The Development of Computerized Mathematical Learning Dispositions Scale for Elementary School Children

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ABSTRACT

The purpose of this research is to develop a Mathematical Learning Dispositions Scale for elementary school children, based on the definitions of learning dispositions, proposed by Carr & Claxton. The instrument differs from traditional highly cognitive approaches because it highlights the dominant influence of emotions and intentions. It includes both A Scale and B Scale, A Scale is mainly concerned with the Semantic Differential, whereas B Scale with the Likert-type Scale. The principal concepts of learning dispositions lie in resilience, playfulness and reciprocity.

The research objects are 98 senior students in an elementary school in the Taichung County. The internal consistency reliabilities of the two scales are between 0.708 and 0.888. The correlation coefficients for the Chinese and Mathematics courses in A Scale are 0.384 and 0.507, respectively; while those in B Scale are 0.249 and 0.437, respectively.

In the research, we also ask students to choose pictures to portray their roles in Mathematics for some open questions of self-assessment, and make initial discussions according to students with different learning styles. Our study is based on the Learning Orientation Model（Martinez, 1999, 1998, 1997）, including four learning orientations: Transforming, Performing, Conforming, and Resistant Learners.

Keyword: learning style, learning dispositions scale

Introduction

1. Beyond ability: from IQ to IC（Intellectual Character）

Learning to learn is ultimate life skill for the 21st century (Burgogne, 1998). In a world of rapidly developing technology, how do we teach or learn what we don't know？The purpose of education is to help the people function well and take responsibility, and help them become good real-life learners (Carr & Claxton, 2002). A capable man cannot be sure to want to learn, think to learn or be ready to learn. For lifelong learning, it is more important that attending to the cultivation of positive learning dispositions.

Learning power contains two interrelated facets: capabilities and dispositions（Claxton,1999a; Carr & Claxton, 2002）. There is a distinction between capabilities and dispositions. Capabilities are the skills, strategies and abilities, whereas a disposition to learn is an inclination towards learning, i.e., being ready and willing as a volitional activity (Carr & Claxton, 2002; Sadler, 2003). To understand and develop fully a person's lifelong learning potential, it is required that we pay more attention to learning dispositions.

In Taiwan, the sequence of nine-year curricula emphasizes on developing the basic abilities that students can take away with them, helping students to understand, accept, and believe in themselves, and being willing to effectively develop themselves. It was found that in respect of study motivation, students being highly supported by teachers are superior to those in the control group; while in respect of validity of remedy teaching, the learning-disposition item is more sensitive to the cognitive item (Hung et al., 2002).

Much research on individual learning differences remains focused on cognitive interests, however, many contemporary researchers have extended their research to psychological constructs that include conative, affective, and social influences on learning differences (McCombs, 1996; Corno, 1993; Snow, 1989). There have been several major thrusts to research in the area of learning style in the past 20 years. The initial emphasis was to document that there are style differences among learners and to develop instruments that accurately assess those differences (Wakefield, 1993).

Snow (1987, p.1) suggested that sound learning theories should include a whole person view that integrates cognitive, conative, and affective aspects. Recently, many research motivations have already focused on behavioral special cognition and dispositional interposition. The change of research directions also explains that motivation itself gives shape to cognition, emotion, and behavior（Heckhausen ＆ Dweck,1998）, and learning itself shows complicated interaction among cognition, meta-cognition, and affection（Hartman & Sternberg,1993;Palincsar & Brown,1989）.

There are few instruments dealing with dispositions scales. Only male-disposition, female-disposition, and bi-sexual-disposition scales exist in the studies of sexual parts in these days.

It is even lacking in instruments for dispositions scale in respect of learning. Due to the vague concept of learning dispositions scale, it is difficult to develop scale instruments, and there are only few ones developed for learning dispositions.

