Epistemological beliefs and approaches to learning: Their change through secondary school and their influence on academic performance

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Background. In recent decades, two lines of research, phenomenographic and meta-cognitive, have examined students' approaches and epistemological beliefs about learning. To date there has been very little research describing the change in epistemological beliefs in European secondary students, or analysing interrelationships between epistemological beliefs and approaches in order to explain their influence on academic performance.

Aims. The first aim of this investigation is to analyse the change in epistemological beliefs and learning approaches in secondary students as they progress through their studies. The second aim is to examine the effects of epistemological beliefs on learning approaches, and learning approaches on academic performance.

Sample. About 1,600 Spanish students, boys and girls, from several secondary schools took part in the study. They were between 12 and 20 years old and their average age was 14.79 years.

Methods. Measures of epistemological beliefs (EQ: Epistemological Questionnaire), learning approaches (LPQ: Learning Process Questionnaire), and academic performance were obtained. Confirmatory factor analysis was used to examine the dimensionality of the EQ and LPQ questionnaires. In order to achieve our two aims, different statistical techniques were used: MANOVA and ANOVA for our first aim, and structural equation modelling for our second aim.

Results. Throughout secondary education epistemological beliefs undergo change, becoming more realistic and complex, and deep-approach scores decline significantly. It was shown that, as predicted, epistemological beliefs influenced academic achievement directly, and also indirectly via students' learning approaches.

Conclusions. Our findings point to two conclusions. First, epistemological beliefs and learning approaches change as pupils advance in their studies. Second, the relationship between epistemological beliefs and academic achievement is mediated by approaches to learning.

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DOI:10.1348/000709905X22583
Learning and academic performance are influenced by numerous cognitive variables (Glover & Ronning, 1987; Gustafsson & Undheim, 1995). Examples of these are students' conceptions and beliefs about knowledge and learning (Entwistle & Entwistle, 1992; Perry, 1968, 1970; Sternberg, 1985).

Perry (1968, 1970) investigated university students' ideas about knowledge and learning, and how these were modified as students progressed through their studies. He showed that many students, during their early years at university, thought that knowledge was simple, certain, and transmitted by authority. On reaching the later years of their university careers, students came to believe that knowledge was complex, more provisional, obtainable through reasoning, and might involve ambiguities and conflicting truths. Perry's research has been developed on different lines by other authors. Two perspectives, especially, have received much attention over the last three decades (Purdie, Douglas, & Hattie, 1996).

The meta-cognitive perspective originated in the USA, and focuses on the analysis of students' beliefs about knowledge and learning, or epistemological beliefs (Ryan, 1984; Schommer, 1993). The phenomenographic perspective was developed in Europe and Australia, and centres on the study of students' approaches and conceptions of learning (Dart et al., 2000; Marton & Säljö, 1984;).

The meta-cognitive and phenomenographic perspectives describe the changes which, parallel to students' advancement, occur in their epistemological beliefs and their learning approaches, respectively. They have also analysed the impact of these variables on academic achievement, especially in the university setting. Two facts strike us as surprising, however. First, very little research has been conducted to date into epistemological beliefs in European secondary students, and second, these two perspectives have been investigated separately. It is highly likely that the constructs in question, although different, are related to one another, especially when we attempt to explain learning outcomes. Perry hypothesized, without conducting research into his idea, that students' points of view about the nature of knowledge are related to their manner of studying (Hofer & Pintrich, 1997).

In this investigation we set out to examine the change that European secondary students' beliefs about knowledge and learning, as well as their approaches to learning, undergo as they advance in their studies (change/s, henceforth). We will also analyse possible interrelationships among beliefs about knowledge and learning, and approaches as regards predicting students' academic performance.

After briefly examining these aspects of the question, we go on to offer two hypotheses which constitute the main purpose of this article. First, European students' epistemological beliefs will follow a similar pattern of change to that observed in North American students. Second, students' epistemological beliefs will have an impact on their academic achievement, not only directly, but also indirectly, through their influences on learning approaches. In order to explain these influences, we will propose a path model which will be tested using linear structural equation modelling procedures (LISREL).

**Research into students' beliefs about knowledge and learning**

Research on epistemological beliefs is a growing and complex area of interest for psychologists and educators. Hofer and Pintrich (1997, 2002) have written a detailed overview, distinguishing among three groups of researchers. The first are investigators interested in how individuals interpret their educational experiences (for example,
Baxter Magolda, 1987; Perry, 1970). In the second group are those who are concerned with analysing thought and reasoning processes (e.g. Kitchener & King, 1981). The third and most recent group are interested in studying the relationship between epistemological beliefs and numerous aspects of learning. The central tenet of this group is that students' beliefs about the nature of knowledge and learning are part of the underlying meta-cognitive mechanism (Hofer & Pintrich, 1997; Ryan, 1984; Schoenfeld, 1983; Schommer, 1990; Schommer, Crouse, & Rhodes, 1992).

