

A Study of the Effect of Picture Word Inductive Model and Mathematics Self-Efficacy on Management of Teaching Algebraic Identity to Students of Fadak Girls' High School in District 1 of Tehran, Iran

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ABSTRACT

One of the most important aspects of training courses is to consider how education is provided and how it is managed. The main purpose of the present study has been to determine the effect of picture word inductive model and mathematics self-efficacy on teaching algebraic identity. In order to conduct the study, 60 female students of the first grade of a high school in district 1 of Tehran city were selected through simple random sampling; and one class was selected as control group and another one as experimental group. The research methodology has been applied and quasi-experimental in terms of purpose and data collection respectively. The instruments included Hackett Betz's (1989) self-efficacy questionnaire containing 51 questions, and in order to assess their progress, two tests in the form of picture word inductive model (geometric shapes of algebraic identities) and traditional form were administered, and in order to review the educational effects of picture word inductive model, a 40-item test were employed. The reliability coefficient calculated for the self-efficacy questionnaire was 0.916, and for the picture word inductive model was 0.919. In the descriptive statistics section, the obtained data has been presented in the form of tables, mean, standard deviation and variance, and in the inferential statistics section, the independent T-test has been employed. The results revealed that the picture word inductive model and mathematics self-efficacy affects teaching algebraic identity.

KEYWORDS: picture word inductive model, mathematics self-efficacy, teaching algebraic identities

INTRODUCTION

Math has been taught as the most exalted subject of study to educate people for centuries, and it is claimed that math teaches students how to think, argue and reason. Based on standards of teaching mathematics, the ability resulting from teaching math is real when it can manifest outside classroom in daily life of people. For example, no one ask us to prove a mathematical theorem in daily life, but s/he wants us to judge, decide, defend our claim and argue to convince others. Thus, the ability to argue and reason is not limited to the subject of math. In fact, the purpose of learning different methods of arguing and reasoning is helping students to be able in future to knowingly employ proper methods when facing any problem in order to solve them (Kilpatrick, 2001).

Today, mathematics is not well situated among students and some of them pay less attention to this subject. There are many reasons for such defect among them such as low mathematics self-esteem, less background in mathematics and traditional teaching methods, etc. which all lead to low mathematics self-efficacy; in long term, this inflicts serious damages to development of science and technology. As a result, there is a need for a tool to help them to understand math, especially algebraic identity as well as a need for a scale to measure their mathematics self-efficacy beliefs after teaching algebraic identities (Bohrani, 2003).

In pedagogy experts' opinion, students who learn through active learning, not only learn better, but also enjoy more from learning, because instead of being only listeners, they actively participate in the process of learning and know they are responsible for their own learning (Gardner & Jeweler, 2000). One of the active methods which is today considered by many pedagogy experts is picture word inductive model (PWIM). Picture word inductive model is a research-based strategy of skills which consists of pictures containing familiar objects (Calhoun, 1999); it familiarizes the fluid mind of students with the pictorial proving of the algebraic identities by picturing and presenting geometric shapes, and then proceeds to algebraic proving of them. This model supports insatiable curiosity and allows them to think inductively. This model improves thinking, data collection, organization and control. In this model, the teacher initiates the activity, but there is friendship and collaboration between the teacher

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and student, and there is an opportunity for all students to better understand and solve possible problems, and students learn more stuff by making eye contact and seeing the pictures (Mousavi, 2008).

One another factor which affects mathematics performance is self-efficacy. Bandura (1997) in an article titled "Toward a Unifying Theory of Behavioral Change" stated that self-efficacy is people's judgments' about their capabilities, and these beliefs affect their efforts and perseverance. Self-efficacy beliefs affect feeling, thought, behaviour and motive of the learners. Researchers (Bandura, 1986; Schunk, 1991) concluded that self-efficacy beliefs predict students' mathematics performances, whether these performances are evaluated based on the scores of criterion-referenced test or through progress indexes. Kranzler & Pajares (1990) found that the effect of self-efficacy on mathematics performance is the same as the effect of general ability. The students with higher self-efficacy are more precise in math calculations (Colins, 1992, cited in Pajares, 1999, cited in Keramati, 2001).

Therefore, given the importance of teaching algebraic identity in mathematics and other courses, this study aims at investigating the relationship between self-efficacy and picture word inductive model in teaching algebraic identities; the study also seeks to find out if there is a relationship between picture word inductive model and mathematics self-efficacy in management of teaching algebraic identities. In other words, how much difference is there between traditional teaching of algebraic identities and picture word inductive model in terms of students learning? Is students' progress, who are taught through picture word inductive model, considerable? Is the difference in self-efficacy between the students who are taught through traditional method and students who are taught through picture word inductive model, significant?

