Reciprocal Relationships between Knowledge Structures and Motivation to Learn

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Abstract

Historically, research has separately investigated the role of prior knowledge structure and the importance of motivation in learning engagement. Limited attention has been given to the reciprocal effects of these two influences. In this paper, we present a theoretical model that may explain the reciprocal relationship between domain specific knowledge and domain specific motivation. Contemporary research demonstrates that individuals develop complex structural networks of domain knowledge. We propose that domain specific knowledge and motivation will combine to affect the performance and future development of knowledge and motivation in a reciprocal manner. While we adhere to the importance of domain specificity, we propose that overlap between domains at a deep structural level may strengthen the reciprocal effects between knowledge and motivation. Research in this area will benefit the development of pedagogical approaches that may better serve to develop the learning and motivation of students in school.

Introduction

The central objective of pedagogical design is the enhancement of performance. Generally, this is achieved through programs designed to improve either an individual's domain knowledge or their motivation to engage in learning activities. Knowledge and motivation objectives for pedagogy are often conceived quite separately or at best, as parallel influences on performance. This is also evident in theoretical research, where knowledge is rarely considered in conjunct or as interactive with motivation. The investigation of possible reciprocal relationships between knowledge structure and motivation will build on the separate areas of research in a new way and may inform the design of more effective pedagogies across domains.

Current Scene

The Relationship between Knowledge and Performance.

The linkage between knowledge and performance has been a key area of cognitive research. Early views considered performance to be founded on combinations of domain specific knowledge and general problem solving strategic skills (Flavell, 1985; Polya, 1954, 1957). Research into the development and architecture of expertise challenged the validity of heuristic for problem solving. For example, Chi and Ceci's study of memory for chess board configuration by novice adults and expert children (1987) demonstrated that knowledge was the key to expertise, and that heuristic for problem solving did not effectively explain advanced performance.

Constructivist theory considers expertise to reflect an intricate networking of knowledge in schemata (Chi & Ceci, 1987; Sweller, 1991). Schemata are defined as complex interrelated mental structures of concepts (Anderson, 1981; Marshall, 1995). Schemata structure is proposed to reflect ongoing and active accommodation, assimilation and adaptation processes by an individual as they constantly attempt to find meaning by establishing connections and cues with their existing knowledge frameworks (Anderson, 1981; Mandler, 1985; Marshall, 1995).

While this is viewed as an independent process, social constructivists consider that schemata configuration and structure is dependent on social and contextual elements (Davydov, 1995; Rogoff, 1990, 1995). A fundamental feature of these theories and research into the relationships between cognition and performance is the role of prior knowledge.

There is substantial contemporary support for the notion that prior knowledge provides more than a simple foundation for the acquisition of new knowledge (eg. Halford, 1993). Prior knowledge directs an individual's attention causing them to discount or focus on particular environmental elements (eg. Marshall, 1995). Prior knowledge also allows people to make inferences and therefore colours the perceived meaningfulness of new information (Gagne, Yekovich & Yekovich, 1993; Marshall, 1995). In essence, existing knowledge interacts directly with knowledge from new experience in a way that ensures schemata are uniquely individual (see Bruner, 1966, 1985; Marshall, 1995). Research on the role of prior leaning in new knowledge structure has had profound impact on pedagogical practice and design. Cooperative learning, reciprocal teaching, cognitive apprenticeship and other approaches designed to scaffold an individual's learning have drawn on social constructivist and cognitive theory and the role of prior knowledge in new learning (eg. Brown & Palinsca, 1989; Collins, Brown & Newman, 1991; Kagan, 1994;).

A companion element of these considerations has been the role of domain specificity. Some models of learning have considered knowledge to be structured within domains. That is, they propose that like information is constructed in complex independent structures (Bassok, 1990; Glaser, 1984; Singley & Anderson, 1981). This view would propose that disparate knowledge such as mathematics and music would form separate schemata in specific and distinct domains. These models informed the design and implementation of pedagogical practices that emphasised differences between subject areas as a way to better serve the construction of knowledge (Wiltshire, 1994). The idea was that this would presumedly enhance the individual's construction of domain specific schemata. The notion of domain specificity derived primarily from research that demonstrated limited transfer of information from one domain task to another (Ellis, 1965; Larkin, 1989; Perkins & Salomon, 1989; Resnick, 1987).

More recently though, it has been suggested that knowledge may not be bound differentially in distinct domains, and that at deep knowledge levels there may be overlap between ostensibly disparate domain knowledge in areas where there is deep structural similarity (Bahr, 1997a, 1997b; Bahr & Christensen, in press). Thus, it would appear that prior knowledge might underwrite the acquisition and structure of new knowledge across domains where there appears comparable deep similarity (Anderson, 1981; Bahr, 1997a, 1997b; Bahr & Christensen, in press; Singley & Anderson, 1989; Zohar, 1994). This may impact upon subsequent performance across domains. Pedagogical practice and design that attempted to capitalise on potential domain overlap has taken over from more domain specific approaches (Bahr, 1997b).