This paper will focus mainly on the work of Schommer for several reasons. Hofer and Pintrich (1997, p. 106) recognize that Schommer 'has developed a research programme that is more quantitative than that of her predecessors and takes a more analytical view of the components of beliefs'. Most authors have studied epistemological beliefs in late adolescence and adulthood only, using complex, time-consuming instruments such as production tasks and/or interviews, and trained observers, to evaluate those beliefs. Schommer, on the other hand, has worked with both university and secondary school students, using a quick, simple instrument, the self-report questionnaire. This quantitative method (fundamentally quasi-experimental), enables the researcher to study more subjects/individuals in less time, and in the case of my research, facilitated my stated aims. What is more, Schommer provides a relevant criticism and contribution in this area. She criticizes the theoretical stances of Perry, Kitchener and Ryan and she makes a notable contribution to research on epistemological beliefs by showing that they are too complex to be captured on a single dimension. Schommer (1990) proposes, therefore, reconceptualizing them as a system of more or less independent beliefs.

Schommer's use of the term system suggests that more than one belief exists that should be taken into account, and the expression 'more or less independent' means that a student might be sophisticated in some beliefs, but not necessarily in others. The four dimensions she proposes are measured by her Epistemological Questionnaire (Schommer, 1993) and refer to the structure and certainty of knowledge, and the control and speed in its acquisition. These dimensions were obtained through a factor analysis of 12 groups of items measuring subjects' agreement to statements about knowledge and learning. What individuals believe about the nature of knowledge and learning (the four proposed dimensions) is what Schommer calls epistemological beliefs. We might ask ourselves if the terms belief and knowledge are distinguishable one from the other. Fenstermacher (1994) asserts that knowledge has justifiable, supportable claims, and higher epistemic status than belief, while 'in the context of epistemological models, this distinction would be applicable to models that focus on students' reasoning and justification for their epistemological thinking (e.g. King & Kitchener, 1994; Perry, 1981), in contrast to models that describe students' epistemological beliefs as relatively unexamined beliefs or assumptions (e.g. Hofer & Pintrich, 1997; Schommer, 1994, p. 112).

Schommer's theory hypothesizes that epistemological beliefs evolve, but it does not assert the degree to which education and maturation contribute to this change. Rather, it simply acknowledges that both factors are important influences in epistemological development (Schommer, 1994).

Research into changes in epistemological beliefs is sparse, but results are convergent, as is the case with Mason's and Schommer's studies. Although the main focus of Mason's research has been the analysis of the process of conceptual change (Mason, 2000, 2003), she has paid some attention to students' epistemological beliefs (Mason, 1998) as a variable related to that process. In the later study, presented as a proposal to a congress on instruction, she reported that the further high school
students progress through their studies, the less they believe in both simple and certain knowledge. Schommer (1993, 1998) has found, in line with Perry (1970), that the lower the educational level of students, the more naïve their epistemological beliefs. For example, at the outset of secondary education, pupils are more likely to believe that the ability to learn cannot be improved, or that knowledge consists of simple facts (Schommer, 1995). We posited that European students’ epistemological beliefs would follow a similar pattern of change to those observed in their North American counterparts. If this were so, then students’ epistemological beliefs would be more complex and realistic in the later years of secondary education than in the earlier years.

As regards beliefs about quick learning and fixed ability, differences depending on gender have been detected (Schommer, 1993). Girls believe to a greater extent than boys that learning takes place gradually, which may give them a slight epistemological advantage, as this would encourage them to exert greater control in their efforts at comprehension. This aspect is related to different ways of studying, or approaches to learning.

**Research into students’ approaches to learning**

In the phenomenographic perspective framework (Marton, 1981) researchers use a qualitative method. In-depth analyses are carried out on small numbers of participants mainly through interviews, in order to ascertain how they experience, conceptualize, perceive, and understand various kinds of phenomena proposed by the investigator. The latter is not so much interested in the phenomenon itself as in the participants’ interpretations of it.

Marton and Säljö (1976a, 1976b) and Säljö’s (1979) early research identified two opposing ideas about learning. Students who pay attention to details (e.g. signs in the text) in order to reproduce them later on, have a superficial idea, or quantitative conception, about learning. Students who focus on the meaning of what they are learning (e.g. the author’s intention) have a deep idea, or qualitative conception, about learning.

Numerous investigations in Europe (Entwistle, Hanley, & Hounsell, 1979; Marton & Säljö, 1984; Van Rossum & Schenk, 1984), built upon these findings and showed that there exist what have become known as approaches to learning. These reflect learners’ ideas or conceptions of learning (Säljö, 1982), how they experience and define their learning situation, the strategies they use to learn and the motivation underlying their conduct.