RELATED LITERATURE

Mathematics Self-efficacy

One of the beliefs that today psychologists try to study is mathematics self-efficacy which is indicator of efficacy attitudes in selecting field of study and academic achievement (Zimmerman, 1995); in practice, there are certain strategies for the students, including teaching mathematics through picture word, geometric shapes, practical exercises as well as animation and computer and everything which brings mathematics from frame of mind into belief and application.

Researcher such as Hakett (1985), Hakett and Betz (1989) and Pajares and Miller (1994, 1995) have studied the role of personal self-efficacy in educational areas including mathematics. Hakett and Betz (1989) define 'mathematics self-efficacy' as "a situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular [mathematics] task or problem (p. 262, cited in Bohrani, 2008). The studies have indicated that this assessment of an individual or outcomes such as selecting field of study and academic achievement (Lent & Hakett, 1987; Multon et al., 1991) and willingness and intention to enroll in fields related to mathematics are correlated (Lent et al., 1993).

Therefore, the scale of 'mathematics self-efficacy' is one of the tools which is widely used in educational counseling research (Pajares, 1997). Betz and Hakett (1982, 1983) specifically formulated the 'scale of mathematics self-efficacy' for evaluating students' mathematics self-efficacy against former tools. This scale is in two main forms including two subscales of assignments and math problems. The revised scale includes three subscales of assignments, lessons and math problems, which has 52 articles and each subscale shows a different area of behaviour related to mathematics (Bohrani, 2003).

Pajares and Kranzler (1995) found that the subscale of math problems predicts problem-solving and general mental ability. Randhawa et al. investigated the role of mathematics self-efficacy scale in mathematics achievement of high school students and found that self-efficacy was a mediator variable between mathematics attitude and mathematics achievement (ibid).

Some researchers (Hakett, 1985; Pajares, 1996, cited in Keramati, 2001) have reported that people's judgment about their own abilities to solve math problems indicates their real ability. Besides, these judgments moderate the effect of other predictors such as mathematics background, mathematics anxiety, perceived usefulness of mathematics, previous progress and gender. Self-efficacy can predict general mental ability, as it can reveal the ability to solve math problems.

Self-efficacy and performance

People's perception of self-efficacy is as the cognitive mediator of human action. This perception affects human's thinking and action. In order to help students in mathematics, they can be persuaded to divide their tasks into sub-objectives. Monitoring their performance and giving feedback in a way that increases sense of self-efficacy in them will enhance their interest in learning and raises their performance level.

Bandura believed that judgment about the level of self-efficacy is based on four sources of information:

- 1- Performance accomplishments: successful past experiences of various tasks.
- 2- Vicarious experience: seeing others' successful performances.
- 3- Verbal persuasion and other forms of social influence: saying the individual concerned s/he has requisite abilities to achieve what s/he wants, realistically increases self-efficacy.
- 4- Physiological arousal states: an individual who feels a lot of tension and anxiety cannot be expected to succeed. Thearousal states should reach an average non-disturbing level (Bandura, 1977, cited in Alinia, 2003).

Picture word

Picture in this model refers to a series of related images which contain the main theme of the course of study; and in its normal form, these pictures are drawn on the board by the teacher and student jointly and the learning is based on them, and the student learns more through eye contact and seeing the pictures. This model supports curiosity of the learners and allows them to think inductively (Mousavi, 2009). The teacher plays the role of the guide, leader of the group and learning facilitator in this model and is responsible to provide the conditions for learning. The picture concept inductive model is considered one of the active teaching models which, as a new model, includes paving the way for students participation, making use of proper technology for learning, complete design of course of study, preparation of learning environment for mutual understanding and interaction, formative evaluation, acquiring modeling skills for independent learning in learner groups as a life skill, evaluating your learning method during development and nurturing creative talents of students (Behrangi&FaraghiVaighan, 2009). In this model, the student themselves play the major role of teaching learning activities. Therefore, in this model, the student is the center of learning and extractor of learning results. In this model, the teacher plays the role of the guide, leader and learning facilitator and is responsible to provide the conditions for learning. Picture in this model refers to a series of related images which contain the main theme of the course of study; and in its normal form, these pictures are drawn on the board by the teacher and student jointly and the learning is based on them (Behrangi, 2013).

