:			
• Of surface approach	.00	.00	.00
• Of deep approach	.39*	.00	.39*
• Quick learning	.02	.03	.05
• Simple knowledge	.07	.08*	.15*
• Fixed ability	.03	.06*	.09
• Certain knowledge	.15*	.03	.18*
On understanding:			
• Of surface approach	.00	.00	.00
• Of deep approach	.09	.03	.12*
• Of habitual action	.08	.00	.08
• Quick learning	.60*	.01	.61*
• Simple knowledge	-.09	.03*	-.06
• Fixed ability	-.07	.02*	-.05
• Certain knowledge	.00	.02	.02
On reflection:			
• Of surface approach	.00	.00	.00
• Of deep approach	.11 *	.01	.12*
• Of habitual action	.00	.01	.01
• Of understanding	.12*	.00	.12*
• Quick learning	-.04	.08*	.04
• Simple knowledge	-.06	.01	-.05
• Fixed ability	-.13*	.01	-.12*
• Certain knowledge	.64*	.01	.64*
On critical reflection:			
• Of surface approach	.00	.00	.00
• Of deep approach	.07	.00	.07
• Of habitual action	.00	.00	.00
• Of understanding	.00	.00	.00
• Of reflection	.00	.00	.00
• Quick learning	.04	.01	.05
• Simple knowledge	-.06	.01	-.05
• Fixed ability	.61*	.01	.62*

• Certain knowledge	.07	.00	.07
On deep approach			
• Quick learning	.08	.00	.08
• Simple knowledge	.19*	.00	.19*
• Fixed ability	.16*	.00	.16*
• Certain knowledge	.07	.00	.07
On surface approach			
• Quick learning	.01	.00	.01
• Simple knowledge	.29*	.00	.29*
• Fixed ability	.09	.00	.09
• Certain knowledge	.12	.00	.12

Summary of results from Study 2

Our findings from path analysis are significant as they establish causal relationships between epistemological beliefs, the SAL, and reflective thinking frameworks. In particular, as Cano (2005) and others (Phillips, 2001; Schommer-Aikins *et al*., 2005) argue, although research studies associated with each framework have been extensive, there has been very few evidence, if any, concerning the relationships between the three theoretical frameworks within the one study. A possible explanation, as explained earlier, may lie in the different contexts in which the three theoretical perspectives have been situated. Taking this shortcoming into account, our results contribute to the relevant literature pertaining to the prediction of academic performance in curriculum studies via epistemological beliefs and students' learning approaches.

As shown, epistemological beliefs according to the students in this study are not unidimensional but are conceptualized as multidimensional beliefs. The four dimensions established in this study, quick learning, simple knowledge, fixed ability, and certain knowledge, are consistent with those beliefs of older and tertiary students found in previous studies (Schommer, 1990, 1993; Phillips, 2001). Furthermore, epistemological beliefs exert a significant direct influence on academic performance. This evidence, consonant with some findings of existing research (Cano, 2005; Schommer, 1993; Schommer-Aikins *et al*., 2005), suggests students who believe that knowledge is organized as integrated conceptions are more successful in their academic learning. Contrary to previous findings however, our study shows students who believe that learning is fixed and not changeable perform successfully in their academic performances. We explain this finding, although it is relatively small in beta value, by suggesting students in this region, based on the exam-driven curriculum, etc, are more inclined to view the concept of ability or knowledge as something that is inherently fixed and cannot be altered; either they have it or they don't. With this instilled mindset, students who

then believe that intelligence is fixed and cannot be incrementally developed are more likely to be performance orientated (Dweck & Leggett, 1988; Schommer, 1993).

Epistemological beliefs also play an important role in students' development of reflection. This finding is significant as it indicates that students who believe learning is developed through education and experiences are more likely to reflect on their learning and acquired knowledge. Similarly, students' lack of reflection maybe explained from the beliefs they hold that learning is quick and requires very little effort, and that knowledge is absolute and not subject to interpretation. Similar to the research evidence established between epistemological beliefs and academic performance, this finding signifies the importance of epistemological beliefs in the development of reflection. In this analysis, epistemological beliefs influence reflection by affecting the ways students think and view learning and knowledge. Whether knowledge is organised as isolated facts, or that learning is innate and occurs in quick rapid successions all contribute to influence and foster students in their reflective thoughts. Research could explore this relationship further from a longitudinal perspective to determine how epistemological and reflective thinking develop, relate, and change over time.