In Australia, investigations conducted by Biggs (1987a, 1987b, 1987c), using a quantitative methodology in which large samples, questionnaires, and multivariate analyses were employed, yielded similar results to those found in European research. Students who have a surface approach to learning tend to be extrinsically motivated (fulfilling requirements, avoiding failure) and resort to repetitive strategies (selecting certain details of information, memorizing and reproducing them accurately). Students who have a deep approach to learning tend to be intrinsically motivated (attempting to reach a personal understanding of material; material and tasks contribute to their self-actualization) and employ meaningful strategies (searching for meaning, integrating formal knowledge with personal experience and relating facts to conclusions). Students who have an achievement approach tend to be motivated by the need to achieve (be successful, obtain the highest possible marks, compete) and deploy organizational strategies (making optimum use of time and effort, using study skills). The degree to
which the choice of strategy is compatible with motive (e.g. organizational strategies and achievement motivation) will depend upon meta-learning, which Biggs (1987b, p. 5) refers to as 'students' awareness of and control over their own learning processes'. Biggs (1987b, 1987c) has developed two instruments for examining students' approaches to learning, the Learning Process Questionnaire (LPQ; for secondary students), and the Study Process Questionnaire (SPQ; for undergraduate students). The results of some investigations confirm the three-factor model (Kember & Gow, 1991; Watkins, Regmi, & Astilla, 1991), while other research confirms only two factors: deep approach combined with achievement approach, and surface approach (Biggs, Kember, & Leung, 2001; Kember & Leung, 1998).

Investigations into the change in learning approaches have been numerous, focusing mainly on university students. The results obtained from comparing responses given by advanced students with those given by lower-level students are ambiguous. In some cases, advanced students score more highly in deep approach and achievement approach (Davis & Sales, 1996; Richardson, 1994; Watkins & Hattie, 1981). In other cases, results are the opposite. Perhaps through institutional demands (dense curriculum, severe time limits, etc.) students in their final year tend to adopt less desirable approaches (surface) (Gow, Balla, Kember, & Stokes, 1989; Kember, 2000). One variable that may influence change in university students' learning approaches is gender. Some researchers have obtained data that appear to outline a certain stereotype: women tend to score higher on deep and achievement approaches, while men have higher surface-approach scores (Richardson & King, 1991; Watkins, 1984). However, these differences are very slight (Dart et al., 2000; Hayes & Richardson, 1995; Richardson & King, 1991).

Relatively little research has been carried out into secondary student change. Watkins, Hattie, and Astilla (1986) found that as pupils progressed from one year to another, they employed more and more deep-approach strategies. However, this result has not been borne out by other studies. Biggs (1987b) detected a decline in both surface and deep approaches between the ages of 14 and 16. In a nationwide Australian survey, Biggs and Moore (1993) identified a similar decline regardless of student gender. Eklund-Myrskog and Wenestam (1999) obtained similar results in a study into Finnish upper-secondary school students. They found that 18-19-year-old students obtained lower deep strategy and achievement approach scores than both 16-17 and 17-18-year-old students. Reasons for these observed changes are unknown. Watkins (1996) posits that responses to learning process instruments may be influenced by social desirability. In his study, the latter was seen to correlate significantly, though moderately, to surface strategy scores in boys and achievement strategy scores in girls. Participants were exclusively first-year secondary pupils, however (12-13 years). We may conclude that, broadly speaking, there is a tendency towards a decline in scores in all the types of approaches under discussion. In any case, it is difficult to reach any definite conclusion as regards change in approaches, especially in the light of two of their basic characteristics. First, they are not stable psychological attributes, and second, they are dependent upon the learning context (Entwistle & Ramsden, 1983), including the teacher's conception of learning and teaching (Entwistle, McCune, Walker, Sternberg, & Zhang, 2001; Kember, 2000).

In addition to describing changes in epistemological beliefs and approaches, we considered that it would be of value for educational theory and practice to discover whether these two variables influence academic performance, and if so, how.
Research into the interrelationships between epistemological beliefs/approaches and academic achievement

Schommer (1993) asserted that epistemological beliefs predict academic achievement. However, she recognized the need for further research in this area, as the influence of epistemological beliefs could be both direct and indirect. She advanced the hypothesis that epistemological beliefs might affect the selection of study strategies and comprehension criteria employed by students, and that these strategies and criteria might in consequence influence academic achievement (Schommer et al., 1992). This is, in fact, a more complex version of Perry's proposal mentioned at the beginning of this article. Taking into account that the other variable that is central to this investigation, approaches to learning, refers to the way in which the student learns (his/her perception of the learning situation, his/her motivation and his/her learning strategies), it is possible to restate Schommer's hypothesis in order to put it to the test in this research: Epistemological beliefs will influence academic achievement, not only directly, but also indirectly, through their effect on learning approaches.

Numerous theoretical models have emerged from research into approaches to learning (Biggs, 1991; Entwistle, 1981; Ramsden, 1988). They all assert that a student's academic performance or achievement will depend on his/her approach, which in turn will depend on other factors. These are characteristics of the teaching context (teaching styles, ways of assessment, etc.) and the pupil's perception about this context and the academic tasks set, which is also related to his/her personal characteristics (intellectual skills, personality, etc.), including beliefs about knowledge and learning.