The Relationships between Motivation and Performance

Motivation is another key concern for understanding students' performance. There is a general lack of agreement as to how motivation should be conceptualised and measured (Bong, 1996). Wigfield, Eccles and Rodriguez (1998), Schiefele and Rheinberg (1997) provide general reviews of the development of motivational study in education. This paper considers the research studies that contribute to the development of a research model delineating the reciprocal relationships between knowledge and motivation.

In general, two types of motivation have dominated the research on motivation to learn; expectancy-related and purpose-related motivation. These are concerned with two types of motivational resources. The first relates to the cognitive assessment of one's ability, expectation or likelihood of finishing a task or a course of action. It includes research on self-efficacy, expectancy of success, perceived control and some other similar constructs. The second type of motivation research has explored the intentions, reasons and goals for learning. The focus of this research is on understanding why a certain course of learning behaviour is taken to complete a learning task. This type of research includes investigations into intrinsic-extrinsic motivation, interest and achievement goals, which are examples of purpose-related motivation. This paper uses this broad classification of motivation research to facilitate the discussion, but it is by no means exclusive.

In general, the research on motivation to learn, conceptualised and operationalised though differently, consistently supports the notion that motivation is a significant variable that contributes a great deal to variance in performance. For example, Bandura (1977) defined self-efficacy as "people's judgement of their capabilities to organize and execute courses of action required to attain designated types of performance". Self-efficacy affects students' choice of activity, effort and persistence (Schunk, 1991). The study of self-efficacy posits that when students perceive that they are capable of finishing a task, they are more persistent, are more willing to choose to take on that task and will exert more effort in the engagement. Research in this area also shows that self-efficacy predicts future performance even when past performance has been taken into account (c.f. Pajares, 1997)

Another major form of expectancy related motivation is concerned with students' perceived control. The study of control can be traced back to Rotter's internal and external locus of control and later de Charms' study on personal causation (de Charms, 1972). Individuals who perceive internal control over their actions rather than external will be more motivated to engage in the activities concerned and will subsequently perform better (e.g. Findley & Cooper, 1983). Self-determination theory (e.g. Ryan, 1991) can also be taken as a form of perceived control. Whenever an activity is deemed as internalised into the self, it is motivating enough to drive extra effort and time to it. In contrast, when an activity is

introjected or extrinsic to the self, individuals will be more reluctant to commit themselves to it.

Research into purpose-related motivation primarily considers the study of intrinsic and extrinsic motivation. Intrinsic motivation is defined as motivation for the sake of an activity itself while extrinsic refers to the motivational attraction derived from the attainment of the task. Research shows that students who are intrinsically motivated perform better relative to those who are extrinsically motivated (Deci, 1971). Interest is another form of intrinsic motivation. Researchers (e.g. Schiefele, 1992, Krapp et al, 1992) have discussed two different types of interest: individual and situational. Individual interest is a form of rather stable and consistent disposition. Students who develop individual interest for a subject devote more time and effort to it, use deep level strategies and develop a higher level of comprehension of the learning materials. In contrast, situational or text based interest depends more on the nature of a passage. Research has found that situational interest can arouse attention, prolong reading engagement and improve performance on recall tasks (Renninger, Hidi, & Krapp, 1992).

The most explicit construction of purpose-related motivation is achievement goals. Achievement goals are defined as students' perceived purposes for learning (Ames, 1992). Thus far, achievement goal theorists have successfully contrasted the impact of two types of achievement goal, namely performance and mastery goals. Students who learn with a mastery goal (for example, to master the knowledge or to learn something new) are more intrinsically motivated to devote effort and time in the learning task. They also show a relatively higher level of persistence when facing challenges and difficulties. Students who learn with performance goals (for example, to beat others or to get high marks) focus on their performance and therefore learn with more anxiety and relative lower levels of achievement. This line of research also demonstrated that the effects of achievement goals on learning are mediated through learning strategies. Therefore, the variables related to why and how students learn, combine to explain the level of their achievement (e.g. Ames, 1992; Dweck, 1986; Pintrich & Garcia, 1991; Wolters, Yu & Pintrich, 1996; Young, 1997).

Relationships between Knowledge and Motivation

It is pertinent to ask if there is a relationship between knowledge and motivation and their combined effects on performance. A moderate amount of work has been done in this regard on the study of interest and text comprehension (e.g. Hidi, 1990; Hidi & Baird, 1986; Schiefele, 1992, 1996; Schiefele & Krapp, 1996; Wade, 1992).