Similar to previous findings (Cano, 2005; Phillips, 2001), our study shows that both deep and surface learning approaches are influenced by students' epistemological beliefs. Students are more inclined to adopt a deep approach to learning if they believe that knowledge is not fixed but rather developed by means of personal experiences and education. Likewise, students who believe that knowledge is complex and integrative are more inclined to adopt a deep approach to learning. This finding supports the present view (Schommer *et al*., 1992; Schommer-Aikins *et al*., 2005) that students' epistemological beliefs may indeed influence their selection of study strategies and motivation. For example, in his study with accounting students, Phillips (2001) found that students' epistemological beliefs were associated positively with related study strategies and that these strategies, in turn, were associated with problem-solving performance.

Our results also indicate deep learning approaches significantly influence academic performance as well as the stages of reflective thinking. Similar to Study 1 and previous findings (Cano, 2005; Wong & Watkins, 1998), the evidence indicates that students who adopt a deep approach to learning are more successful in their academic learning. Consistent with some previous studies, we did not find a significant relationship between a surface learning approach and academic performance. Furthermore, a finding emerged to show that reflection is influenced by a deep learning approach. This lends support to Leung and Kember's (2003) findings in terms the positive associations between learning approaches and reflection.

Conclusion

Previous research examining students' epistemological beliefs, learning approaches, and reflective thinking has identified the important relationships between these three theoretical frameworks and academic performance outcomes. The results of the two studies reported in this article suggest a number of theoretical and practical implications in higher education. First, from a theoretical point of view, the evidence established contributes to the contentions concerning: (i) the influences of learning approaches on reflective thinking, and learning approaches and reflective thinking on academic performance, (ii) the influences of epistemological beliefs on learning strategies and motivation and reflective thinking, and (iii) the influences of epistemological beliefs on academic performance. The findings of the two studies, in particular, support existing postulations that students' epistemological beliefs function as a part of a much larger system in teaching and learning (Cano, 2005; Phillips, 2001; Schommer-Aikins *et al*., 2005; Schommer-Aikins & Hutter, 2002). Furthermore, there is an added theoretical contribution to the non-existing literature pertaining to the relationship between the SAL framework and reflective thinking (Leung & Kember, 2003). The present findings also indicate the important existence of learning approaches and reflective thinking practice in different subject disciplines. In this analysis, an examination was made on understanding tertiary students' learning orientations, epistemological beliefs, and reflective thinking in two different subject disciplines; one that is theoretical driven (mathematics), and one that has a practical professional component (curriculum studies).

Secondly, from a practical point of view, this research encourages educators to help students develop their epistemological beliefs as these beliefs relate positively to academic learning. For example, educators in classrooms may query and assess students' beliefs about the nature of knowledge and learning. Thirdly, given that there is now clear evidence to suggest the positive relationship between epistemological beliefs and learning approaches, it is important that educators help students reflect on their epistemological beliefs as well as their study strategies and motivation as these will then lead to academic success. In this analysis, learning is only meaningful when students are taught to use a deep learning approach and teaching and learning strategies implemented by teachers should reflect this deep learning orientation. Students should also be encouraged to reflect in and on their learning and to critique the knowledge, presuppositions, and assumptions that are passed on by teachers, adults, and others. At the same time, students should be encouraged to reflect on their epistemologi-

cal beliefs and the type of learning approach that they themselves see as being academically appropriate.

There are limitations pertaining to the present research. Future studies could expand the research inquiry by focusing on two main issues. First, to contribute to the existing literature, studies could examine how students' epistemological beliefs, learning approaches, and reflective thinking fit in with the learning environment. Research could explore the way in which the classroom environment influences students' epistemological beliefs and their alignment to a specific learning style that may lead to academic success. For example, Wong and Watkins (1998) found in their study of Chinese students that an enjoyable classroom environment is important as it mediates relationships between a deep learning approach and high-level achievement. Secondly, longitudinal studies involving multiple time points of data collection could examine the relationships between epistemological beliefs, learning approaches, and reflective thinking over time. In relation to this line of inquiry, longitudinal research could explore the direction of cause-and-effect relationships between epistemological beliefs, learning approaches, and reflective thinking (Phillips, 2001). The potential limitation of these two studies is that we assumed, based on structural equation analyses, the direction of causality. For instance, one might argue that learning approaches, instead of being a product of epistemological beliefs, are in fact one source of beliefs that students develop over time. Likewise, one could postulate that rather than being products of epistemological beliefs and learning approaches, academic learning could actually influence the types of learning styles that students adopt, and the epistemological beliefs that they develop over time.

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