Domain-specificity of Self-concept and Parent Expectation Influences on Short-term and Long-term Learning of Physics

Alexander Seeshing Yeung

University of Western Sydney and National Institute of Education, Singapore

Loganantham Kuppan, See Kit Foong, Darren Jon Sien Wong,
Munirah Shaik Kadir, Paul Choon Keat Lee, Che Ming Yau

National Institute of Education, Singapore

Abstract

Background: Students' academic self-concepts are known to be domain specific. Researchers have also identified two related components of self-concept:cognitive (how competent students feel about a subject domain) and affective (their interest in the subject). This paper examines whether both components are domain specific. Research has also shown that parents tend to influence children's academic behaviours and choices, but it is unclear whether parent influences would also be domain specific.

Aim: This paper examined whether both the cognitive and affective components of self-concept in learning were domain specific with regard to learning physics and whether students' perceived parent support in learning physics would have short-term and long-term influences.

Sample: A sample of secondary 1 students (7th graders) in Singapore responded to 29 items in a survey about their self-concepts in learning physics (competence and interest), self-concepts in English (competence and interest), perceived parent expectations in physics, engagement in learning physics (a short-term outcome), and aspiration to learn physics in future (a long-term outcome).

Method: Structural equation modelling was conducted to establish the 7 factors. Path analysis examined the relations of physics self-concepts to engagement (a short-term outcome) and aspiration (a long-term outcome). The paths from parent expectations were also examined.

Result: The cognitive and affective components of self-concept were highly correlated, but only within respective domains. Physics self-concepts were uncorrelated with English self-concepts. The path from competence in physics to engagement was statistically significant, but not the path to aspiration. Paths from interest in physics to both outcomes were positive. Competence in English did not have positive relations with outcomes in physics, but interest in English had a positive relation with engagement in physics. Parent expectations had positive influences on both engagement and aspiration.

Conclusion: The results provided partial support for the domain specificity of both the cognitive and affective components of self-concept. Parental influences tended to be strong even when the impacts of self-concepts are controlled.

Keywords: physics, self-concept, parental expectation, domain specificity

自我觀的範疇獨特性和家長的期望對學習物理科的短期及長遠影響

楊書誠

澳洲西悉尼大學及新加坡國立教育學院

Loganantham Kuppan，馮仕杰，黃存善，Munirah Shaik Kadir，李俊杰，丘志明

新加坡國立教育學院

摘要

*背景：*學生的學習自我觀是有其範疇獨特性的，而且可以分成兩個類別：認知（就是學生對該科目的能力評估）和感性（就是學生對該科目的興趣），但這兩個類別的範疇獨特性並未曾確認。本文探討這兩個類別是否都有其範疇獨特性。另外，學者又發現家長對學童在學習行為和學科選擇方面有莫大的影響，但這些影響是否也都有範疇的獨特性就不得而知。

*目的：*本文探討學生在學習物理學方面的自我觀中，認知和感性這兩個類別是否顯現範疇的獨特性，而且探討學生感受家長對他們在學習物理學時的支持會否有短期和長遠的影響。

樣本：學生來自新加坡的中一（七年級），他們回答29個問題，分別有關學習物理學方面的自我觀（包括能力和興趣）、學習英語方面的自我觀（也包括能力和興趣）、他們感受家長對他們在學習物理學方面的期望、他們在學習物理學時的投入程度（短期的影響），和他們對將來學習物理學的抱負（長遠的影響）。

*方法：*本研究先採用確定因數分析法去確定以上七個不同因素，再以結構程式法測試學生的物理學自我觀和他們在學習物理學時的投入程度（短期的影響）和抱負（長遠的影響）之間的關係。另外，家長對學生的期望和短期

及長遠影響之間的關係也一併測試。

*結果：*學生的自我觀之中的認知和感性類別在個別的範疇內有頗高的相關性，但物理學自我觀和英語自我觀完全沒有相關。物理學的能力對投入學習物理學有顯著的影響，但對抱負卻沒有正面的影響；反之，學生對物理學的興趣卻同時影響學生對物理學的投入和抱負。英語的能力對學習物理學沒有影響，但學生對英語的興趣卻正面地影響學生對學習物理的投入程度。最後，家長對學生的期望顯著地影響學生對學習物理學的投入和在將來學習物理學的抱負。

*結論：*學生的學習自我觀大致上是有其範疇獨特性的，認知和感性兩個類別皆然。而在獨特的範疇中，家長對學童在學習的成果方面的確有莫大的影響。

關鍵詞：物理學，自我觀，家長的期望，範疇獨特性

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Researchers have demonstrated that students' academic self-concepts are domain specific (e.g., Marsh & Craven, 2006; Lee et al., 2000; Yeung & Lee, 1999). Hence students' self-concepts can be differentiated across a range of curriculum areas (e.g., English, maths, science, etc). In the last decade, researchers have further considered the separation of two major components of self-concept: the cognitive and affective components (Marsh, Craven, & Debus, 1999). The separation of the cognitive and affective components is important because the distinctiveness of the two factors implies that students' perceptions of a high level of competence may not guarantee their interest in an academic area. Likewise, students who like schoolwork may not feel competent. However, although Marsh et al. (1999) have demonstrated that students' sense of competence and interest in learning are distinguishable, they have not examined their domain specificity and their relations with other constructs. In the present study, we examined the distinctiveness of the two components in two specific academic domains: physics and English. To examine the domain-specific relations of the two components with other variables, we also tested their relations with two learning outcomes pertaining specifically to physics: engagement in physics (short-term learning) and aspiration to learn physics in future (long-term learning). Also, in facilitating students to learn well at school, parental support is known to be one of the major driving forces (e.g., McInerney, Dowson, & Yeung, 2008). However, parental influence may or may not be domain specific and the current literature does not indicate whether parents' expectations of their children learning physics, for example, would have any impact on the children's short-term and long-term outcomes in physics specifically. Therefore, we also attempted to investigate parents' influences on top of the impacts of students' own competence perceptions and interests.