Earlier research in this area, as reviewed by Tobias (1994), was confused as to the relationships between prior knowledge and interest. Some studies (e.g. Entin & Klare, 1985; Garner & Gillingham, 1991) found positive associations between prior knowledge and level of interest while others concluded otherwise (e.g. Baldwin, Peleg-Bruckner & McClintock, 1985; Long, Winograd & Bridge, 1989). Still some reported a more complicated finding, that individual interest predicted the level of comprehension independent of the effect of prior knowledge and despite the close association between prior knowledge and interest (Schiefele, 1992). While this result indicated the importance of interest as a motivational variable related to text comprehension, it is not necessarily an indication of the relative unimportance of knowledge. Tobias (1994) noted that several design or technical problems might have contributed to the minimal relationships between prior knowledge, interest and comprehension in the early studies on this line of research. These were:

1. The prior knowledge assessed usually had a little relationship with the topic knowledge covered in the textual passage assigned to the students during test session. As such students' responses to the interest of the text would have had little to do with prior domain knowledge;
2. The method of categorising students into groups might have introduced noise into the relationship between interest and prior knowledge;
3. Reliability and validity of some of the measures of interest and prior knowledge were quite low and many studies failed to report these important statistics;
4. The reading materials used during the test session did not match the ability or academic level of the participants (they were either too easy, too difficult or poorly situated);
5. The difficulty of the experimental task may have affected the students' interest levels assessed during or after the experimental task.

There was also a major conceptual problem in these studies in addition to these technical deficiencies. Prior knowledge was usually assessed as confounding variable before the actual experimental task. As such, prior knowledge was not considered as an independent variable in most of these studies. This may have impacted upon the non-significant relationships between interest and knowledge and their effects on comprehension and recall of the text. Moreover, it is hard to make conclusions about the relationships between knowledge and motivation from these studies using correlational approach (Krapp, 1999).

More recently, the relationship between knowledge and motivation has captured some attention from educational researchers. Benton and his colleagues (1995) studied the relationship between knowledge, interest and narrative writing among ninth graders and undergraduate students. In both samples, knowledgeable students generated more meaningful and detailed sequences of actions related to ball games than less knowledgeable students. Similarly, across both samples, students with high individual interest wrote with greater thematic maturity than students with low interest. These effects were maintained after controlling for grade and gender. One of the key findings was that topic knowledge and interest in baseball showed relatively strong association (r=.53). Using confirmatory factor analysis technique, they confirmed that topic knowledge and interest in baseball were separate variables. This study has overcome the conceptual and technical deficiencies identified by Tobias (1994). Therefore, the findings provide some initial empirical evidence for the notion that knowledge and motivation are related.

Alexander and her colleagues have made a more concerted effort to explore, and understand, the relationships between knowledge and motivation in a specific subject domain. Alexander *et al* (1994a, 1994b) maintained that knowledge and interest were associated and proposed a stage model (Model of Domain Learning or MDL) delineating the relationships between knowledge, interest and recall in learning a subject matter. Alexander *et al* identified three stages of development: acclimation, competence and proficiency. Each stage is characterised by a specific combination of subject matter knowledge (including domain knowledge and topic knowledge) and interest characteristics. (see Figure 1)

Intensity

Acclimation	**Competence**	**Proficiency**

Figure 1: Model of Domain Learning (from Alexander, Kulikowich & Schulze, 1994a, p.316)

Stage of Domain Learning

During the acclimation stage, learners are characterised by a limited amount of both domain and topic knowledge of a subject. In addition, their knowledge is fragmented and disorganised. Acclimated learners show low individual interest in the domain. Their interest is rather transient and short term. They are more interested in "personally involving, concrete and sensational" texts than more abstract and technical texts. Therefore, they show better recall of verbatim materials related to a text.

Competent learners develop richer and more coherent subject matter knowledge and their individual interest becomes stronger with increased exposure to the field through formal instruction. However, competent learners may still be attracted to the more situational interest of a text. Their strategic processing becomes more effortful, playful and effective. They therefore demonstrate a better performance in understanding and recalling text materials related to the field and are able to distinguish important information from the unimportant.

Proficient learners do not just hold a rich and well-organized network of domain and topic knowledge on the domain. They also have developed deep-seated personal interest in the subject. Few learners reach the proficient stage. Proficient learners find it easy to recall or

process less interesting, but more technical, materials related to the subject. They are able to identify central ideas related to a topic or a domain. They also demonstrate a high level of persistence and remain interested when facing difficulties in understanding a relevant piece of text.

Table 1: The three-stage model of domain learning

	Acclimation	**Competence**	**Proficiency**
Knowledge amount	Low	Moderate	High
Knowledge structure	fragmented	Organised	Well-structured
Individual interest	Low & unstable	Moderate & stable	High & stable
Situational interest	High	Moderate	Low

This three-stage model of domain learning represents an important theoretical progress for understanding the relationships between knowledge and motivation. In essence, Alexander *et al*'s (1994a) model denotes that knowledge is associated with a particular form of motivation. With the increase of knowledge comes the shift of interest from those of unstable, transient and tentative nature (situational interest) to those of more personal, stable and dispositional form of motivation (individual interest). In other words, knowledge is associated with the types and intensity of motivation. The more the knowledge and the more structure it has, the more stable will be the form of motivation to follow.