The relationship between learning approaches and the quality of learning outcomes has been the subject of much research (Biggs, 1979; Marton & Säljö, 1976a; Trigwell & Prosser, 1991; Watkins, 1983), as has the link between learning approaches and academic achievement. As regards the first relationship, results are conclusive, for example, deep approach is generally associated with high-quality outcomes. However, as regards the second relationship, results are less clear-cut. Most studies have centred on university students, and in some cases have obtained results which significantly relate all or some of these approaches to academic performance (Drew & Watkins, 1998; Hall, Bolen, & Gupton, 1995; Watkins & Hattie, 1981; Watkins et al., 1991; Wong & Watkins, 1998). In secondary education, poor performance in maths has been reported in those subjects who learn by means of a surface approach (Watkins, 2001; Wong & Watkins, 1998), while higher grades are obtained by those who use deep approaches (Watkins, 2001; Wong & Watkins, 1998) and by those who display achievement motivation (Eklund-Myrskog & Wenestam, 1999). These researchers also found that students who performed poorly in English employed surface strategies. While it is difficult to reach a definitive conclusion, it would seem that deep and achievement approaches tend to be positively linked to academic success, and that surface approaches are linked negatively (Watkins, 2001).

We feel that it is of importance to carry out an in-depth investigation into the influence of secondary students' learning approaches on their academic achievement, for two reasons. The first is the fine tuning of results already obtained so as to ascertain both the direct and indirect effects of approaches as modulating variables on the influence of epistemological beliefs on achievement. The second is an extension to the European educational setting of results obtained in other parts of the world.
In sum, the present investigation addresses two questions:

(1) Is there any change in secondary students’ epistemological beliefs and approaches as they progress through their studies?
(2) What are the effects of both epistemological beliefs and approaches to learning on academic performance?

To answer the latter question, a path model defining the relationship amongst these variables was developed.

Method

Participants
These were 1,600 Spanish secondary students, who for the purpose of this study were grouped at three school levels, middle (200 boys and 309 girls; aged 12-14 years), junior high (200 boys and 238 girls; aged 14-16 years) and senior high (241 boys and 332 girls; aged 16-18 years). They attended several high schools, came from all social strata, and were not streamed according to ability. Boys accounted for 54.9% of the sample, and girls for 45.1%. Age range was from 12 to 20 years ($M = 14.79; SD = 1.95$). Twenty-five of the senior high participants were over 18 years old and were repeating students. Prior to the investigation, parents had given consent for students to participate.

Instruments
The Learning Process Questionnaire (LPQ) in its Spanish version (Barca, 1999), is composed of 36 items, grouped into six subscales, each containing six items. Students gave responses on a Likert-type scale, from 1 (never or rarely true of me) to 5 (always or almost always true of me). The subscales measured the learning approach dimensions proposed by Biggs (1993, 1987b): surface motive, surface strategy; deep motive, deep strategy, and achieving motive, achieving strategy. The subscales were subjected to two types of factor analyses, exploratory and confirmatory. The exploratory factor analysis, using the principal components method followed by oblique rotation of the factor loading matrix, indicated the presence of two factors or components with eigenvalues greater than 1, explained 62% of the variance, and fitted well with Biggs’s model. Deep-approach scales, followed by achieving-approach scales, loaded on Factor 1 (deep). Surface-approach scales loaded on Factor 2 (surface). Reliability, measured by means of Cronbach’s $\alpha$, was .74 for Factor 1 and .47 for Factor 2. The confirmatory factor analysis of that solution, using the covariance matrix and the unweighted least squares method (ULS), gave acceptable goodness-of-fit indices, $\chi^2 = 61.43, df = 8, p < .001$. Goodness-of-Fit Index (GFI) = 0.98, Adjusted Goodness-of-Fit Index (AGFI) = 0.94; Root Mean Square Residual (RMR) 0.06. These results are in line with those submitted by other authors (Kember & Leung, 1998).

The Epistemological Questionnaire (EQ), comprised 12 groups of items which were translated with suitable linguistic and cultural adaptations into Spanish, and approved by Dr. Schommer, the author. These items loaded on four factors or dimensions (Schommer, 1993). From a naïve perspective these are: learning occurs quickly or not at all (quick learning), knowledge is composed of discrete items (simple knowledge), learning ability is innate (fixed ability), and knowledge is unambiguous and absolute (certain knowledge). It is important to point out that the lower a student’s scores on these
factors, the less naïve will be his/her epistemological beliefs. So, for example, a student who obtains a low score on certain knowledge will not believe, in a naïve way, in knowledge as something absolute and unchanging, but quite the opposite. She/he will believe that a vast amount of knowledge is constantly evolving, and will therefore be an individual with a sophisticated epistemological belief as regards the certainty of knowledge.

To ensure the applicability of this questionnaire to our sample, two types of factor analyses were carried out, exploratory and confirmatory. The exploratory factor analysis, using the principal components method and varimax rotation, revealed the presence of three factors with eigenvalues greater than 1 and which explained 42% of the variance. Factor 1: beliefs in quick, effortless learning (quick, effortless learning); Factor 2: belief in simple knowledge (simple knowledge); Factor 3: beliefs in certain knowledge (certain knowledge). Inter-item reliabilities for items composing each factor, measured by means of Cronbach's α, were .64 for Factor 1, .60 for Factor 2, and .42 for Factor 3. The structure largely resembles that obtained by Schommer (1993, 1998), the only major difference being that the scales about learning beliefs load together on the first factor; the second and third factors are similar to Schommer's. A confirmatory factor analysis was also carried out, which provided reasonably acceptable goodness-of-fit indices: $\chi^2 = 408.58, df = 48, p < .001$, GFI = 0.95; AGFI = 0.92; RMR = 0.021.