Domain Specificity of Self-Concept

In the school context, the understanding of students' self-beliefs in learning and attitudes towards the curriculum is crucial. In particular, as Craven, Marsh, and Burnett (2003) have noted, an understanding of students' self-concept is essential because it is an important educational outcome and also an important factor that contributes to other valued educational outcomes. Numerous studies have shown close relations of academic self-concept to academic achievement and academic behaviour (e.g., Chapman & Tunmer, 1997; Eccles & Wigfield, 1995; Hay, 1997; Helmke & van Aken, 1995; Marsh & Yeung, 1997; Muijs, 1997; Yeung & Lee, 1999), and Marsh, Byrne, and Yeung (1999) have proposed a reciprocal effects model showing the mutual enhancing effects of achievement and self-concept (also see Marsh & Craven, 2006; Marsh & O'Mara, 2008). These studies have also shown that academic self-concepts and their relations to other constructs are very domain specific. Thus recent research on academic self-concept has emphasized its domain specificity and multidimensional nature (e.g., Byrne, 1996; Hattie, 1992; Lau, Yeung, & Jin, 1999; Marsh, 1993; Marsh, Byrne, & Shavelson, 1988; Marsh, Kong, & Hau, 2001; Yeung, Chui, Lau, McInerney, Suliman, & Russell-Bowie, 2000). The emphasis has also led to the development of instruments that measure self-concepts in distinct areas (e.g., Marsh, 1990, 1992, 1993).

The emphasis on domain specificity is primarily due to the consistent finding of distinct self-concept constructs and their domain-specific relations to other constructs. Intuitively, we may assume that self-concepts in various curriculum domains should be positively correlated. However, studies have often found a nonpositive (often near-zero) correlation between students' verbal and maths self-concepts (e.g., Marsh, 1987; Marsh, Byrne, & Shavelson, 1988; Yeung & Lee, 1999). Based on consistent findings of a high correlation between verbal and maths achievements but a low correlation between verbal and maths self-concepts, Marsh (1986) proposed an internal-external frame of reference (I/E) model to provide a plausible account for the near-zero correlation between the domain-specific self-concepts. Marsh (1986) argued that the development of students' academic self-concepts is primarily based on their achievement compared to their peers. By comparing externally with other students in class, those students who are strong in their verbal scores tend to have a high verbal self-concept. For those students whose verbal ability is not as good as their ability in maths, however, an internal comparison across subject domains tends to give them a lower verbal self-concept. The combined operation of both the internal and external comparisons leads to the low correlation between self-concepts in the two domains. In the last two decades, researchers have replicated the patterns of the I/E model in various cultural and language backgrounds (e.g., Lee et al., 2000; Marsh, Kong, & Hau, 2001; Yeung, Chow, Chow, Luk, & Wong, 2004; Yeung & Lee, 1999). The I/E model has provided an important framework for examining the domain specificity of academic self-concepts.

Components of Academic Self-Concept

Further to the domain specificity and distinctiveness of academic self-concepts across a range of curriculum domains, more recent research has also suggested that there are two distinct components of self-concept. Marsh, Craven, and Debus (1999) tested the hypothesis of a separation of two components of academic self-concept: the cognitive and affective components. They provided evidence for the separation of the two components, and they found that the differentiation of these components tends to be more pronounced in more matured students. Hence at least some students who believe that they are competent in science (cognitive), for example, may not like science (affective). Likewise, some students who like science may not find themselves competent in science, although in most cases, students who feel good about their competence in science would probably like science as well.

However, although Marsh et al. have demonstrated that the two components of self-concept are distinguishable, they have not seriously examined their domain specificity and their relations with other constructs. Neither have they tested whether each component in a curriculum domain is associated with the same component in another domain. Furthermore, a test of the domain specificity of such components would also require a test of their respective relations with domain-specific outcome variables. To this end, path analysis using a structural equation modelling approach (SEM; see Byrne, 1998; Jöreskog & Sörbom, 2005; Pedhazur & Schmelkin, 1991) would be useful to demonstrate the positive relations between predictors and outcomes in matching domains and non-positive relations in non-matching domains. The present study attempts to provide such a rigorous scrutiny of the distinctiveness of the two components of self-concept and their domain-specific relations with other variables.

Self-concept in Learning Physics

In the science curriculum, the significance of investigating students' self-beliefs in learning science and attitudes towards the science curriculum probably lies with (a) increasing evidence of a decline in students' interest in pursuing scientific careers, (b) an increasing tendency of scientific ignorance in the general populace, and yet (c) an increasing recognition of the importance and economic utility of scientific knowledge such that the falling numbers choosing to pursue the study of science have become a matter of considerable societal concern (Osborne, Simon, & Collins, 2003). In their review of reports about students' choice of science coursework, Osborne, Simon, and Collins (2003) note that there have been warnings of the potential problem both in the UK (Haskell & Martin, 1994; Nottingham Skills & Enterprise Network 1992) and the US (National Commission on Mathematics and Science Teaching for the 21st Century, 2000). The problem is not only limited to the decreasing number of students choosing science, but also a shortage of teacher supply in the science curriculum (O'Leary 2001).

This situation is common in most modern countries although there are also exceptions (e.g., Scotland; see Reid & Skryabina, 2002). Whereas fewer students seem to be interested in science than in other curriculum areas, among various science domains, physical science seems to be one of the least appealing. In explaining why students did not seem to like physical science, Osborne, Simon, and Collins (2003) argued that it was probably due to the fact that "the relevance of the physical sciences was difficult for students to identify" (p. 1061). As such, physics has traditionally attracted fewer students than other areas of science.

Indeed, recent studies have indicated that students may hold dichotomous attitudes towards science. Data from the Relevance of Science Education (ROSE) project (Sjøbeg & Schreiner, 2005; also see Ogawa, 2006) reveal that the issue of dichotomous attitudes towards science is especially prevalent among youths from developed countries. In particular, this is seen in England (Jenkins & Nelson, 2005) where students recognise the importance of science to society but they do not personally engage themselves as much as they do in other subjects. Hence while students may have positive *extrinsic* attitudes towards science at the societal level, they may embrace negative *intrinsic* attitudes towards science at the personal level. This differentiation between *intrinsic* and extrinsic attitudes towards science was further affirmed empirically by Kim and Song (2009) who, using structural equation modelling, demonstrated that intrinsic attitudes towards science exclusively stimulated students' interest and conceptual understanding in physics.