Alexander and her colleagues have reported research evidence to support the major premises of MDL (Alexander, Kulikowich, & Schulze, 1994a, 1994b). However, these studies offered limited support as their findings were based on between group comparison and Alexander admitted that their earlier empirical studies still had some design short falls as those Tobias (1994) described.

Using cluster analysis, Alexander, Jetton & Kulikowich, (1995) gathered more stringent research findings in another study. These findings supported their model. Alexander *et al* designed two experiments to test the interrelationships between knowledge, interest and recall among two heterogeneous groups of university students. The participants represented varied academic abilities, educational backgrounds, and diverse career interests. The study used multiple textual passages on human immunology and physics. They found three and four clusters of students in the first and second experiment respectively. In both of the experiments, the first cluster was composed of students having high knowledge, which accompanied high interest and performance on recall tasks. Cluster 3 in the first experiment, and cluster 4 in the second experiment, were formed by students with low knowledge, low interest and poor recall scores in reading the passages on immunology. In addition, a similar dynamic interplay of knowledge, interest and recall was found when the reading the physics passages. This implied that there was a transfer between similar or related domains at the higher structural level (Alexander, Jetton & Kulikowich, 1995).

In general, these findings matched the guiding premises of the MDL. That is, that knowledge and interest are associated differently during the acclimation and proficiency stage of

domain learning. However, more work is needed to clarify the relationships for students at the competence stage (as revealed in cluster 2 of the first experiment and cluster 2 and 3 in the second experiment). Students of relatively high knowledge but varied interest, recall ability and performance formed the middle clusters. Although the variation in recall and interest scores might have been attributed to reading and recall abilities, Alexander *et al* (1995) suggested that this might also indicate a more complex relationship between knowledge and interest at the competence stage. This implies that more work is needed in this area.

The Reciprocal Relationships

The Gap

In general, the literature demonstrates that there is a relationship between knowledge and motivation. However, the nature of possible reciprocal relationships between knowledge and motivation are still unclear. At this stage, research into these reciprocal relationships is extremely limited. The following considerations are pertinent to advance our understanding of the relationships between knowledge and motivation.

Interrelationships between knowledge and motivation may hold if motivation is conceptualised in other ways. Interest as a form of intrinsic motivation may be confounded with prior knowledge (c/f. Entin & Klare, 1985). Renninger et al (1992), when defining interest suggested that it comprised two components, value and knowledge. As such, the close relationship between knowledge and interest might have been the result of an overlap in these conceptualisations. A clearer picture of the relationships between knowledge and motivation will evolve if motivation is assessed through expectancy and purpose related forms.

It is intuitive to assume that high knowledge is associated with high motivation, which is also the major premise of MDL. However, interrelationships between knowledge and motivation may not be so simple. The fact that Alexander et al (1995) found non-significant association between knowledge, interest and recall with middle clusters of participants implicated that knowledge and motivation might be linked in a more complex fashion.

In addition, the research has not dealt explicitly with the effects of knowledge structures on motivation. It is doubtless that in Alexander's conceptualisation, knowledge structure is an important quality of knowledge at each stage of domain learning development. However, no empirical evidence is available to illustrate the relationships. It is still unclear in Alexander's model how the structure of knowledge might be associated with level of interest.

The Model

Building from the previous studies, the writers consider that it is timely to design research that investigates the reciprocal relationships between knowledge structures and motivation. We propose a model of reciprocal relationship between knowledge structure and motivation. The model is a response to the current lack of research and we try to address the deficiencies of current studies, especially those conducted in the interest paradigm.

Figure 2 depicts a schematic representation of the proposed reciprocal model. We assumed that people are innately active learners, constantly seeking to learn and adapt to their

environment, despite their initial lack of knowledge of the environment (White, 1959). As such, individuals are motivated to seek knowledge, which in turn helps them to develop hypotheses about their environments. An individual's knowledge of themselves and their relationship with the environment accumulates through these explorations, which in turn helps them to continue to further explore and to make new hypotheses. However, this motivation to seek knowledge needs to be considered together with other personal conditions. These personal conditions include the amount of knowledge to be acquired, the difficulty of the task, the value of a task. When learning is to occur in a more formal setting like a school, these personal considerations can interact with the learning. In other words, a process of cognitive assessment precedes individuals' engagement in a task or activities and will continue to operate during the engagement.