**Procedure**

In classtime, students were each given a booklet containing information about the research, the questionnaires and instructions, as well as assurances regarding the confidentiality of all data collected. They were given an hour to complete the LPQ and the EQ. Students also gave their full name, age, and sex. At the end of the academic year, students' grades for all subjects were noted; their average mark was used as a measure of academic performance. This measure was standardized within each course to take into account differential marking within particular courses, and to allow more exact comparison among participants' scores.

**Statistical analyses**

The analysis of changes undergone in the different variables was conducted using school level (2 school years) as a unit of reference, for two main reasons. The first was psychological. The participants were adolescents and at a stage in which both epistemological beliefs and conceptions are likely to be as yet unclear and unstable. We considered that 2-year periods would yield more stable, realistic results. The second reason was statistical. Working with a large number of participants would enable us to fulfil parametric analysis requirements.

Data obtained were submitted to five types of analyses: descriptive, factor, MANOVA, ANOVA and LISREL. The programs used were 1D, 4M, 4V, and 7V from the BMDP statistical package (Dixon, 1985). The proposed path model was recursive, that is, all the arrows flowed one way, with no feedback looping, and was tested using LISREL 8 (Joreskog & Sorbom, 1993). Regarding path analysis, it worth clarifying some points. First, path analysis is an observational rather than a manipulative or experimental technique for modelling a theoretically hypothesized relationship among variables (Keitz, 1988). It allows one to examine the relative contribution of some variables in predicting other variables, both directly from one variable to another and via other
variables positioned between the other two. Second, pathways in path models represent the hypotheses of researchers, and can never be statistically tested for directionality (Everitt & Dunn, 1991).

Results

Changes in epistemological beliefs and learning approaches depending upon school level and gender

Using the factor scores obtained (by multiplying the standard scores for the original variables by the factor score coefficients) in the EQ and LPQ exploratory factor analyses as dependent variables (DV), a 3 (school level) × 2 (gender) multivariate analysis of variance (MANOVA) was conducted. This technique is more advantageous than univariate analyses, as it allows for the detection of significant differences which may exist in the criterion variables as a whole, due to changes in the controlled independent variables (IVs), and it provides an exact overall evaluation (Dillon & Goldstein, 1984). The analysis detected the presence of significant main effects for the two factors, school level, $F(10, 3180) = 27.80, p < .001$, and gender, $F(5, 1590) = 12.71, p < .001$, as well as for the school level × gender interaction, $F(10, 3180) = 2.03, p = .02$. Table 1 shows the descriptive statistics for the different DVs.

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<td>2</td>
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<td>3</td>
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As the interaction was significant, in order to extract maximum information we carried out two types of analyses: (a) separate analyses for boys’ and girls’ epistemological beliefs and approaches across all school levels, and (b) separate analyses for the three school levels comparing boys’ and girls’ epistemological beliefs and approaches.

Boys’ and girls’ epistemological beliefs and approaches across all school levels

Comparison of boys’ scores at the three school levels showed significant differences in all the dependent variables, except in simple knowledge and deep approach. The effect size, measured by means of eta-squared values ($\eta^2$), was .085. Comparison of girls’ scores at the three school levels also obtained significant differences in all the dependent variables, except in quick, effortless learning ($\eta^2 = .080$). These results, and the subsequent trend analysis, are seen in Table 2.
Table 2. ANOVA of differences among school levels in beliefs and approaches, and trend analyses, in boys and girls

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<td>3.56**</td>
<td>.39</td>
<td>6.59*</td>
<td>1.04</td>
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<td>2</td>
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<td>42.52**</td>
<td>1.47</td>
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<td>21.69***</td>
<td>41.81**</td>
<td>2.26</td>
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<td>Approaches</td>
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<td>Deep</td>
<td>23.41***</td>
<td>45.74**</td>
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<td>Surface</td>
<td>1.64</td>
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Note. *p < .05; **p < .001; F_L = F for linear trend, F_Q = F for quadratic trend.

Boys’ epistemological beliefs become less naïve and more realistic as they progress through their studies. The trend analysis shows that this change is linear for Factors 2 (simple knowledge) and 3 (certain knowledge), and is more irregular for Factor 1 (quick, effortless learning), as there is a pronounced rise in junior high. Similarly, we may observe a significant linear decline in deep-approach scores, also seen between junior and senior high levels, \( F(1, 439) = 5.71, p = .01 \).

Girls’ epistemological beliefs also become more realistic as they advance through high school. Moreover, this change is absolutely linear for Factors 2 and 3, as indicated by the trend analysis. As regards learning approaches, girls' scores also drop significantly in a linear fashion as they pass from one school level to another. This occurs in surface approach, even between junior and senior high, \( F(1, 568) = 4.56, p = .03 \), and also in deep approach. Although the quadratic trend in the latter is seen to be significant, post hoc comparisons between junior and senior high are not, \( F(1, 568) = .07, p = .79 \).