Even at the personal level, students' interest in physics and their sense of competence in physics may not always go parallel to each other. Gardner (1975), for example, distinguishes between 'attitudes towards science' and 'scientific attitudes', arguing that these perceptions may be subtly different. Following Gardner (1975), Osborne, Simon, and Collins (2003) differentiate between the affective and cognitive aspects of attitudes and beliefs respectively. Hence, consistent with Marsh, Craven, and Debus (1999), students' attitudes and beliefs in physics may be studied as two discrete but interrelated components: affective and cognitive. Not surprisingly, each of these components may also be further differentiated to a range of relevant constructs. For example, to Klopfer (1971), the affective aspect may include a range of attitudes and behaviours such as the enjoyment of science learning experiences, the development of interests in science and science-related activities, and the development of an interest in pursuing a career in science or science-related work. Nevertheless, in the present study we focused only on the broad conceptualization of the cognitive (sense of competence), and affective (the extent of liking physics) components regarding physics learning.

Long-term and Short-term Influences of Self-beliefs

Based on previous research studies demonstrating that students' self-beliefs have significant influence on essential academic outcomes (e.g., Marsh & Craven, 2006), we may hypothesize that the better self-beliefs students possess, the better chance it is for them to excel in physics. Indeed, researchers have shown that students' self-beliefs do influence learning in science. For example, analysing the TIMSS 1995 and 1999 datasets, House (2004) found that students' beliefs are associated with their achievement. In particular, House (2004) found that students who were interested in science tended to score higher in the TIMSS science tests.

Nevertheless, for interest and attitude, although researchers suggest that students' motivation and positive attitudes towards science should be associated with better performance in science, there is little evidence of a direct relationship between the predictors and learning outcomes (see Gardner, 1975; Schibeci, 1984; Shrigley, 1990). Even though recent international studies with the TIMSS data did show some positive relationship between attitude and achievement (Beaton et al., 1996; Weinburgh, 1995), there was a serious limitation of the survey instruments of TIMSS as it did not allow sophisticated investigations of such a relationship. There was also a paucity of studies that investigate the differential influences of the cognitive and affective components of student beliefs on short-term and long-term learning outcomes. Hence we attempted to unveil the link between these components of self-beliefs and short-term and long-term outcomes in this study.

A major form of valuable outcome as a consequence of successful physical science education includes positive learning behaviours and engagement in scientific endeavours (see Martin, 2008; Steinberg, Lamborn, Dornbusch, & Darling, 1992). The assumption is that the more confident the students are in physics and the more interest they find in learning physics, the more engaged they will be in physics–related learning activities. Their engagement in learning tasks keeps them involved in physics learning that requires continuous effort, determination, and perseverance, and these are crucial for improved achievement outcomes (Fredricks, Blumenfeld, & Paris, 2004). That is, students' sense of competence is likely to lead them to higher levels of engagement because they have the confidence to do well. Their interest in physics will also lead to higher levels of engagement because interest provides a driving force for them to persist in learning tasks and activities that may seem to be difficult (Elliot & Church, 1997).

In contrast to the behavioural outcome such as engagement, which may be apparent in the short term, students' selection of further studies in physics is probably one of the most important long-term outcomes of physics education. Based on previous research, we may expect that students' beliefs and attitudes towards science predict their intentions to enrol in science classes in future (e.g., Gardner, 1975; Koballa, 1988; Crawley & Coe, 1990; Crawley & Black, 1992; Reid & Skryabina, 2002). Hence a student who finds interest in physics is more likely to choose physics in further studies. However, compared to personal interest in physics, a students' sense of competence in physics may or may not have a strong role to play in the long-term decision process. Indeed, as some researchers have suggested (e.g., Jenkins & Nelson, 2005; Kim & Song, 2009; Sjøbeg & Schreiner, 2005), students' may hold conflicting self-beliefs and attitudes simultaneously, and they may have different impacts on different outcomes, short term and long term.

Interestingly, data from the international studies of PISA reveal that students in developed countries tend to show relatively low levels of interest in science, although their achievement levels are relatively high compared to students in developing countries (Ogura, 2009). In general, students expressed most interest in learning about health or safety issues that they might encounter personally and least interest in learning about abstract scientific explanations and how scientific research is conducted. This trend of decreasing interest as the topic moves farther away from personal experience and immediate relevance is in agreement with the finding of Osborne & Collins (2001). Given the reduced interest, students would be less likely to choose science, especially physics, in their future academic pursuit even though some of them appreciate the short-term advantage of being competent and scoring high in the school subject.

Influence of Parent Expectations

Students' learning is influenced by a wide range of factors, internal and external (Barker, Dowson, & McInerney, 2002; Dowson & McInerney, 2003). External forces in students' social environments may facilitate or inhibit their development of dispositions in learning (McInerney, Dowson, & Yeung, 2008). Significant others, for example, may facilitate or inhibit students' achievement motivation and behaviour, depending on a variety of contexts and conditions. Students' perceptions of support and care from parents, for example, can have great influence on their engagement in schoolwork and academic achievement (Allocca & Muth, 1982; Bempechat, 1990, 1992, 1998; Connor, 1994; Ford & Harris, 1996; Harter, 1996; Jordan & Nettles, 1999; van Etten, Freebern, & Pressley, 1997; Walters & Bowen, 1997). Indeed, research has indicated that parental involvement in the education of their children is a good predictor of student learning and success (Fantuzzo, Tighe, & Childs, 2000; Hill, 2001; Hill & Craft, 2003). It is known that parents' beliefs in their children's competence in mathematics contribute directly to the children's higher mathematical performance (Aunola, Nurmi, Lerkkanen, & Rasku-Puttonen, 2003; Hill & Craft, 2003), although some researchers do hold contrary views (see Pezdek, Berry, & Renmo, 2002). In general, parent-school involvement appears to improve children's social behaviour and interactions among peers and may be positively associated with rule compliance and sociability. In physics, we may expect that students who perceive parental support in studying physics would engage more in physics learning activities and would be more likely to choose physics in their future studies. However, it has not been tested whether the effects of parental support would be notably strong after controlling for the predictably strong effects of self-concepts.