Knowledge				
		Mediating		Achievement
		Variables		
Motivation				

Figure 2: Reciprocal effects of knowledge and motivation on learning and achievement

Knowledge affects motivation, which affects the development and instantiation of knowledge structures. Conversely, motivation affects knowledge, which affects future motivation. These are linear propositions about the reciprocal relationships between the two variables. This linear proposition about the reciprocal relationships between knowledge and motivation may at best make it clear the impact of these variables on each other. However, in reality students are characterised by special learning configurations comprising their specific knowledge and motivational characteristics. It is therefore more important to assess the combined effect of knowledge and motivation on each other. The linear model is inadequate to map the complexity of the learning processes affecting these two variables together. Therefore, in a reciprocal model, it is relatively fruitless to stipulate a causal sequence, the most important task is to explicate the complex reinforcing links (c.f. Wigfield & Karpathian, 1991). Thus, these two variables should be considered simultaneously to establish their combined effects on achievement and future learning development.

We also assumed learning strategies, both cognitive and metacognitive, would mediate the impact of knowledge and motivation on each other. This assumption is based on the recent research into achievement goals (e.g. Dowson & McInerny, 1997; Greene & Miller, 1996; Ng, 1998; Young, 1997). This research has consistently found a mediatory role for learning strategies on the effects of goal orientations for achievement. The assumption of a mediation role of learning strategies may be different from Alexander and other researchers who considered learning strategies as part of the domain knowledge. However, we believe that the manner in which a person approaches a task or a domain may not necessarily be related to that domain. More often, learning strategies are affected by, or are determined by why one engages in a task (Wolters, Yu & Pintrich, 1996; Pintrich & Garcia, 1991).

Different Types of Reciprocal Relationships

The reciprocal relationships between knowledge and motivation depends on:

1. The knowledge quality; and
2. The type of motivation.

The combined effects and reciprocal relationships suggested in our model are clearer if different types of learners are considered. Alexander and her colleagues (1995) proposed three types of learners according to different combinations of knowledge and interest. In this section, we propose a constellation of learner types according to their mix of knowledge and motivation. Motivation is first conceptualised in terms of self-efficacy and later, achievement goals. This represents the contemporary expectancy and purpose related motivation respectively. Effectively, when knowledge combines with self-efficacy and perceived control, there emerge three types of learner (see Table 2). Eight specific types of learner emerge (see Table 3) when both performance and mastery goals are taken into account along with students' knowledge quality in a specific domain.

Table 2: Learner types constructed in terms of knowledge quality, efficacy and control.

Learner types	Knowledge quality	Efficacy	Control
Unconfident-acclimated	Poor & unstructured	Weak	weak
Confident acclimated	Poor & unstructured	Strong	strong
Confident competent	Rich & structured	Strong	Strong

Learners with little and unstructured knowledge in a domain usually have relatively weak self-efficacy and a lower sense of perceived control. Consequently, they are more likely to use superficial learning strategies during the learning process. We expect that this type of learner will do poorly in the domain. This type of learner is referred to as unconfident-acclimated.

Nevertheless, there may be some people that continue to believe they have the ability to do well and thereby assert a high level of control, despite their lack of knowledge. This type of learner is labelled as confident-acclimated. The learner type may arise when a person has been successful in a related domain and perceive that a new domain is similar at a deeper structural level. For example, students who are good at mathematics will also be likely to learn computing with confidence despite their limited exposure to computing. As such, their successful experiences in a related domain helps them to remain confident in achieving in a new domain, regardless of their barren domain specific knowledge. They will often use deep strategies in the learning of the new subject.

Of course, students with rich and structured knowledge will be self-efficacious and maintain a high level of control in their learning of new subject matter. It is very unlikely that knowledgeable learners will feel unconfident in their ability and control in a domain where

they have excelled. They are confident and competent and their learning is characterised by the employment of deep strategies.

Overall, the relationship between knowledge quality and these two types of expectancy motivation are similar to that found in Alexander *et al*'s work (1995). Specifically, rich knowledge is associated with strong efficacy beliefs and high level of perceived control, which in turn will lead to employment of deep strategies and high level of achievement.

However, a person who knows they have the ability to do well will not necessarily be willing to engage in a task and it is not sufficient to ensure their strong commitment to it. People need to know why they are engaged in certain activities (Wigfield, 1997). The simple linear logic applied to expectancy related motivation may not apply to purpose-related motivation. The following table specifies eight types of learners constructed in terms of their knowledge quality and different types of achievement goals.

Table 3: Eight types of learners constructed in terms of knowledge quality, performance and mastery goals.