In fact, picture word is a kind of using model and modeling. It is a new model which can incorporate all the educational objectives in contrast to traditional model; however, there has been few studies because it is a new topic. This model called 'picture concept inductive model', as a new model based on educational opinions of Benjamin Bloom, Hilda Taba, Jerome Bruner, Goodnow and William Austin is added to the picture word inductive model of BruceJoyce, Marsha Weil and Emily Calhoun, and is placed in the family of data processing models (Behrangi&FaraghiVaighan, 2009); while picture word inductive model is a research-based strategy of time skills, which uses pictures containing familiar objects and actions for extracting words from students' lexical resources through listening, speaking and modeling (Calhoun, 1999).

Picture word inductive model

In teaching algebraic identities by picture word inductive model, the following advantages is thought to be existing for all classes and for all students with different abilities and cultures.

- This method generates motivation and heightens the feeling of success in students
- By this method, students learn algebraic identities practically and their figures are imprinted on their mind.
- Students get to applied math from pure mathematics.
- Transfer of math from speech to writing happens.
- The concepts about math functions are framed.

Teaching mathematics is one of the courses of study which is based on logic and the teaching should be managed in order to achieve creativity and stability of learning, so that a precise, correct and functional understanding of the models and mathematics reasoning can be acquired by modern teaching methods, considering teaching objectives and students' level of learning. The main purpose of teaching math is to develop the ability to understand, reason and argue, to lay a proper ground for thinking, to devise a reasoning and logical thinking method, and to foster intellectual creations.

General principle of teaching and learning

1. Provisions before learning (preparing the student) 2. Generating motivation in learners 3. Providing an example or sample of the final performance (research sample works, projects, exam questions) 4. Active participation of the learner in learning 5. Leading the learners 6. Practice 7. Awareness of the performance results 8. Following teaching stages (discuss subjects from simple to difficult) 9. Respect for personal individual differences 10. Doing various educational activities in classroom (Seif, 1997). The most comprehensive definition proposed for learning process belongs to Hilgard and Marquiz. These two psychologists have defined learning as the relatively permanent change in the potential behaviour of the individual due to past experience (Seif, 1989). This definition

has a special priority over other definitions, because it has presented a new viewpoint of learning process and this new viewpoint can be sought among concepts such as process, change, relatively permanent, potential behaviour and experience.

Management of teaching algebraic identities

Mathematics is a kind of scientific language. Engineers, physicists and other scientists, all use mathematics in their respective works. Other experts who are interested in studying numbers, quantities, shapes and space purely, use pure mathematics (non-applied). Number theory is devoted primarily to the study of the integers, a branch of pure mathematics. In the new world, mathematics is one of the key elements of electronics and computer science (Davoudi, 2011).

In mathematics, we sometimes face difficult and very exhausting expressions which often are replaced by equivalent expressions shorter or more compact than original expressions. Thus, there is equality between original expressions and next shorter expressions. It means that an equality relation can be written in such a way that the longer expression is placed on one side and the shorter one on another side. In this way, there is equality established for all numbers. Such expressions are called algebraic identities in mathematics terminology (Adeli, 2012). The management of teaching algebraic identity means:

- a) Its mathematics teaching should be properly performed with respect to teaching methods.
- b) Its teaching should beperdurable and do not be erased from the students memory.

RESEARCH METHODOLOGY

The present study is applied, quasi-experimental, quantitative and experimental in terms of purpose, nature of the subject of study and research objectives, data types and data collection respectively. The statistical population of the study includes first grade students of girls’ high schools in district 1 of Tehran city, Iran. For selecting the sample group and increasing the accuracy of measurement and given the statistical assumptions of the research model, the Fadak high school was randomly selected from district 1 of Tehran, and two 30-student classes were randomly selected from among the three first grade classes of this high school. In addition, the following instruments were employed in this study:

The instruments used for measuring the independent variables has been 51-question self-efficacy questionnaire of Hakett and Betz (1989) and 40-question researcher-made picture word questionnaire; and for measuring dependent variable, the researcher-made test in two traditional and picture word forms has been used. Besides, the criterion for student’s educational progress has been their scores.

Finally, the collected data was analyzed using independent T-test.

RESULTS

Table.1: for description of study variables

Standard error	Standard deviation	Mean	Number	Group	Variable
1.784	9.774	160.9	30	Control group	Self-efficacy
2.128	11.655	121.933	30	Experimental group	
4.01	22.01	140.5	30	Experimental group	Picture word
4.58	25.12	122.4	30	Control group	

Based on above table, the mean for picture word in experimental group is 140.5, standard deviation is 22.01 and standard error is 4.01. In control group, the mean is 122.4, standard deviation is 25.12 and standard error is 4.58. Besides, the mean for self-efficacy in control group is 160.9, standard deviation is 9.774 and standard error is 1.784. In experimental group, the mean is 121.9, standard deviation is 11.65 and standard error is 2.12.

