Study orchestrations and motivational differences in a mathematical context

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Keywords:
Study orchestrations
Deep learning
Surface learning
Motivation
Academic achievement

The aims of this study are to examine the learning approach profiles, or study orchestrations, of 357 pre-university students and its relations to academic achievement and motivation. As study orchestrations are context-specific, the current research is based on the subject of mathematics. Results indicated that four types of study orchestrations emerged: high-high, high-low, high-mid and low-low in deep and surface learning. Students with a high-high and high-low study orchestration had the highest academic achievement and intrinsic motivation. The level of identified regulation differs across all clusters whereas there were no significant differences in introjection except for the low-low study orchestration. External regulation is associated mainly with surface learning. Amotivation is associated mainly with a lack of deep learning.

1. Introduction

Ever since the notions of a deep and surface learning approach first appeared (Entwistle, 1977; Marton, 1976c; Marton & Säljö, 1984), much research has been conducted based on the perception that a deep learning approach leads to positive learning outcomes whilst a surface learning approach leads to negative learning outcomes (Dinsmore & Alexander, 2012; Vermunt & Vermetten, 2004). Many of these studies have constructed their study by isolating the variables of deep and/or surface learning and subsequently investigating the relationships between these variables and academic achievement or motivation (Biggs, 1987; Entwistle, 1986; Severiens & Ten Dam, 1994; Watkins, Sternberg, & Zhang, 2001). However, students may not solely adopt a deep or surface approach when learning. In reality, many of them might have used a combination of both deep or surface learning, but nonetheless, many studies did not consider the inter-relations amongst the two types of learning approach. Thus, this study will examine this aspect by first profiling students into clusters according to their inclination towards deep and surface learning, followed by investigating the differences in academic achievement and motivation across the different profiles.

1.1. Learning approaches, study orchestrations and academic achievement

A deep learning approach is characterised by an intention to seek understanding and meaning. Students who adopt the deep learning approach search for relations with previous knowledge and connecting links with other subjects. They generally focus on the main ideas, concepts or applications of their subject content. On the other hand, a surface learning approach is characterised by a mere memorisation of facts as a substitute for understanding. “Students who adopt a surface learning approach tend to accept ideas and concepts without question. They generally aim to learn the minimum amount of material needed to pass (Biggs, 1987; Chamorro-Premuzic, Furnham, & Lewis, 2007; Entwistle, 1986).

A student’s study orchestration is defined as the manner in which students combine their approaches to learning according to their perception of the learning context (Meyer, 1991). In some cases, the student might display ‘conceptual consonance’ between how the learning context is perceived and how learning takes place, i.e. the patterns of learning are theoretically interpretable. For example, a student might combine a high deep approach with a low surface approach in a specific learning environment. In other cases, the student might exhibit ‘conceptual dissonance, i.e. the patterns of learning show an atypical linkage between some or all of the more common explanatory variations. For example, another student might combine a high deep approach with a high surface approach in the same learning environment (Cano, 2005; Lindblom-Ylänne & Lonka, 1998). Several studies have concluded that four clusters of students exist, namely two consonant approaches, i.e. high-low and low-high in deep and surface learning and two dissonant approaches, i.e. high-high and low-low in deep and surface learning (Cano, 2005; Entwistle, Meyer, & Tait, 1991; Entwistle, Tait, & McCune, 2000; Lindblom-Ylänne & Lonka, 1998; Vantbournout, Coertjens, Gijbels, Donche, & Van Petegem, 2013). Nevertheless, it is conceivable that students may adopt a level of deep and surface learning that is average relative to other students yet none of the
previous studies managed to uncover the possibility of a fifth cluster.

Comparisons of academic achievement across the various clusters have led to different conclusions. The traditional view that deep learning leads to positive academic achievement and surface learning leads to negative academic achievement has been shaken by incon- 
tent empirical results (Cassidy, 2012; Cassidy & Eacius, 2000; 
Dennewy, 2014; Diseth, 2003; Duff, Boyle, Dunleavy, & Ferguson, 2004; 
Furnham, Monsen, & Ahmetoglu, 2009; Richardson, Abraham, & Bond, 
2012; Swanberg & Martinsen, 2010; Yonker, 2011). The situation is also 
somewhat unclear when a student’s study orchestration is taken into 
account. For example, a study conducted on a sample of high achieving 
medical students indicated that the grades between the various groups 
were not statistically significant (Lindblom-Ylänne & Lonka, 1998) 
whereas in two studies conducted on first year university students, 
students who adopted a dissonant approach had a lower academic 
achievement (Entwistle et al., 2000; Meyer, 1991). In a fourth study 
conducted on secondary school students, the mean academic scores 
across all subjects in the dissonant groups were below average, al-
though students in the consonant groups, namely high-low and low-
high in deep and surface learning, had the highest and lowest academic 
achievement respectively (Cano, 2005). These disparities in results 
might possibly be due to differences in learning contexts 
(Meyer & Watson, 1991), e.g. in the study conducted by Cano (2005), 
academic achievement was measured by taking the mean across all 
subjects and does not take into account the different learning contexts 
of individual subjects. For example, a particular subject, mathematics, 
consists of both conceptual and procedural elements (Hiebert, 2013). 
Students may adopt a deep approach when learning mathematical 
concepts, yet due its procedural nature of solving problems, they may 
also adopt a surface approach as well. For instance, in the topic of 
calculus, students may adopt deep approach to understand the concept 
of limits but may adopt a surface approach to find derivatives. In this 
instance, a combination of both approaches would be advantageous to 
attain good academic achievement and this may partially explain the 
previous inconsistencies regarding the relations of learning approaches 
and academic grades. Thus, in the current study, we will examine the 
students’ study orchestrations in the context of a mathematics module.