Learner types	Knowledge quality	Performance goal	Mastery goal
Unmotivated-acclimated	Poor & unstructured	Weak	weak
Motivated acclimated	Poor & unstructured	Weak	strong
Forced-acclimated	Poor & unstructured	Strong	weak
Over-strived acclimated	Poor & unstructured	Strong	Strong
Unmotivated competent	Rich & structured	Weak	weak
Motivated competent	Rich & structured	Weak	Strong
Forced competent	Rich & structured	Strong	Weak
Over-strived competent	Rich & structured	Strong	Strong

Unmotivated acclimated learners see no purpose in the learning of specific subject matter and they have limited amount of unstructured knowledge in it. These types of learners expect to do poorly in this domain and are more likely to employ superficial learning strategies in their learning of the subject.

Motivated acclimated learners are those who despite their poor knowledge in the field, show genuine interest in the subject. These types of students have a strong mastery goal and are more likely to do well given time and quality instruction. They are more willing to exert effort and use deep learning strategies during the learning process.

Forced acclimated learners are commonly students who see no genuine reason to learn a subject except those extrinsic to it, for example, to beat others or to get approval. Their

performance is not generally comparable to those who have genuine motivation for the subject and they often rely on superficial learning strategies for learning the subject.

Over-strived acclimated learners are those who are very motivated to do well and show interest in what they are learning. These types of students will usually do well. However, their performance may be hampered by their anxiety to maintain high performance. Their use of strategy will be characterised by a mixture of deep and superficial strategies, depending on the nature of the task.

The same four categories of learners can be located according to their motivational goals when considering students with rich and structured knowledge. Unmotivated competent learners are those who despite their rich knowledge in a subject, feel that they have had enough of the subject and are ready to quit. We often hear students who swear that they will not do any more of a subject after certain event like a public examination. These types of learners will still maintain a relatively good performance in the subject depending on the nature of the task. However, they often learn or perform with a high level of reluctance. They tend not to exert effort and time in it. Their use of learning strategies depends on the nature of the task.

Forced competent learners are those who learn the subject in order to maintain or achieve some extrinsic rewards derived from their performance goals, for example to get into university. It is highly probable that forced competent learners will develop into unmotivated learners when the extrinsic motivation is removed, or attained. It is likely that they will eventually quit learning the subject. Since their learning focus is not on understanding, they tend to use superficial learning strategies. However, these students still maintain reasonably good performance in the subject because of their rich knowledge in the domain.

Competent learners with high motivation are those who stress mastery goals or both mastery and performance goals simultaneously. These types of learners will do relatively well in a subject, as they are likely to employ deep learning strategies in order to master the subject matter. However, the focus on performance by over-strived competent learners may lead to a high level of anxiety, which may hamper performance. They generally will be likely to develop into proficient learners. According to Alexander *et al* (1995), few will reach the stage of proficiency.

We do not intend to specify the combined effects of both types of motivation and knowledge at this stage. Nevertheless, our discussion of the reciprocal relationships in the form of different types of learners demonstrates clearly that the relationships between knowledge and motivation are much more complex than depicted in Alexander's model. Further, it is important to consider the combination of these two variables before their combined effects, especially those over the long term, can be assessed clearly.

Figure 3 presents a developmental model of the reciprocal relationships between knowledge and motivation. This model is an expansion of the previous one in that the reciprocal relationships between knowledge and motivation are conceptualised in a developmental sense. In essence, this developmental model allows that unconfident-acclimated learners can develop into confident acclimated and later confident competent learners in a subject domain. Alternatively, in terms of achievement goals, unmotivated acclimated learners can develop into motivated competent learners. Of course, some people may develop into forced competent or even totally unmotivated learners despite their acquisition of rich knowledge in the domain. Therefore,, in assessing developmental changes with respect to knowledge and motivation relationships, focus should not only be placed on the reciprocal relationships between these two variables. We need to assess relevant contextual and other personal variables that may have bearing on this developmental process.

Time 1		Time 2		Time 3
Knowledge		Knowledge		Knowledge
Motivation		Motivation		Motivation

Figure 3: Reciprocal effects of knowledge and motivation: A developmental perspective

Transfer at Deep Level

We also hypothesized that these reciprocal relationships within a subject domain will also have 'spill-over' effect on related domains. Alexander et al (1994b, 1995) have studied the relationship between knowledge and interest in different subject matter. They have found that the same type of association between knowledge and interest stipulated in one domain will also be felt in a related domain.

Recent research into knowledge provides evidence for blurred or overlapping boundaries between domains (Bahr, 1997; Bahr & Christensen, in press; Singley & Anderson, 1989). That is, knowledge in one domain may impact on learning in another where there are deep structural similarities between them. Knowledge instantiated in one domain may assist learning in a seemingly incongruent domain due to some sharing or similarity between the knowledge structures at a deep level of conceptualisation.