2. Purpose

This research is to develop a Mathematical Learning Dispositions Scale（MLDS） for elementary school children, based on the definitions of learning dispositions, proposed by Carr & Claxton. The purpose of this study was to investigate the issue of elementary students' learning dispositions and examine the positive or negative reaction of the students' mathematical learning dispositions. The instrument includes both A Scale and B Scale, A Scale is mainly concerned with the Semantic Differential, whereas B Scale with the Likert-type Scale. The principal concepts of learning dispositions lie in resilience, playfulness and reciprocity. Furthermore, the research also developed the open-figure type, including homework of portraying their roles in mathematical learning. We ask students to choose pictures to portray their roles in Mathematics for some open questions of self-assessment (C Scale), and make initial discussions according to students with different learning styles.

It is hoped that the tools can provide elementary school teachers with the reference information of students' learning dispositions in Mathematics, and record students' growing and developing loci in different grades, which will then be used as a basis for teachers to adjust their teaching programs. In addition, this research also tried to computerize MLDS, i.e., put all the questions and related pictures into FlashMX files in the computer, so that the assessments will be accomplished via the computer networks.

The construct of dispositions

Learning dispositions are habits of the mind, tendencies to respond to situations in certain ways (Katz, 1988, p.30); they guide the interpretation and editing of experience in characteristic ways (Carr,1999). Perkins et al. (1993) argued that a disposition has three aspects: skill, inclination and sensitivity to occasion.

For the capacity to know 'how to learn', Goleman (1996) listed seven key ingredients: confidence, curiosity, intentionality, self-control, relatedness, communication and cooperation. Carr (1999) argued that the learning dispositions of children include courage, curiosity, playfulness, perseverance, confidence and responsibility. Claxton (1999b) described what he referred as 'learnacy' should comprise curiosity, mindfulness, selectivity, resilience, experimentation, reflection, opportunism and conviviality.

The study is based on the operational definitions of learning dispositions -- resilience,

playfulness and reciprocity, proposed by Carr & Claxton. Table 1 lists the content and the opposite meaning of assessment construct.

Table1 The content and opposite meaning of assessment construct

Construct	Content	Opposite Meaning
Resilience	♦ learning challenges where the outcome is uncertain ♦ persist with learning despite temporary confusion or frustration ♦ recover from setbacks and rededicate oneself to the learning task	♦ get upset at the first sign of difficulty ♦ brittleness ♦ shift from 'learning mode' into a defensive, self-protective stance
Playfulness	♦ perceptual openness which relies upon the inclination to notice the unfamiliar or to 'read the situation' in different ways ♦ more persistence, self-control, and enjoyment ♦ the ability to play with or explore physical material and conditions so as to discover their latent properties and possibilities	♦ see only in terms of familiar categories and ignore details that are incidental to the process of categorization or inconvenient to it ♦ not being able to see beyond an initial interpretation and being stuck with it as the 'literal truth' of the situation ♦ conventional and functional fixedness; seeing only familiar uses for objects and being unable to shift categories when it might be useful to do so
Reciprocity	♦ a willingness to engage in joint learning tasks ♦ expressing uncertainties and asking questions ♦ taking a variety of roles in joint learning enterprises and taking account of the opinions and needs of others	♦ a kind of epistemic solipsism in which the existence of others, both as resources and as learning partners with needs and goals of their own, is ignored

Methodology

1. Participators

The study involved 98 six-grade pupils in an elementary school in the Taichung County, and the detail is listed in Table 2.

Table 2 The tested classes and the corresponding numbers of boys and girls

class	I	II	III	Total
Boy	18	21	6	45
Girl	17	17	19	53
Total	35	38	25	98

2. Instruments

This research is based on Carr & Claxton's viewpoint to learning dispositions, uses the content of Table 1 as the framework, and adopts the method of Semantic Differential (A Scale). In addition, this research also designs the Likert-type five-point scale (B Scale). Table 3 illustrates the correspondence between the construct and the question numbers. In the research, we also ask students to choose pictures to portray their roles in Mathematics for some open questions of self-assessment (me in Mathematics, C Scale).