The Present Investigation

In the present study, we attempted to examine whether the cognitive and affective components of self-concept are domain specific. We also examined whether parents' influence on children's academic behaviours and choices are also domain specific. We asked a sample of secondary students to respond to survey items about their self-concepts in learning physics and English (in both cognitive and affective components) and their perceived parent expectations in physics, and then related these variables with two outcome variables: engagement in learning physics (a short-term outcome) and aspiration to learn physics in future (a long-term outcome). We hypothesized that competence and interest in physics would be positively correlated but neither variable would be positively correlated with competence and interest in English. Path analysis would provide us with important information about the predictive paths from the cognitive and affective components in physics and in English self-concepts to outcome variables (i.e., engagement and aspiration). The relative significance of parent expectations in predicting student outcomes (i.e., engagement and aspiration) would also be elucidated.

Method

Participants

The participants were Secondary 1 (7th grade) students from a secondary school in Singapore (N = 275; median age = 13). There were 100 boys and 175 girls involved in the study. All the students were ethnic Chinese, the largest ethnic group of the nation (>75%). Although the students were from a Chinese origin, 143 of them used English as a major spoken language at home. English is the medium of instruction in all government schools in Singapore, and all students formally start learning English in 1st grade. However, among the other students, 113 of them used Mandarin while the rest used other Chinese dialects at home. All participants were high achievers in primary schools. They were selected for admission into the participating school on the basis of their Primary School Leaving Examination (PSLE; see Road to PSLE, 2010), of which the score range is 0 to 300. Usually only students with a score of about 240 would be admitted to this highly reputed school, although there were also students with lower PSLE scores admitted for their sports or other achievements. The mean PSLE score for this sample was 243; hence the students were considered to have "above average" academic capabilities when compared to the secondary one cohort in Singapore.

Material and Procedure

In a survey conducted in the second semester of secondary education (end of 7th grade), the students were asked to rate on a scale of 1-6 on seven factors, with items randomized in the survey form. Five of these factors were about learning physics and two factors were about learning English. All the seven factors and their associated items, together with their descriptive statistics and scale reliability, are given in Table 1. Apart from background variables such as age, gender, language background, a total of 29 forced-choice items were used. The variables were:

Competence in physics. This is the cognitive component of physics self-concept. The items were adapted from the Marsh (1992) Academic Self-Description Questionnaire (ASDQ) instrument. A total of four items were used to ask students about their sense of competence in physics.

Table 1. Descriptive Statistics of Variables

Scale	Item	Mean	SD	Alpha
Competence in physics	I am good at PHYSICS	3.34	1.31	0.94
	I have always done well in PHYSICS	3.46	1.30	
	PHYSICS is one of my best school subjects	3.13	1.44	
	I learn things quickly in PHYSICS	3.72	1.16	
Interest in Physics	I enjoy doing PHYSICS	3.97	1.25	0.91
	I am really interested in PHYSICS	3.88	1.30	
	I think it's great that I learn all sorts of things in PHYSICS	4.40	0.97	
	I find PHYSICS interesting	4.36	1.23	
Competence in English	I learn things quickly in ENGLISH classes	4.13	1.13	0.89
	I get good marks in ENGLISH	3.44	1.27	
	Work in ENGLISH classes is easy for me	3.95	1.18	
	ENGLISH is one of my best subjects	3.48	1.38	
Interest in English	I like ENGLISH	4.30	1.18	0.92
	I enjoy ENGLISH classes	4.46	1.09	
	I am interested in ENGLISH	4.30	1.19	
	Work in ENGLISH classes is interesting	4.38	1.12	
Perceived parent expectation	My parents think that I should take an advanced science course in future	4.21	1.10	0.90
	My parents think that I should do science in school	4.73	0.95	
	My parents encourage me to do science in my future education	4.38	1.10	
	My parents want me to choose science as a major subject	4.24	1.19	
Engagement in physics	I pay attention during PHYSICS lessons	4.67	0.93	0.87
	I am attentive to my work during PHYSICS lessons	4.49	0.91	
	I listen carefully when the teacher explains something about PHYSICS	4.81	0.75	
	I try my best to complete my work in PHYSICS	4.87	0.86	
	I try my best to answer PHYSICS questions	4.74	0.76	
Aspiration to learn physics	If I could do exactly what I wanted, I would like to study PHYSICS in future	3.57	1.28	0.85
	We can't always do what we want to, but I think I can actually learn PHYSICS in college/university	3.81	1.15	
	My parents believe that I can take a PHYSICS course in future	3.76	1.16	
	If I can choose after secondary school, I will study PHYSICS in college/university	3.62	1.29	

Note: Items were randomized in the survey.

Interest in physics. This is the affective component of physics self-concept. The items were adapted from the Marsh, Craven, and Debus (1999) study and the Elliot and Church's (1997) measure of personal interest and enjoyment. A total of four items were used to ask students about their interest in physics.

Competence in English. Like competence in physics, this is the cognitive component of English self-concept. Again, the items were adapted from the Marsh (1992) ASDQ instrument. Four items were used to ask students about their sense of competence in English (Table 1).

Interest in English. This is the affective component of English self-concept. The items were adapted from the Marsh, Craven, and Debus (1999) and Yeung et al. (2004) studies. Four items were used to ask students about their interest in English (Table 1).

Perceived parent expectation. Four items were used to ask students' about their perception of their parents' expectation of their future studies in physics (Table 1).

Engagement in physics. The measure of individual engagement in physics was based on students' report of their attention and participation in class, which was adapted from Steinberg, Lamborn, Dornbusch, and Darling (1992). An example is: "I listen carefully when the teacher explains something about physics".

Aspiration to learn physics. This scale asked students about their aspiration to pursue physics courses at advanced levels in future. It was adapted from Yeung and McInerney (2005). An example is: "If I can choose after secondary school, I will study physics in college/university".