For example, mathematics and music are easily recognisable as separate domains of knowledge. A recent study of the mathematics and musical knowledge of 85 Year 10 students at a suburban public secondary school in Brisbane, demonstrated that knowledge domains might overlap (Bahr, 1996; Bahr & Christensen, in press). Student musicians performed significantly better than their peers in mathematical tasks where there were deep structural similarities with music (eg. spatial abstraction, symbol usage, and pattern manipulation) (see Figures 4-6). These students were not advantaged in their mathematics performance in areas where there were no deep structural similarities (maths residual score) between the domains (eg. number handling). So it appears that learning in one domain may enhance learning in another.

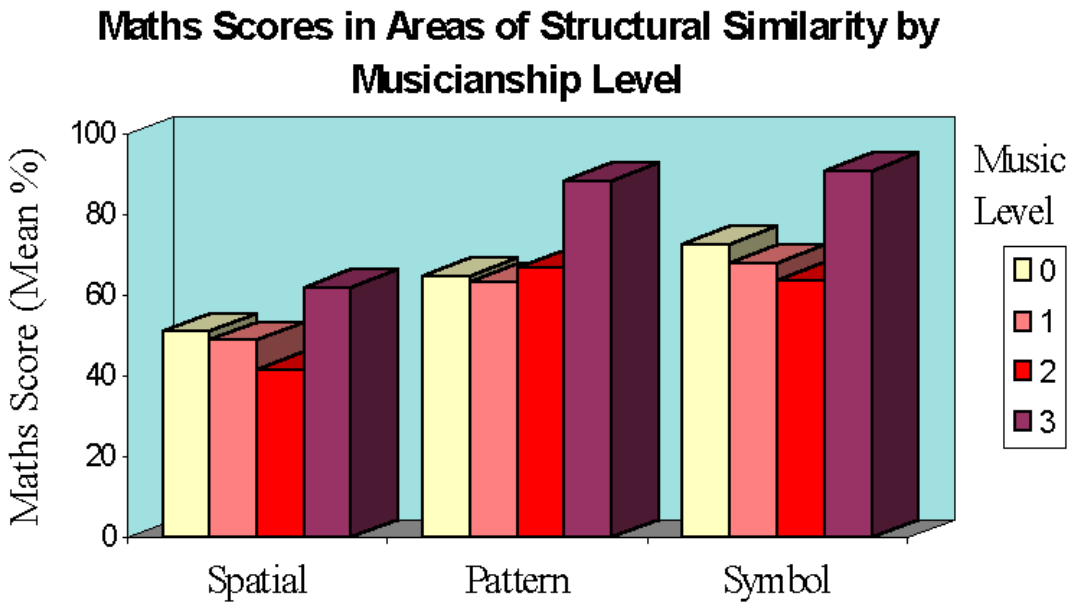

Figure 4: Comparison of mathematics performance by musicianship level in each of the areas of structural similarity between the domains.

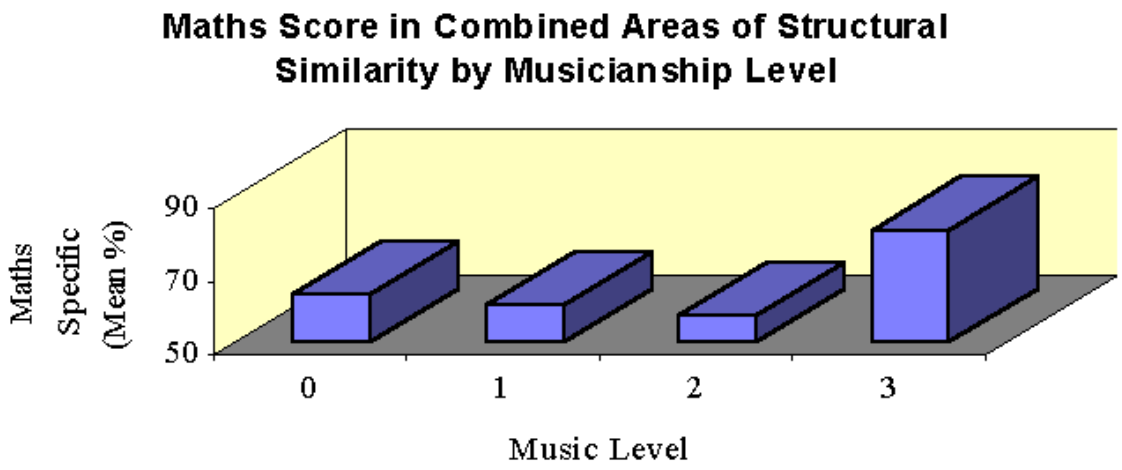

Figure 5: Comparison of mathematics performance by musicianship level in combined areas of structural similarity between the domains.