Table 3 The correspondence between the construct and the question numbers

Construct	Question Numbers	
	Semantic Differential (A Scale)	Likert-type Scale (B Scale)
Resilience	1, 2, 3, 4, 5, 6	1, 2,3
Playfulness	7, 8, 9, 10, 11, 12	4, 5, 6
Reciprocity	13, 14, 15, 16, 17, 18	7, 8, 9, 10

3. Scoring and Data Processing

The questions designed in MLDS are all regarding to learning characteristics, and the possible answers are spread inside the five-point ruler. According to what best represents his own learning dispositions in Mathematics, the testee can choose the corresponding letters (A to E). Positive and negative mathematical learning dispositions are distinguished from the tested scores. The score range for every question is from one to five, for example, scoring five for choosing answer A – like the challenge, or scoring one for choosing answer E – being afraid of the challenge. Figure 1 shows one example of the questions in MLDS.

I am very confident in mathematical understanding

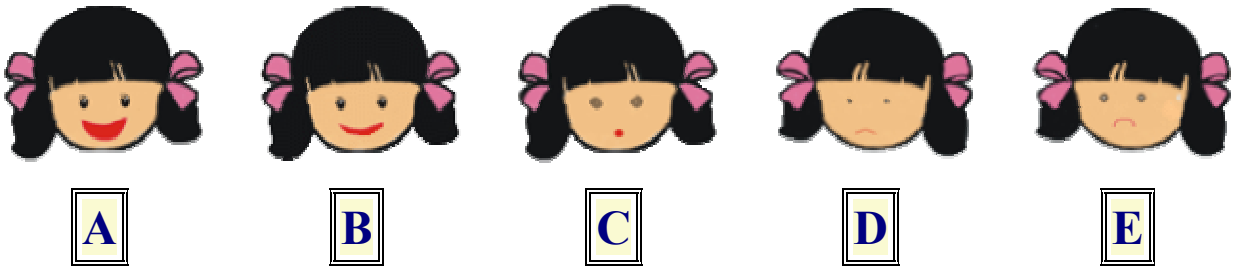

Fig. 1 One example of the questions in MLDS

No sooner was the tested data collected than it was transferred into computers, and was analyzed by the SPSS (Statistical Package for the Social Science) software to obtain useful results.

Results

1. Question Analysis, Reliability, and Validity in MLDS

As shown in Table 4, the internal consistency reliabilities, Cronbach's α, for learning dispositions scales are between 0.7 and 0.88. The correlation coefficients of the three instruments with respect to Math score and Chinese score are between 0.3 and 0.5, as shown in Table 5. The correlation coefficients among the construct of A Scale and B Scale are shown in Table 6. As indicated in Table 7, the correlation coefficients of A Scale with respect to B Scale and C Scale are 0.833 and 0.662, respectively, while that of B Scale with respect to C Scale is 0.575.

Table 4 Internal Consistency Reliabilities, Cronbach's α

Learning Dispositions		Total numbers of questions	Cronbach's α
Semantic Differential (A Scale)	Resilience	6	0.813
	Playfulness	6	0.708
	Reciprocity	6	0.718
	Total Scale	18	0.888
Likert-type Scale (B Scale)		10	0.809
Me in Mathematics (C Scale)		6	0.808

Table 5 The correlations of the three instruments with respect to Math score and Chinese score

Scale Name	Math score	Chinese score
Semantic Differential (A Scale)	.477**	.389**
Likert-type Scale (B Scale)	.382**	.340**
Me in Mathematic (C Scale)	.548**	.531**

Table 6 The correlations among the construct of A scale and B Scale（n=98）

A Scale / B Scale	Resilience（A1-6）	Playfulness（A7-12）	Reciprocity（A13-18）
Resilience（B1-3）	.633**	.577**	.616**
Playfulness（B4-6）	.598**	.756**	.589**
Reciprocity（B7-10）	.355**	.443**	.639**

Table 7 The correlations among the three instruments（n=73）

	A Scale（Semantic Differential）	B Scale（Likert-type Scale）
B Scale（Likert-type Scale）	.833**	
C Scale (Me in Mathematics)	.662**	.575**