**Boys’ and girls’ epistemological beliefs and approaches at each school level**

The analysis of differences between boys and girls in the various DVs at each school level yielded the following results.

First, significant differences were seen at each one of the school levels: middle, \( F(5, 583) = 2.79, p = .01 \) \((\eta^2 = .025)\); junior high, \( F(5, 432) = 5.69, p < .001 \) \((\eta^2 = .062)\), and senior high, \( F(5, 567) = 7.10, p < .001 \) \((\eta^2 = .059)\).

Second, girls’ epistemological beliefs about knowledge and learning, at all school levels, are more realistic than boys’. The differences for the three school levels are as follows. Middle: in Factor 1 (quick, effortless learning), \( F(1, 557) = 9.57, p < .002 \). Junior high: in Factor 2 (simple knowledge), \( F(1, 436) = 16.70, p < .001 \), and Factor 3 (certain knowledge), \( F(1, 436) = 5.76, p = .01 \). Senior high: in Factor 1, \( F(1, 571) = 13.13, p < .001 \); Factor 2, \( F(1, 571) = 5.16, p = .02 \); and Factor 3, \( F(1, 571) = 6.18, p = .01 \).

Finally, learning approaches in boys and girls are shown to be similar at the beginning of secondary education, but tend to become differentiated towards the end. Boys show higher surface-approach scores in junior high, \( F(1, 436) = 4.66, p = .03 \), and senior high \( F(1, 571) = 7.66, p < .001 \). Deep-approach scores in girls exceed those in boys, but only in senior high, \( F(1, 571) = 5.45, p = .01 \).
After conducting these analyses, our next step was to ascertain possible interrelationships among the aforementioned DVs and academic performance.

**Interrelationships among epistemological beliefs, approaches and academic performance**

In view of the lack of research into these interrelationships in the literature, for the specification of a structural model, we used Biggs' 3P model (Biggs, 1987b, 1993). Here learning approaches act as mediating (process) variables between student characteristics (presage), in which we include beliefs about knowledge and learning, and the final result (product) or student performance. Figure 1 shows this proposed path model. It assumes that epistemological beliefs and learning approaches influence achievement directly and that, furthermore, epistemological beliefs influence it indirectly through their effect on approaches. This model is recursive (all arrows flow one way) because of the temporal relationship between these variables. The academic performance was measured using end-of-year examination results, whereas the other variables were assessed at the beginning of the year. The main object was not so much to search for causation among these variables, but to analyse the proposed interrelationships and influences between them.

![Figure 1. The *a priori* path model of interrelationships among epistemological beliefs, approaches to learning, and academic performance.](image)

Linear structural equation modelling procedures were employed to evaluate the goodness-of-fit of the hypothesized model. The covariance matrix (see Appendix) was analysed using the LISREL 8.20 program. Our objective here was to obtain a model which would offer a reasonable fit to the data. The indices of overall fit suggested that the model would serve the data reasonably well, but some paths were non-significant. We refined the model in two successive steps, at each stage eliminating the path between deep approach and certain knowledge, and between the latter and academic performance, respectively.

This partially-mediated model has two features which were of benefit to our study. First, it accommodates the data reasonably well, as is shown by its indices of overall fit: \( \chi^2_{(5)} = 5.19, \ p = .16; \ \text{GFI} = 1.00; \ \text{AGFI} = 0.99; \ \text{RMR} = 0.01. \) The explained variability is very high and the residuals are very low. These results are supported by a notable incremental adjustment, Non-Normed Fit Index (NNFI) = 0.98. A second favourable feature of the model is that it explains quite a high proportion of the variance percentage in each one of the DVs, as indicated by the squared multiple correlations for
structural equations: 10% in deep approach, 12% in surface approach, and 17% in academic performance.

The standardized parameter estimates for the model, all significant at the 0.05 level, are presented in Fig. 2.

![Diagram](image)

**Figure 2.** The final path model showing the influences of epistemological beliefs, and approaches to learning on academic performance.

We see that academic achievement is predicted by approaches to learning, which in turn are predicted by beliefs about knowledge and learning. The more naïve a student’s epistemological beliefs, the poorer his/her academic performance. The standardized total effects are as follows: quick, effortless learning (−.27), and simple knowledge (−.10). This effect occurs in two ways: first, directly, through the epistemological beliefs themselves, and second, indirectly, through their influence on learning approaches. The indirect effect is statistically significant for the Factor quick, effortless learning (−.09), which to some extent confirms the hypothesis put forward at the beginning of this paper. The more a student believes that learning occurs rapidly and without effort, the more she/he is likely to adopt a surface approach.

As may be observed in Fig. 2, learning approaches also help to account for student achievement directly and significantly. A surface approach is linked negatively to performance, while a deep approach is associated positively with it.

Two alternative models, one mediated and the other non-mediated, showed worse fit to the data: $\chi^2(3) = 63.96, p < .001$; GFI = 0.99, AGFI = 0.90; RMR = 0.047 for the mediated model (no paths between epistemological beliefs and academic performance), and $\chi^2(2) = 118.14, p < .001$; GFI = 0.97, AGFI = 0.74; RMR = 0.066 for the non-mediated model (no paths between approaches to study and academic performance).