1.2. Learning approaches and motivation

The motivational framework posited by self-determination theory 
will be applied in this study. In this framework, motivation can be 
conceptualised as distinct types that lie along a continuum. At one 
extreme end lies amotivation or the complete lack of motivation. 
Individuals who are amotivated do not act or act passively. At the other 
extreme end lies intrinsic motivation. Individuals who are intrinsically 
motivated act based on inherent satisfaction. In the middle band lies 
extrinsic motivation. Individuals who are extrinsically motivated per-
form activities due to some external stimuli. Extrinsic motivation can be 
further differentiated into three types, namely external regulation, in-
trojection and identified regulation. External regulation occurs when 
the sole motivation is caused by externally imposed rewards or pun-
ishment. Introjection occurs when individuals self-impose their own 
constraints, e.g. guilt, shame or obligation. Identified regulation occurs 
when individuals identify with the reason for their actions, e.g. to 
achieve a better future for themselves (Deci & Ryan, 2002).

Previous studies have generally associated intrinsic motivation with 
deep processing and extrinsic motivation with surface processing 
(Entwistle, 1986; Lawson, 2012). Several studies have also combined 
the motivational constructs into autonomous (intrinsic motivation and 
identified regulation) and controlled motivation (introjected regulation 
and external regulation) and subsequently examined their relations 
with cognitive processing (Vansteenkiste, Sierens, Soenens, 
Luyckx, & Lens, 2009; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 
2004). However, there has been relatively few studies investigating the 
relationship between motivation constructs of self-determination 
theory and study orchestrations. Furthermore, the distinction between 
the various types of extrinsic motivation is essential because whilst 
external regulation is usually linked with negative learning outcomes, 
introjection has been linked with positive and negative learning out-
comes and identified regulation is often linked with positive learning 
outcomes (Ng et al., 2012; Pelletier, Fortier, Vallerand, & Briere, 2001). 
By understanding the relationships between these types of extrinsic 
motivations and study orchestrations, appropriate intervention strate-
gies can thus be designed by educators to alter a student’s study or-
chestration to a more theoretically desirable one.

1.3. The present study

The present study will seek to address the gaps in literature by ex-
amining the following research questions: (1) What is the relation be-
tween learning approach, motivation and academic achievement 
for students learning mathematics? (2) What are the different study or-
chestrations in students enrolled in a mathematics module? (3) Which 
study orchestrations will predict a higher mathematics achievement 
scores? (4) What are the motivational patterns across study orchestra-
tions?

We hypothesize that:

1) Deep learning will be a positive predictor of intrinsic motivation, 
identified regulation, introjected regulation and academic achieve-
ment whereas surface learning will be a positive predictor of ex-
ternal regulation but a negative predictor of academic achievement.

2) There will be four different types of study orchestrations, namely 
high-high, high-low, low-low and low-high in deep and surface 
learning.

3) Students with high-low in deep and surface learning will have the 
highest level of academic achievement, followed by students with 
high-high, low-low and low-high in deep and surface learning.

4) Students with high-high and high-low in deep and surface learning 
will have a higher level of introjected and external reg-
ulation. Students with low-low and low-high in deep and surface 
learning will have a higher level of introjected and external reg-
ulation.

2. Methods

2.1. Sample and procedure

The participants were 357 students enrolled in a diploma course. 
The diploma course was a prerequisite to an undergraduate program in 
business management. The sample consisted of 161 male and 196 fe-
male students. The mean age was 19.4 years, SD = 2.11. English was 
the medium of instruction.

The survey was conducted in the middle of the semester during a 
mathematics lecture. Students were asked to complete a questionnaire 
that related to their current mathematics module. In line with ethics 
procedures, approval was sought and granted by the university's in-
itutional review board. Students were also informed that their re-
sponses would be confidential and that they had the option to withdraw 
from the survey at any given time.

2.2. Measures

Approaches to learning: Surface and deep learning were measured 
using a modification of the revised two-factor version of the Learning 
Process Questionnaire (LPQ) and the Motivated Strategies for Learning 
Questionnaire (MSLQ). The MSLQ was originally developed by Pintrich 
and his colleagues for a North American sample but it has been used 
extensively and translated into > 20 different languages. The LPQ was 
developed by Biggs and his colleagues based on a Chinese context. Both 
are relatively simple in item construction and are similar in the
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