Procedures approved by the university's ethics committee were followed. Informed consent was obtained from the school and the parents of the students before data collection. The survey was uploaded onto the school online portal and was open to all Secondary One students for one week. The students logged on to their individual accounts in their own time (at home or in school) to respond to the online survey at any time during the access period of one week. The students responded to the survey items in a randomized order on a six-point scale (1 = strongly disagree to 6 = strongly agree).

Statistical Analysis

The students' responses were coded such that higher scores reflected more favourable responses. In preliminary analysis, we examined the descriptive statistics of each item and the alpha reliability of each *a priori* scale formed from respective items. There are various strong approaches to testing our hypothesis, such as Rasch modelling (see Sideridis, 2007; Smith & Smith, 2004) and structural equation modelling (SEM; see Byrne, 1998; Jöreskog & Sörbom, 2005; Pedhazur & Schmelkin, 1991). Considering our purpose of examining linear relationships between variables with a relatively small sample (N = 275), we chose to apply the SEM approach.

We first examined the factor structure of a full measurement model with the 29 items forming seven factors, allowing each item to load on to one factor only. Then we tested a single-factor model with the 29 items so as to compare against the *a priori* seven-factor model. The procedures for conducting SEM have been described elsewhere (e.g., Byrne, 1998; Jöreskog & Sörbom, 2005; Pedhazur & Schmelkin, 1991) and are not further detailed here. The SEM was conducted with the LISREL software (Jöreskog & Sörbom, 2005). Both absolute fit statistics and incremental fit statistics were used to evaluate the model fit (see Byrne, 1998; Hoyle & Painter, 1995; Tanaka, 1993). The absolute fit statistics included

$\chi 2$ tests of model fit and the root mean square error of approximation (RMSEA; Browne & Cudeck,1993). The incremental fit statistics (Hoyle & Painter, 1995) included the Comparative Fit Index (CFI; Bentler, 1990) and the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), also known as the non-normed fit index (NNFI; Benter & Bonett, 1980). For the fit indices, in general, the CFI and TLI vary along a 0-to-1 continuum in which values equal to or greater than .90 and .95 are typically taken to reflect acceptable and excellent fits to the data, respectively. For RMSEA, according to Browne and Cudeck (1993), RMSEA values in the vicinity of .05 indicate "close fit," values near .08 indicate "fair fit," and values above .10 indicate "poor fit."

In a measurement model, the parameters typically consist of factor loadings, factor variances and covariances, and measured variable uniquenesses (i.e., measurement errors associated with each item). For the full model using 29 items to form seven factors, support for model fit would require: (a) acceptable reliability for each scale (i.e., alpha = .70 or above), (b) an acceptable model fit (i.e., TLI and CFI = .90 or above and RMSEA < .08), (c) acceptable factor loadings for the items loading on the respective factors (>.30), and (d) acceptable correlations among the latent factors such that they would be distinguishable from each other (r < .90).

To the extent that the model was established, we further examined a path model testing the relations between five predictor variables (competence in physics, interest in physics, competence in English, interest in English, and parent expectation) and two outcome variables (engagement in physics and aspiration to learn physics in future). By inspecting the paths from the predictors to the outcomes, we would be able to examine the relative strengths of each predictor in influencing the outcomes (see Figure 1).

Table 2 *Goodness-of-fit Summary for Models*

Model	x2	df	TLI	CFI	RMSEA
1. Full 7-factor model	866.51	356	.91	.92	.07
2. 4-factors: Physics, English, Parent, Outcomes	1770.88	371	.77	.79	.12
3. Path model	866.51	356	.91	.92	.07

Note: N = 275. CFI = Comparative fit index. TLI= Tucker-Lewis index. RMSEA = Root mean square error of approximation.

Results

Preliminary Analysis

The mean score for each item and the alpha estimate for each scale are given in Table 1. All the seven a priori factors had acceptable alpha reliabilities (α > .70). The lowest alpha was found in aspiration (α = .85), and the highest was in competence in physics (α = .94). These high reliabilities provided preliminary support for the scales.

Structural Equation Modelling

Measurement model. All the three models reported here converged to proper solutions (Table 2). Model 1 tested the ability of 29 items to form seven distinct factors. The model provided a good fit (TLI = .91, CFI = .92, RMSEA = .07). The parameter estimates are presented in Table 3. In contrast, Model 2 testing a single-factor model with 29 items (Table 1) did not provide a good model fit (TLI = .77, CFI = .79, RMSEA = .12). The parameter estimates were unreasonable (with many factor loadings < .30). Hence Model 1 was selected as a better model. In Model 1, the factor loadings were all acceptable (all > .50), with the lowest being .61 and the highest being .95 (Table 3). The correlations among the latent constructs were reasonable, ranging from -.11 (between Competence in English and Aspiration to learn physics) to .89 (between Interest in physics and Aspiration to learn physics). The correlation between the cognitive (competence) and affective components of self-concept in English (interest) was high (r = .86). Similarly, the cognitive and affective components of self-concept within the physics domain were also highly correlated (r = .80). These results were consistent with the Marsh, Craven, and Debus (1999) findings. Between the English and physics domains, the correlations were close to zero (rs = .03 between the cognitive components, -.01 between the affective components, and -.06 and -.09 for the other non-matching components; Table 3). These results provided preliminary evidence for the domain specificity of both components of self-concept. For the parent expectation factor, the correlations were positive with all other factors about physics (rs from .37 to.53) but were near zero with both English self-concept factors that were not of the same domain (rs = -.03 and .03). Hence there was also support for the domain specificity of parent expectation.