Table.2: Summary of different results between students in terms of mathematics self-efficacy and picture word in educational progress

Picture word	Mathematics self-efficacy	Control and experimental groups’ students
T= 2.95	T= 14.03	
Sig.= 0.005	Sig.= 0.000	
P<0.05	P<0.05	

Since the value of T calculated for mathematics self-efficacy has been14.031 at the level of 95% confidence and significance level of 0.000, there is a difference between self-efficacy’s scores average in experimental and

control groups. In addition, since the value of T calculated for picture word has been 2.95 at the level of 95% confidence and significance level of 0.05, there is a difference between picture word's average scores in experimental and control groups.

DISCUSSION AND IMPLICATIONS

Based on the presented findings in tables, the mean for picture word in experimental group has been 140.5 and in control group has been 122.4, which shows that picture word is in a good situation for experimental group. Besides, for generalizing this result to the entire statistical population and comparing two control and experimental groups, the independent T-test was used; and based on the presented data in above table, the calculated value of T at the significance level of 0.005 is 2.95. Therefore, there is a difference between average of picture word's scores in control and experimental groups. Asadi and Behrangi (2009) concluded that there is a significant difference between application of picture word inductive model in teaching English language in first grade of junior high school in comparison to traditional method. Besides, Mousavi (2009) concluded that there is a significant difference between application of picture word inductive model in teaching Arabic language in first grade of junior high school and teaching through traditional method. Therefore, the results of the present study are consistent with available related literature.

Based on the data presented in above tables, the mean for mathematics self-efficacy in experimental group has been 160.9 and in control group has been 121.9, which shows mathematics self-efficacy is in a good situation for experimental group. Besides, for generalizing this result to entire statistical population and comparing two control and experimental groups, the independent T-test was used; and based on the presented data in above table, the calculated value of T at the significance level of 0.000 is 14.03. Therefore, there is a difference between the average of self-efficacy's scores in control and experimental groups. Bohrani (2003), in a study titled "the Analysis of the Scales Articles of Self-Efficacy Beliefs", concluded that there is a consistency with previous analyses in this respect. Alaiee et al. (2012) concluded that self-efficacy increases motivation for progress in students. Therefore, the results of this study are consistent with available related literature.

Findings

Given the positive assessment carried out of the effect of the components of mathematics self-efficacy and the effect of picture word inductive model in management of teaching algebraic identity as well as considering that this model has been deemed successful in a school located in district 1 of Tehran, it can generally be concluded as that the effect of picture word inductive model and mathematics self-efficacy in management of teaching algebraic identities is confirmed, and by considering this positive relationship, it can be predicted that using this model will result in educational progress of the students. In schools, although the curriculums are designed beforehand by the Education Department for students' progress and the educational policies are developed weekly and daily by the teachers, the share of self-efficacy and motivation for educational progress of the student is considerable. It might have been seen that a student who simply had a higher motivation for success and more efficient ability of behaviour management achieved better scores than a student who had a higher ability for learning (but had no motivation for progress) (Bandura, 2001, cited in AbbasianFard). Piaget believed that self-efficacy schemes form during countless internalizations and externalizations which cause the individual to spontaneously try in the environment and achieve self-efficacy beliefs (SharifiDaramadi, 2001). On the other hand, it is believed that self-efficacy beliefs play a major role in increasing intrinsic motivation (Kadivar, 2003). Alignment of motivation for progress and self-efficacy at high level causes the individual to make use of his/her full learning potential. On the contrary, non-alignment causes the individual not to be able to realize his/her potential, and this treasure remains untouched, so the individual's academic performance declines every day. Thus, the best opportunity is that the individual's wishes be consistent with his/her capabilities (Seif, 2007). Other factors effective in the process of teaching are teaching method, teaching model, classroom management, etc. Picture word inductive model is considered to be one of the active teaching models which, as a new model, includes paving the way for students participation, making use of proper technology for learning, complete design of course of study, preparation of learning environment for mutual understanding and interaction, formative evaluation, acquiring modeling skills for independent learning in learner groups as a life skill, evaluating your learning method during development and nurturing creative talents of students (Behrangi, 2013). Therefore, in our educational system in which the books are designed beforehand and the teaching time is specified as well, and the teacher and the student should act in a way that produce the best result, especially in subjects such as mathematics which, according to many students, is neither easy nor enjoyable, the teacher has serious responsibility to properly teach, bring the enjoyment of teaching to students and achieve the best results; therefore, the results of such projects conducted can untie the Gordian knot of not achieving results from much attempts made

by the students and the teacher, and help the teaching and education in future, and pave the way for other related studies not only in the area of mathematics but also in other subjects.

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