**Discussion**

The results of this investigation lead to two major conclusions. The first is that, as students advance through their studies, both their epistemological beliefs and learning approaches change. The second is that epistemological beliefs significantly predict academic performance both directly and indirectly, via learning approaches.

**Epistemological beliefs, learning approaches, school level and gender**

Our findings suggest that as secondary students progress through school, their epistemological beliefs and learning approaches evolve. Epistemological beliefs about
knowledge and learning change, becoming less naïve and simplistic, and more realistic and complex. This lends support to our initial hypothesis that epistemological beliefs of European students (Spanish students in this case) would follow a similar pattern to that of their North American counterparts. Also, learning approaches change. Scores for these tend to go down as students move from one school level to another. These results appear to bear out Schommer's (1993) findings on epistemological beliefs and those of several other researchers (Biggs & Moore, 1993; Eklund-Myrskog & Wenestam, 1999) on learning approaches. However, we can only tentatively conclude that these changes occur, as the design we used was cross-sectional.

Some previous investigations found that these changes were related to the variable student gender (Biggs, 1987b; Dart et al., 2000; Schommer, 1993). The results of our study support this, and furthermore yield information about different tendencies between boys and girls. Boys’ beliefs in quick learning are more unstable throughout secondary education, as may be deduced by the fact that the quadratic trend is significant. Beliefs in simple knowledge and in certain knowledge, however, follow a similar pattern in both boys and girls, as is shown by the fact that the linear trend is significant, although girls generally express more realistic and elaborate epistemological beliefs than boys. Even so, all these differences observed in gender are slight and account for only a small proportion of the variance.

Learning approaches in boys and girls are seen to be similar at the beginning of secondary education, but tend to diverge later on. In spite of this, the stereotype proposed by Watkins (1984), that girls exceed boys on deep-approach scores, is only partially borne out. The reason is clear. Junior high and senior high boys score more highly on surface approach than junior and senior high girls. But girls do not obtain higher scores than boys on deep approach, except in senior high. These results extend to the level of learning approaches those obtained by Eklund-Myrskog and Wenestam (1999) at the level of learning strategies only. However, these differences in learning approaches depending on gender are, as in the case of epistemological beliefs, of small magnitude. To our mind, what is more striking than gender differences as regards epistemological beliefs and learning approaches is the significant decrease in all learning approach scores, especially deep approach, as students go through secondary education.

What, then, happens to learning approaches in high school? Why does this decline occur in learning approach scores? Biggs (1987b) asserts that there is no precise reason for this effect, which is also manifest in university students. In our opinion, it may be that as students advance through their years of study and become more aware of their own learning processes, three interrelated phenomena occur. In the first place, students may be swayed less by what they feel to be socially acceptable, and give more truthful answers. Secondly, they may have different academic orientations, veering from task goals to performance goals (Bouffard, Vceau, & Bordeleau, 1988), task goals being connected to deep approach, persistence and academic success, and performance goals being associated with surface approach and poor performance (Elliot, McGregor, & Gable, 1999). And thirdly, in connection with this last point, the student is likely to adapt to the demands of the education system, and learn to navigate the choppy waters of the curriculum. This is what Biggs (2001) has called the ‘institutionalization of learning . . . whereby students tend to pick up the tricks that get you by’ (p. 91).

The purpose of secondary education is the development of critical thought, problem-solving skills, and learning to learn (Kember, 2000). In other words, at the end of it, students should be able to deploy meaningful learning strategies and use a deep
approach to learning. As we know, in many cases this does not happen. A crucial question is, then, what student perceptions of the curriculum, teaching methods, and assessment procedures, in other education systems (Biggs, 1987b; Biggs & Moore, 1993; Watkins & Hattie, 1985) as well as our own, bring about such a drop in deep-approach scores? The answer to this question, which may imply a criticism of our education systems, lies outside the scope of this study, but is addressed in numerous other investigations. Although the student usually has predominant or preferred learning approaches, these may be influenced by features of the learning context, such as course contents, assessment, or the teacher's conceptions of teaching (Entwistle & Ramsden, 1983; Entwistle et al., 2001). In consequence, learning approaches deployed by students may well reflect the quality of the education they are receiving (Biggs, 2001), which in many countries appears to leave much to be desired.

Epistemological beliefs, learning approaches and academic achievement

The results of applying structural linear equation analysis to the proposed model make three clear contributions to work carried out to date in this area. The first two reflect results encountered by other authors; the third sheds new light onto this field of investigation.

First, epistemological beliefs exert a significant direct effect on academic achievement. This lends support to some results reported by Schommer (1993), which suggest that students who believe that learning occurs gradually and is not a fixed ability, and that knowledge is an organized structure and is not absolute or unambiguous, are those who achieve most academic success. Contrary to Schommer (1993) results, however, the factor certain knowledge did not have a significant effect on performance. Two facts may explain this: (1) this factor was the last to emerge in the factor analysis, that is, it accounted for the lowest percentage of the variance; and (2) it obtained the lowest reliability coefficient, when high reliability is an essential requisite when analysing variables using LISREL (Kelloway, 1998).

