Learning and Individual Differences 54 (2017) 92–101

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Identifying Taiwanese junior-high school students' mathematics learning profiles and their roles in mathematics learning self-efficacy and academic performance

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ARTICLE INFO

Article history:
Received 26 April 2016
Received in revised form 23 December 2016
Accepted 5 January 2017
Available online xxxx

Keywords:
Conceptions of learning mathematics
Mathematics learning self-efficacy
Academic performance
Latent profile analysis
Learning profiles

ABSTRACT

Conceptions of learning mathematics and their relations to academic self-efficacy and performance have recently received much attention. However, a forced dichotomization of the conceptions of learning and discussing a single conception at a time may provide limited information because students may simultaneously hold multiple conceptions of learning rather than using a dominant one while learning. Accordingly, it would be more comprehensive to characterize students according to several critical conceptions, forming mathematics learning profiles. In so doing, students with a specific profile could be portrayed with an outline of various conceptions of learning mathematics. Therefore, this study aims to investigate the role of students' mathematics learning profiles in terms of three critical conceptions of learning mathematics (learning as preparing for tests, learning as calculating and practicing, and learning as achieving understanding) in their mathematics learning self-efficacy and academic performance. A total of 422 students were solicited from junior-high schools in Taiwan. The results of the latent profile analysis revealed four learning profiles that were able to characterize students, namely the high-engagement, mixed, passive, and surface-understanding learning profiles. Furthermore, the MANOVA results indicated that students with a high-engagement learning profile displayed the best mean value for mathematics learning self-efficacy, as well as the best academic performance; on the other hand, the students with a passive learning profile showed the lowest mean value for mathematics learning self-efficacy as well as inferior academic performance.

1. Introduction

Previous studies have explored the relations among students' conceptions of learning, academic self-efficacy, and academic performance (Chiou & Liang, 2012; Lin & Tsai, 2013a, 2013b), along with the finding that students' conceptions of learning, academic self-efficacy, and academic performance are closely intertwined. In addition, applying these concepts to the domain of mathematics has received much attention (Crawford, Gordon, Nicholas, & Prosser, 1994; Reid, Wood, Smith, & Petocz, 2005). However, the conceptions of learning involve diverse categories ranging from the reproductive (such as learning as repeating mechanical calculation and practice) to the constructive (such as learning as achieving understanding) orientations. Also, since students may hold multiple conceptions of learning rather than a predominant one (Fuller, 1999; Purdie & Hattie, 2002), a forced dichotomization of the conceptions of learning, and discussing a single conception at a time may provide limited information. Therefore, it would be more concise and meaningful if students could be characterized according to the most critical conceptions of learning mathematics, forming several distinct learning profiles that could represent an outline of various conceptions. In so doing, we could further explore the nature of each learning profile. Therefore, the current research aimed to identify mathematics learning profiles based on the critical conceptions of learning mathematics. In addition to identifying the mathematics learning profiles, we further compared the participants' mathematics learning self-efficacy and academic performance among the different profiles.

2. Conceptions of learning mathematics (COLM)

Conceptions of learning mean what learners perceive and how they interpret their own learning (Richardson, 1999). Researchers have been investigating learners' conceptions of learning for some time now. For example, Säljö (1979) investigated what students understand and perceive through learning. He classified students' *conceptions of learning* into five categories: (1) the increase of knowledge; (2) memorizing; (3) the acquisition of facts, skills, and methods to be used as necessary; (4) making sense or abstracting meaning; and (5) interpreting and understanding reality in a different way. Following Säljö's study, Marton,

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http://dx.doi.org/10.1016/j.lindif.2017.01.008
1041-6080/

Dall'Alba, and Beaty (1993), further discerned another conception of learning, personal change in attitudes and values, which is generally regarded as the most elaborate conception of a student's learning. They therefore labelled this conception as "change as a person."

In addition, researchers have recently discussed the domain-specific attribute of learning conceptions (e.g., Buehl & Alexander, 2001), and have further argued that when it comes to specific academic domains, people may have different conceptions of their own learning (Lee, Johanson, & Tsai, 2008; Tsai, 2004). For example, researchers have widely investigated the conceptions of learning with respect to the subject of mathematics. For example, Crawford et al. (1994) investigated students' conceptions of learning mathematics, distinguishing between fragmented and cohesive conceptions. They found that students with a fragmented conception tended to adopt a surface approach to their study, while those with a cohesive conception had a tendency to use a deep approach. Also, Reid et al. (2005) investigated students' experience, understanding, and conceptions of learning mathematics, finding that conceptions of learning can be organized into hierarchical orientations for each aspect. The lowest and limited level is concerned with the extrinsic attributes (techniques), the middle level focuses essentially on the mathematics itself (subject), while the highest and deepest level applies the mathematics to the students' lives (life). In addition, Burton (2004) carried out an interview-based study, further investigating mathematicians' conceptions of mathematics, and found that they paralleled students' conceptions.