2.Four types of learning dispositions

Based on the Learning Orientation Model（Martinez, 1999, 1998, 1997）, there are four types of learning orientations: transforming, performing, conforming, and resistant learners. In the research, it was found students of the transforming type have the highest self-requirements. For example, they can think before doing the homework, pay more attention when doing the homework, and re-check after finishing the homework. Their parents also place high hopes on them, and stimulate them to do deeper and harder mathematical problems. They always speak to themselves that “I can do better” or “I have to understand this.” They compare themselves to mantes, and compare other students to siskins, which means they feel other students may transcend them in any time, therefore, they have to work hard and study diligently.

Comparing with students of the transforming type, students of the performing type in this research are careless about things. They usually set shorter goals with lower criteria and little risks,

and pay more attention to external performances and awards.

Students of the conforming type are more obedient, and more harmonious with other students. They compare themselves to sunflowers, and compare other students to the Sun, which means they feel other students will inspire and accompany them in studies. Because of the long-term setbacks in mathematical learning, students of the resistant type have negative learning dispositions. They feel Mathematics is a boring subject, and will fall asleep when seeing Mathematics. Being insufficient in self-confidence, they compare themselves to old men who react slowly, and compare other students to children who react dexterously.

Some students of the resistant type compare themselves to insignificant ants, and feel feeble in mathematical learning. Some also compare themselves and other students to the Earth and the Universe, respectively, which means they feel themselves to be tiny and humble. The direct projective reactions of learning dispositions from students of the resistant type provide teachers with abundant information going beyond students' accomplishments in studies. Moreover, among those, some students' performances in studies are above normal, but their learning dispositions are negative. It is worthwhile for educators to pay more attention to this phenomenon, and it is better to investigate the reasons that cause the resistances.

3. The Analysis of MLDS

The four learning types, transforming, performing, conforming, and resistant types, can explain the behaviors coming from 75 percents of students. Generally speaking, the percentage for the resistant type is about 23.5%, while those for the performing type, transforming type, and conforming type are 21.4%, 15.3%, and 14.3%, respectively. In mathematical learning, it is shown in the research that almost one-fourth of students are of the resistant type. It is worthwhile for mathematical educators to pay attention to this result.

Table 8 shows the Mean (M) and Standard Deviation (D) in MLDS for different learning-type students. The score sequence (from high to low) for both A Scale and C Scale is transforming, performing, conforming, and resistant; while that for Scale B is transforming, conforming, performing, and resistant.

Table 8 The mean (M) and standard deviation (D) in MLDS for different learning-type students

	A Scale---M（D）	B Scale---M（D）	C Scale---M（D）
Transforming	72.60（2.56）	42.31（1.47）	16.87（.92）
Performing	64.71（1.63）	36.90（1.28）	14.19（1.54）
Conforming	57.21（3.36）	37.57（1.76）	12.79（2.46）
Resistant	49.04（1.96）	30.09（1.59）	8.22（1.44）

**The total scores for A Scale, B Scale, and C Scale are 90, 50, and 18, respectively.

Discussion

The three instruments designed in this research have been changed to FlashMX files in the computer, so that the assessments will be accomplished via the computer networks. However, more research should be done in order to make the instruments more perfect.

It is better to add the design of drawing for junior and senior students, and collect the differences from students of different grades, so that we can provide researchers with the quantitative information of the changes in MLDS. According to the previous results, what affect the changes can be further studied, and the results can be used as important references for teaching.

Based on the changes in MLDS, which lower the effects of learning for senior students, it is better to investigate further the possible factors that make the differences. The results can be used for remedy teaching.

The research samples can be increased to comprise the first-grade students in junior high schools. The research results can be useful for the concatenation of course design between junior high schools and elementary schools.

According to the reports in MLDS, some proper comments and suggestions can be generated for students, and can be further used as important references for discussing with their parents about their learning dispositions.

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