Table 3. Solution of Path Model

	PhyCom	PhyIn	EngCom	EngInt	Parent	Engage	Aspire	Unique
Variable Factor Loadings								
PhyCom1	.94*	--	--	--	--	--	--	.11*
PhyCom2	.87*	--	--	--	--	--	--	.25*
PhyCom3	.93*	--	--	--	--	--	--	.14*
PhyCom4	.82*	--	--	--	--	--	--	.34*
PhyInt1	--	.92*	--	--	--	--	--	.16*
PhyInt2	--	.91*	--	--	--	--	--	.18*
PhyInt3	--	.71*	--	--	--	--	--	.49*
PhyInt4	--	.84*	--	--	--	--	--	.30*
EngCom1	--	--	.86*	--	--	--	--	.27*
EngCom2	--	--	.85*	--	--	--	--	.28*
EngCom3	--	--	.80*	--	--	--	--	.37*
EngCom4	--	--	.80*	--	--	--	--	.36*
EngInt1	--	--	--	.92*	--	--	--	.16*
EngInt2	--	--	--	.79*	--	--	--	.38*
EngInt3	--	--	--	.95*	--	--	--	.10*
EngInt4	--	--	--	.80*	--	--	--	.36*
Parent1	--	--	--	--	.87*	--	--	.24*
Parent2	--	--	--	--	.78*	--	--	.39*
Parent3	--	--	--	--	.84*	--	--	.28*
Parent4	--	--	--	--	.84*	--	--	.30*
Engage1	--	--	--	--	--	.84*	--	.30*
Engage2	--	--	--	--	--	.83*	--	.22*
Engage3	--	--	--	--	--	.77*	--	.41*
Engage4	--	--	--	--	--	.71*	--	.49*
Engage5	--	--	--	--	--	.65*	--	.58*
Aspire1	--	--	--	--	--	--	.78*	.39*
Aspire2	--	--	--	--	--	--	.80*	.36*
Aspire3	--	--	--	--	--	--	.61*	.63*
Aspire4	--	--	--	--	--	--	.91*	.18*
Paths from Column to Row Variables								
Engage	24*	.36*	-.26	.41*	.13*	--	--	
Aspiration	-.04	.84*	.09	-.17	.17*	--	--	
Factor Correlations								
PhyCom	--							
PhyInt	.80*	--						
EngCom	.03	-.06	--					
EngInt	-.09	-.01	.86*	--				
Parent	.37*	.46*	-.03	.03	--			
Engagement	.53*	.62*	.08	.17*	.41*	--		
Aspiration	.72*	.89*	-.11	-.10	.53*	.50*	--	
Residual	1	1	1	1	1	.54*	.18*	

Note: N = 275. Unique = Uniqueness. Parameters estimates are completely standardized. * p < .05.

Path model. Based on the measurement model (Model 1), Model 3 tested the paths from five predictor variables to two outcome variables (Figure 1). Because Model 1 and Model 3 were equivalent models, the fit indices were identical (TLI = .91, CFI = .92, RMSEA = .07). The solution of Model 3 is presented in Table 3. Whereas most of the parameter estimates were identical to Model 1, the critical concern here was the paths that showed the relative strengths of prediction of different predictors. The results showed that whereas interest in physics had significant relations to both engagement in physics (β = .36) and aspiration to learn physics (β = .84), competence in physics showed positive influence only on engagement (β = .24) but not on aspiration (β = -.04). This may imply that although students' sense of competence may have kept them engaged in physics learning, it may not have lasting impacts in the long term. Competence in English did not have any significant relation to either of the outcome variables in physics (βs = -.26 and .09, respectively, neither being statistically significant), and interest in English did not have any significant relation to aspiration to learn physics (β = -.17). Interestingly, however, the path from interest in English to engagement in physics was positive and statistically significant (β = .41). It seems that students' interest in English tended to positively affect their engagement in physics. Taken together, there was partial support for the domain specificity of the relations between predictors and outcome variables of matching and non-matching domains. It seems that domain specificity depends on how salient the predictor is in predicting the outcome variable. For the parent expectation variable, the paths to both engagement (β = .13) and aspiration (βs = .17) were statistically significant, indicating that the influence of parents was substantial even after taking into account the strong impacts of self-concepts. As the parent expectation variable was specifically about physics, the positive relations were obviously domain specific. However, a stronger test of the domain specificity would require testing its effects on a non-matching outcome in future research.

Discussion

Overall, the findings supported the distinction between the two components of self-concept: cognitive and affective. Hence, the level of competence students feel within a subject domain and their interest in that domain are related but distinguishable from each other. That is, for some students, being competent in physics does not necessarily mean that they like physics. In reality, some students who like physics may have difficulty in performing well in that subject domain. This may also be true for English. Hence liking a certain subject area does not equate to being good at it. Nevertheless, the high correlation between the cognitive and affective components (*rs* = .80 and .86 respectively for physics and English) within each specific subject domain also indicates that overall, students who feel competent in physics tend to be interested in physics whereas those who feel competent in English also tend to like English.

Between the two domains studied here-physics and English-there is clear evidence that supports the domain specificity of both of the two self-concept components. That is, similar to previous research showing a near-zero correlation between unrelated domains such as English and maths self-concepts (e.g., Marsh, 1987; Yeung & Lee, 1999), the present data showed no correlation between competence in physics and competence in English (r = .03). Neither was there any positive correlation between interest in physics and interest in English (r = -.01).

That is, students who feel competent in physics may or may not feel competent in English and those who are interested in physics may or may not find interest also in English. In other words, there is no direct association between students' self-concepts in these two distinct subject domains. In essence, there was strong evidence of the domain specificity of both components of self-concept in these two clearly unrelated areas of learning in a school setting, and strong support for our hypothesis that the self-concept components for physics and English would be unrelated to each other.

For parent influences, it is known that parents tend to influence children's academic behaviours and choices, as parental support is one of the major driving forces in schoolwork (e.g., Allocca & Muth, 1982; Bempechat, 1990, 1992, 1998; Connor, 1994; Fantuzzo, Tighe, & Childs, 2000; Ford & Harris, 1996; Harter, 1996; Hill, 2001; Hill & Craft, 2003; Jordan & Nettles, 1999; McInerney, Dowson, & Yeung, 2008; Van Etten, Freebern, & Pressley, 1997; Walters & Bowen, 1997). In Singapore, most parents are extremely keen to see their children perform well in school, and interestingly, most Singaporean parents prefer their children to be in the Science stream rather than the Arts stream particularly in higher secondary levels. They seem to think that being in the Science classes and doing maths and sciences are more prestigious and would give their children a headstart towards academic success. This may be due to their belief that their children would stand a better chance of admission to university courses of high demand and status, such as medicine. This is evidenced in the numerous cases found in many schools where parents appealed to the school to allow their children to take pure sciences and double mathematics subjects, for example, even when their children fared better in the humanities and struggled with passing the sciences.