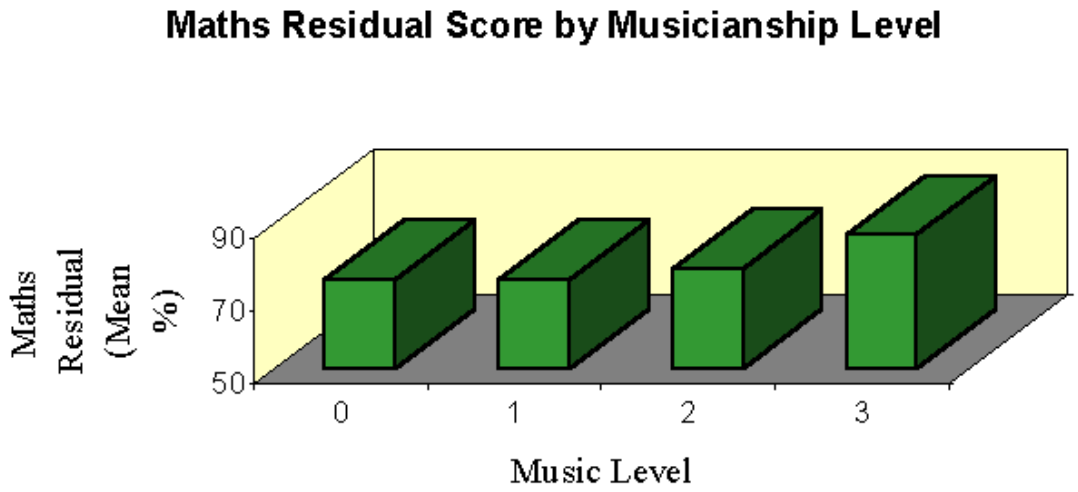

Figure 6: Comparison of mathematical performance by musicianship level in areas without structural similarity between the domains.

If conceptual knowledge blurs at the boundaries of domains, then this may extend to self-schema development. That is, it may be possible that personal knowledge or self-schemata that develop in conjunction with declarative and procedural knowledge for a domain, will also be blurred or overlap at domain boundaries. Further, research suggests the existence of a complex relationship between self-schemata and motivation (Ng, 1999). Therefore, our proposed reciprocal model for the relationship between knowledge and motivation is not conceived as being restricted to single domains. Where there are deep structural similarities between domains, particularly where these are noticed by learners (but not exclusively so), and where the learners have developed self schemata with respect to their performance in a domain there will be overlapping impact on motivation. This effect will also act in reverse. Further, such effects may exist between domains that are seemingly incongruent at the surface levels of declarative and procedural knowledge.

Implications for teaching and learning

Our discussion of the relationships between knowledge and motivation and the classification of learners according to their knowledge-motivation mix highlights the importance for teachers to pay attention to the individual differences in their students. The notion that "knowledgeable students are motivated and less knowledgeable students are less motivated" is an oversimplified principle that can be employed to guide teaching effectively. Teachers need to attend to the particular knowledge-motivation mix of their students and to help them accordingly.

For example, motivated acclaimed students can be encouraged to learn by using the situated interest of the learning materials (Krapp, 1999). Teachers should capitalize on these students' motivational reserve and scaffold them upward with a solid foundation of structured knowledge. It is possible that these students will develop more deep-seated interest in the subject. For forced acclimated learners, teachers need to redirect their focuses to the learning materials and draw their attention to learning the materials. However, often we find teachers are happy with students who behave well and seek approval. Continuing

reinforcement on these extrinsic nature of motivation, teachers will rob these students the chance of developing genuine interest and engagement in the subject.

As far as the competent learners are concerned, teachers need to help overstrived learners to deal with the problem of anxiety, develop challenging and difficult task for motivated learners. However, it is hard to redirect forced competent learners' focus from extrinsic to intrinsic values of the subject. These students are certainly high achievers who are diligent, well organized and self-regulated to do well. The problem is that they may quit the study of the subject altogether once the extrinsic values are removed or attained; and hence develop into unmotivated competent who will only allow their acquired knowledge in the field to fade away.

Our classification of learners when put into a developmental frame warrants the attention of educators from all sites. How often we hear early childhood educators share with each other the joy, the thrill and the excitement they find in teaching and interacting with children who are motivated to learn irrespective of their level of knowledge in a domain. With increased exposure through formal instruction over years of schooling, children develop richer and more structured knowledge about the same domain; however the richness of their knowledge for many seems ineffective in arouse their interest and motivation in the subject. Research conducted with middle graders in the United States reported substantiated evidence that students' motivation to learn drop when they are transferred from primary school to junior secondary school (Anderman, Maehr & Midgley, 1999; Midgley, 1993; Midgley & Eldelin, 1998). This research evidence and our gloomy projections warrant much reflection from educators to consider why many students after involvement with a subject domain for years and yet experience not a rise in their motivation but a strong intention to quit. Further, the research on overlapping boundaries between domains suggests that de-motivation for learning in one domain may infect learning in other domains. This discussion brings us to consider some wider influences on the reciprocal relationships between knowledge and motivation from a developmental perspective.

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