Second, learning approaches also significantly influence academic performance. In keeping with conclusions reached in other investigations, pupils who study with a surface approach to learning tend to perform poorly, while with deep-approach students, the opposite is generally the case. We would assert that these results enable us, on the one hand, to extend to all secondary education and academic performance in general, the results concerning specific subjects reported by some researchers (Wong & Watkins, 1998), and on the other, to confirm Watkins' (2001) findings concerning general academic achievement.

Third, our study brings to light a hitherto undetected finding in that it confirms the hypothesis that epistemological beliefs, as well as influencing academic performance directly, contribute to it indirectly through the effects of beliefs on student learning approaches. Results of a recent study conducted by Zhang and Watkins (2001) with undergraduate students also point in this direction. They discovered a significant link between ideas about knowledge and learning (assessed using Perry's scheme of intellectual and ethical development) and academic achievement. Nevertheless, we would point out that as far as indirect effects are concerned, our hypothesis is only partially confirmed, for they are significant only in the case of beliefs in quick, effortless learning.

Two implications arise from this finding. First, it enriches Biggs and Moore's (1993) theoretical model on school learning. Beliefs about knowledge and learning are an important variable to add to the factor characteristics of the student (presage), since
they affect his/her learning approaches (process) and his/her learning outcomes (product). Second, as far as accounting for academic performance is concerned, this finding confirms the existence of a link between the two concepts proposed from the meta-cognitive and phenomenographic perspectives, outlined at the beginning of this paper. It may be that this link is related to the concept of metacognition present in both lines of investigation - as pupils progress through their studies, their beliefs about learning become more anchored to reality, and their learning approaches more in keeping with curricular demands, reflecting greater awareness and regulation of their own learning processes; that is, meta-cognition, in Schommer's (1993) terms, or meta-
learning, as in Biggs (1987b). The cross-sectional design used and the analyses carried out do not allow us to go any further in our search for an explanation, and only permit a partial verification of the model proposed. In other words, the results should be interpreted cautiously. Even though we used path analysis modelling, this technique does not confirm causation in a model, nor does it even serve to detect variables neglected in the model. This could be improved by including other contextual and individual variables which shape the complexity of student learning.

In spite of these limitations, our results support the importance of two strategies related to some aspects of secondary education. First, as far as course planning is concerned, it is necessary to take into account not only students' previous knowledge and learning strategies (Weinstein & Mayer, 1986), but also their learning approaches and epistemological beliefs (a reactive strategy). That way, we might avoid two problems: deficits understanding of course contents, and subsequent deterioration in performance. Secondly, we should work directly to try to enhance the depth of learning approaches and the complexity of epistemological beliefs, as a way of improving academic achievement (a proactive strategy). In practice we would probably need to put into practice aspects of both strategies. If we hope to enhance learning, we must not lose sight of the fact that approaches are not simply student characteristics. Approaches are influenced by the whole teaching-learning system, and inextricably related to three of its components: aims, teaching, and assessment. To bring about improvements in learning, naturally it will not be enough to tell students what they should believe or what approach they should adopt. We agree with those authors who assert that the three above-mentioned components should all be aligned in the same direction for the improvement of academic practice. Biggs (2001, p. 93) writes that, 'It is easy to see why aligned teaching should encourage deep learning. The curriculum is stated in the form of clear objectives, which include the level of understanding required . . . The teaching methods are chosen that are likely to realize those objectives . . . and . . . assessment should be criterion-referenced . . . optimizing the likelihood [that students] will engage the appropriate learning activities.' Entwistle et al. (2001) state that in order to improve academic practice, both students and staff, as part of the teaching-learning system, should be encouraged to match the meaning of concepts (e.g. approaches in learning and teaching) to their everyday 'experience in ways that promote reflection' (p. 133). In our opinion, one of the results of our study, that is, the change in students' metacognition as they progress through secondary education, could also favour this alignment and reflection in teaching and learning. Teachers and educators in general could tap into this meta-cognitive change in order to facilitate students' constructive learning processes, thereby reducing the institutionalization of learning.

Future research could focus on three key issues. First, longitudinal studies could be undertaken to allow for a deeper examination of the relationships between epistemological beliefs and learning approaches over time, and within individual
students. Secondly, further to such research, the causal model proposed and changes in epistemological beliefs and learning approaches could be tested. Thirdly, in view of the observed impact of beliefs about learning and knowledge, and approaches to learning, teaching procedures could be designed to foster reflection and heighten awareness about learning, thereby guiding students towards deeper approaches, greater academic success, and enhanced personal development.

Acknowledgements
I am very grateful to Associate Editor, Leslie Smith, to the two referees, John Richardson, University of Brunel, and Phillip Adey, King's College, for their critical review of the study, and to Jean Stephenson, University of Granada, Spain for her constant support and help in drafting the manuscript in English.

References


Received 28 February 2002; revised version received 12 November 2003

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**Appendix: Descriptive statistics and covariance among epistemological beliefs, approaches to learning, and academic performance.**

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Participants with complete data = 1,473