Our findings here, based on empirical data, also showed that parental influences tend to be domain specific. Parental support in physics was positively correlated with self-concepts in physics (rs = .37 and .46 respectively for competence and interest), but was uncorrelated with self-concepts in English (rs = -.03 and .03 respectively). That is, the effects of parental support in a certain area may not transcend to another unrelated area. This finding could have important implications. It could mean that on the one hand, students who gain their parents' support in studying physics would benefit from developing a better sense of competence and a greater interest in physics, which will subsequently have positive impacts on their performance in that specific area.For those students who have talents in physics but do not gain their parents' support may suffer from a less optimal level of competence beliefs and interest in that subject domain. On the other hand, those students who are strong in Arts subjects may not have their actual talents fully nurtured because of a lack of parental support. It would not be surprising that if a child does not get parental support in Arts subjects, the child may be pressured into not spending too much time on a project or assignment related to Arts and thus may not realize the true potential in their talented area. Forcing children to work hard in a certain area that does not appeal to them would only result in more resentful attitudes towards it. As a result, some children may do it only to please their parents, thus losing intrinsic motivation and any desire for long-term endeavours in that subject area. Students may also be influenced to choose to specialize in subjects their parents are more supportive of, thus losing the ability to really explore for themselves the subjects that they like and want to pursue further.

So far, no study has examined the domain specificity of self-concept in English and physics. Most previous studies have examined the relations between verbal and maths domains (e.g., Marsh & Yeung, 1997; Yeung & Lee, 1999), in which the distinctiveness of constructs and domain specificity were supported. One contribution in the present study was to test the relations with curriculum domains that have never been tested. The domain-specific relations were supported here, perhaps because the association between self-concepts in English and physics, which were clearly distinct in nature, was similar to the association between self-concepts in English and maths. Therefore the patterns are consistent with previous research indicating a non-positive association between unrelated subject domains (e.g., Marsh, Byrne, & Shavelson, 1988; Yeung et al., 2000; Yeung & Lee, 1999). If maths self-concept had been included, we might expect a closer relation of physics with maths than with English. Hence further research may include English, maths, and physics self-concepts in the same model to tease out their domain-specific and component-specific relations. Another contribution of the current study is the finding that the components of self-concept are also domain specific. This finding implies that students have preference for certain subjects over others, shaped over the years by their school cultures, subject teachers, learning experiences as well as their academic performances in the subjects. Students' learning experiences in different domains have distinctly different influences on their development of competence beliefs and interest in learning.

The results of the path analysis were most interesting. The significantly positive path from competence in physics to engagement but not to aspiration implies that students' sense of competence in physics would lead to their level of engagement in the short term but may not lead to future aspirations to pursue physics at advanced levels. That is, students who feel good about their competence in physics may engage themselves more but a positive sense of competence may not necessarily make them want to learn more physics in future. In other words, feeling competent may influence short-term outcomes but not necessarily long-term ones. In contrast, the paths from interest in physics to both outcomes were positive. This indicates that interest may have significant influences on both short- and long-term outcomes.

This pattern of results has important implications. It goes to show that consistently developing children's interest in a subject may go a longer way and is more likely to influence the students more positively than just pushing the child to get good results in the subject. In Singapore, pushing a child to get good results involves remedial classes after school hours, tuition classes, and homework that make students complete exercises that resemble questions in the examinations. This is a general phenomenon in Singapore families that can afford the expenses. Drills and memorization of information for the examinations could kill the students' interest in the long run, even though they may get good results in the short term. If the road to success in a particular domain is gruelling and uninteresting for the students, they would most likely not want to go through that road again. If students feel negatively about the process of getting good results in physics, they may not want to pursue physics in the future, even though they are presently doing well in physics examinations. Without interest, the learning journey will be meaningless and students may just want to pass exams for the sake of moving on to the next step of the academic ladder, and drop the subject at the first opportunity they get, when they no longer need the subject to go ahead.

For English self-concept, as expected, competence in English did not have positive relations with competence in physics. Because the effect of self-concept is domain specific, as evidenced in previous research (Marsh & Yeung, 1997; Yeung & Lee, 1999), a sense of competence in a domain that bears no direct relation to the specific outcome would not be expected to have any significant influence on that outcome. However, the path from interest in English to engagement in physics was significantly positive. Therefore, the results for the paths from the English domain provided only partial support for domain specificity. The result is surprising because intuitively we would have expected that interest in English would have nothing to do with students' attitude towards physics. Perhaps the relation of competence to behavioural outcomes is different in nature from the relation of interest to behavioural outcomes. Because English is a tool for communication and the medium of instruction in Singapore, students who are interested in English are more likely to find interest also in other areas of learning. However, this explanation does not seem to stand because the data showed a non-positive correlation between interest in English and interest in physics (r = -.01).

An alternative explanation is that due to the use of English as the medium of instruction in physics, students who find interest in English are more likely to engage in schoolwork in physics and other subjects, as all learning tasks are done in English. If this is the case, then students' sense of competence in English should operate in a similar way, given the high correlation between competence and interest in English. The positive correlation between competence in English and engagement in physics (r = .08) seems to provide some weak support for this interpretation. In any case, the positive path from interest in English to engagement in physics calls for further exploration. The present data at least indicate that the affective component of English self-concept may have stronger influence than the cognitive component when an outcome in behavioural terms is considered.

Furthermore, as the result indicates that interest in English could have significant influence on the short-term outcome in physics even though it is of a different domain, interest as a component of self-concept may not be as domain specific as the cognitive component. In order to test alternative explanations of the positive relation of interest in English with learning outcomes, future research should examine the pattern found in the present study by including a range of outcome variables. It would be useful to obtain also achievement scores in respective domains so that the domain specific effects of the components of self-concept can be further tested, and the I/E model (Marsh, 1986) can be examined with physics and non-physics self-concept components.