As can be seen, the topic of conceptions of learning mathematics has already received much attention in the literature. However, it is difficult to make the most of these various conceptions due to their vast number. Also, since students may hold multiple conceptions of learning rather than a predominant one (Fuller, 1999; Purdie & Hattie, 2002), a forced dichotomization of the conceptions of learning and discussing a single conception at a time may provide limited information. Therefore, the current research aims to identify Taiwanese junior-high students' mathematics learning profiles based on just a few of the most critical conceptions of learning.

3. Conceptions of learning and motivation

Students' conceptions of learning are related to their learning motivation (Rabanaque & Martinez-Fernandez, 2009). In terms of motivation theory, goal orientation and value of motivation involve tendencies and weights of different purposes that students adopt according to their learning situation. Among the categorizations regarding goal orientation and value of motivation, the most important differentiations are between mastery and performance orientation and between intrinsic and extrinsic motivation (e.g., Ames, 1992; Ames & Archer, 1988; Dweck, 1986). In addition, the more recent categorizations of motivation lie between approach and avoidance motivation, which differ as a function of valence. Individuals adopt approach motivation whose behavior is directed by a positive or desirable event, whereas people adopt avoidance motivation whose behavior is instigated by a negative/undesirable event (Elliot, 1999). In addition, Elliot and McGregor (2001) further indicated that achievement goals may be differentiated on two fundamental dimensions – according to how they are defined (absolute/mastery vs. normative/performance) and how they are valenced (positive/approaching success vs. negative/avoiding failure). Therefore, they proposed a 2×2 achievement goal framework, which comprises mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance goals. As for the relation between motivation and different conceptions of learning, Rabanaque and Martinez-Fernandez (2009) indicated that students who adopt a mastery orientation or intrinsic value of motivation may view the conceptions of learning as understanding and deep knowledge with interest, while those who adopt a performance orientation or extrinsic value of motivation tend to learn in order to get good grades or to meet others' demands. Based on the aforementioned literature, the current research aims to shed light on the nature of various conceptions of learning ranging from mastery or intrinsic orientation (similar to the conception of understanding) to performance or extrinsic orientation (similar to the conception of testing).

4. Conceptions of learning in Asian culture

Säljö (1987) indicated that the definitions of conceptions of learning are not universal, but are valid in the particular educational environment in which students mature and learn. That is, he suggested that the conceptions of learning are developed by different educational environments, and therefore, in an attempt to shed light on the nature of the conceptions of learning defined by particular culturally established conventions, the current research aimed to investigate student conceptions of learning in a non-Western (i.e., Taiwan) learning environment.

Among the cultural differences in conceptions of learning, research regarding the different conceptualizations of memorization and understanding in various cultures has received accumulating attention (e.g., Purdie & Hattie, 2002; Watkins & Regmi, 1992; Watkins, Regmi, & Astilla, 1991). It has been found that students from non-Western and Western educational contexts have different interpretations of the conception of memorization. In Western learning environments, memorization is more associated with rote learning, regarding learning as merely the mindless repetition of fragmented and discrete pieces of facts or information (Purdie & Hattie, 2002). Accordingly, memorization is regarded as an indicator of surface learning. Nevertheless, in non-Western learning environments, there is a positive view on the conception of memorization associated with the understanding process (Purdie & Hattie, 2002; Watkins & Regmi, 1992; Watkins et al., 1991). The effectiveness of the understanding process may be enhanced or augmented by the process of memorization. Marton et al. (1993) further asserted that Western researchers and educators seemed to dichotomize the processes of memorization and understanding; however, in Asian learning environments, it appears that the dividing line does not lie between memorization and understanding, but between mechanical memorization and memorization in order to assist the understanding process. Along this line, we argue that in terms of mathematics learning, calculating and practicing may play a similar role to that of memorization. The current research, therefore, aims to explore whether there are two different kinds of calculating and practicing (i.e., mechanical calculation and practice vs. calculation and practice with understanding) in mathematics learning.

5. The critical conceptions of learning mathematics

Among those conceptions of learning mentioned above, the current research, according to Lin, T. J., Liang, and Tsai's (2015a) suggestions, proposes three critical conceptions which are able to identify Taiwanese junior-high students' mathematics learning profiles.

The first critical conception of learning mathematics is 'learning as preparing for tests'. This conception explains that learners perceive learning mathematics as being in order to gain good test results or to pass examinations. According to the empirical evidence, it has been suggested that the conception of testing is negatively correlated with student interest and confidence in learning science (Liang & Tsai, 2010), and is also the strongest predictor of the surface learning approaches (Lee et al., 2008). Moreover, the conception of testing is a learning conception featuring cultural characteristics. Tsai (2004) indicated that students' conceptions of learning are influenced by educational contexts and culture. The conception of testing may be heavily influenced by Eastern cultures such as that in Taiwan where success in tests is highly valued. Based on these reasons, we recruited junior-high school students who may suffer high examination pressure and so are probably more sensitive to this conception; we therefore chose testing as one of the critical conceptions of learning mathematics.