Alternative modelling techniques may also be applied. The present SEM approach had the assumption of linear relationships between variables, and any analysis based on classical test theory would have the limitation of confounding item characteristics and respondent characteristics (Grimm & Yarnold, 2000). Future research should consider applying Rasch modelling. Based on item response theory (IRT), Rasch modelling allows us to overcome this limitation by eliminating respondent's bias and it enables us to obtain better psychological constructs. This approach will also enable us to answer substantive questions that involve non-linear relationships between variables (Smith & Smith, 2004). As Sideridis (2007) has suggested, IRT is probably the best approach to investigating phenomena of a dynamic and non-linear nature, which is often true in a school setting.

To conclude, our data showed that students' self-concept in physics can be differentiated into competence and interest factors-corresponding to the cognitive and affective components described by Marsh, Craven, and Debus (1999). These components were positively correlated but they were uncorrelated with the respective components of English self-concept. The results provided evidence of the strong domain specificity of self-concepts in different curriculum areas. These components may operate differently in influencing learning outcomes. Whereas a sense of competence in physics may have relatively stronger impact on short-term outcomes such as engagement in physics, interest in physics may have positive impacts on both short-term and long-term outcomes (i.e., both engagement in physics and aspiration to study physics in future). Hence to facilitate students' learning in physics, teachers should also enhance their students' self-concepts in physics. Teaching knowledge and skills in physics is not sufficient. Students need to build a sense of competence so as to engage in learning tasks, and they need to develop a real interest in physics so as to aspire to learn more. Furthermore, above and beyond the effects of students' self-concepts, perceived parent expectation may also have noteworthy impacts on short-term and long-term outcomes. For parents, it is important to show their support clearly to their children if they wish that they would do well in physics and continue to study physics in future. Our data have shown that parental support as perceived by children has a crucial role to play. Perhaps teachers' expectations would also have a crucial role to play in students' development of self-concepts in physics, which has not been addressed in the current research. Future research should attempt to replicate the findings with samples that are more representative of average-ability students, and should delineate the relations of self-concepts between related (e.g., physics and maths) and unrelated (e.g., English and physics) domains. We may speculate that the domain specificity between physics and maths may not be as distinct as that between English and physics or between English and maths, but we need empirical data to confirm this.

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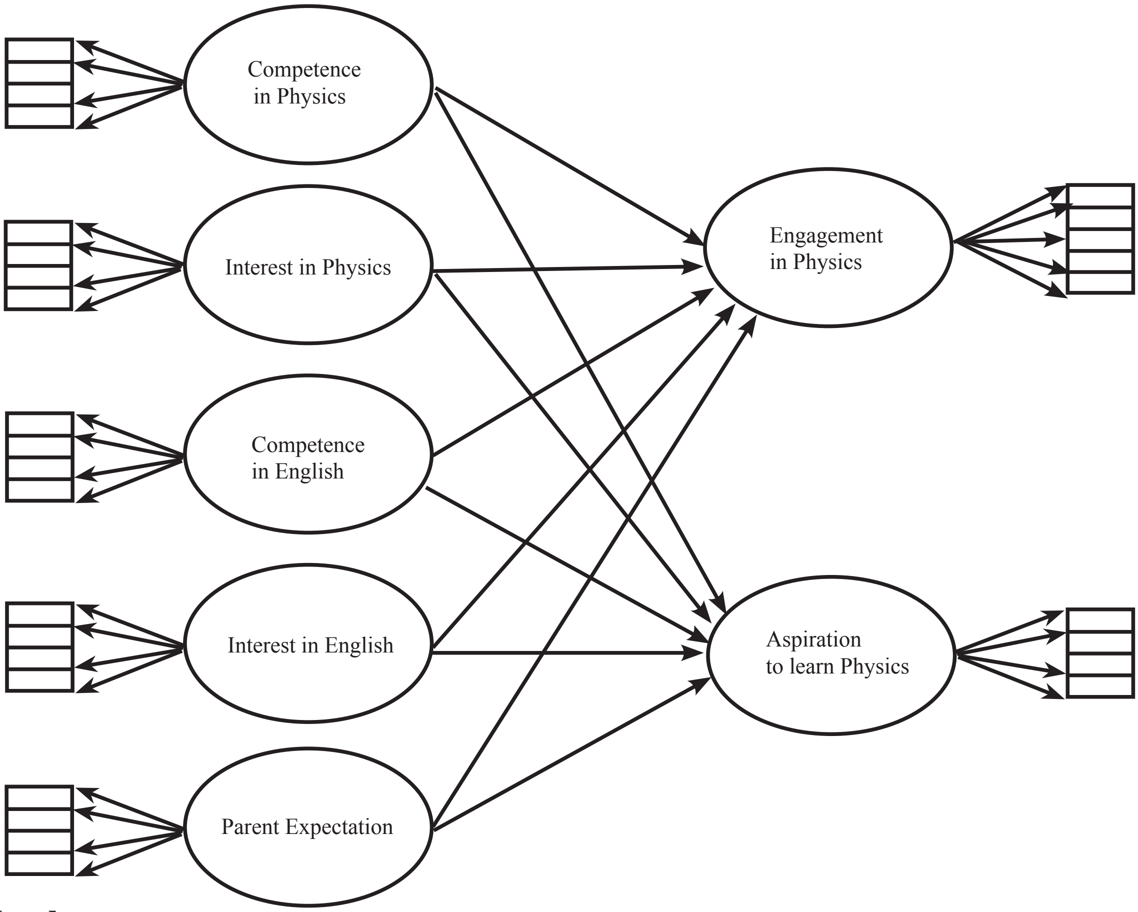
Figure 1. **Path model testing 5 variables predicting 2 outcomes in learning physics**



Authors

Associate Professor Alexander S. Yeung
Educational Excellence & Equity (E^3) Research Program, Centre for Educational Research, University of Western Sydney, Bankstown Campus, Building 19, Locked Bag 1797, Penrith South DC NSW 1797.
Email to *[a.yeung@uws.edu.au]*
Phone: 61(2)9772 6246, fax: 61(2)9772 6432
Loganantham Kuppan, See Kit Foong, Darren Jon Sien Wong, Munirah Shaik Kadir, Paul Choon Keat Lee, Che Ming Yau
National Institute of Education, Singapore

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