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The Impact of Abacus on Mathematic Learning through Teachers' Innovative Behavior in Elementary Schools of Iran

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Abstract

The purpose of this paper is to concentrate on the impact of abacus on mathematic learning through teachers' innovative behaviour with four factors as to realize problems, create ideas, provide support for the ideas, and implement the ideas. The use of abacus is considered as the independent variable of this study and mathematic learning is defined as the dependent variable mediated by teachers' innovative behaviour. This paper attempts to review the previous studies. This study brings about a conceptual framework for the importance of effective factors to improve mathematic learning.

Key Words: Abacus, teachers' innovative behaviour, mathematic learning.

1. Introduction

The abacus was invented by Charles Babbage though it's now being used by the entire world to turn on the mental abilities of young brains. Abacus training sharpens our memory and increases our ability to perform mental calculations. Abacus was designed in such a manner so that the brain visualizes the abacus while performing calculations which automatically activates the right part of our brain especially when we move our fingers over the beads and talk aloud while solving the problems. However, one needs to enjoy the abacus education training process, only then will one be able to truly benefit from the techniques.

The awareness of the importance of abacus and mental arithmetic was rekindled once again in the late 80s and early 90s especially after the reports of the First and Second International Comparative Studies of Mathematics Achievement were published (Husen, 1967). These studies were conducted by the International Association for the Evaluation of Educational Achievement (IEA). In both studies, the performance of the students from the Eastern countries was found to be consistently higher than the Western counterparts.

Since the Islamic Revolution of 1979 in Iran, the educational system of the country has gone under qualitative and quantitative changes. As far as quantitative changes are concerned, this education profile provides an overview of the Iranian education system. A critical assessment of the strengths and weaknesses of the Iranian education system requires an in-depth analysis of its structure.

This study focuses on enhancing the student's mathematics learning in Iran; in this regard, this study provides information for mathematics' teachers about the use of abacus. In relation to increasing student's mathematics learning, this study presents teachers' innovative behaviour with four factors as to realize problems, create ideas, provide support for the ideas, and implement the ideas. Therefore, this study is considered important because it brings about the general trend in elementary school toward more accountability and greater attention to student-learning outcomes and improvement in mathematics.

2. Literature Review

2.1 Abacus

Abacus is a sort of traditional calculator which has been used for thousands of years in China. Abacus masters can use an abacus to perform most arithmetic operations such as addition, subtraction, multiplication, division, square root, cubic root, etc. Instead of manipulating a physical abacus, some abacus experts can calculate mentally with an imaged abacus, and such calculation method is the so-called ''abacus-based mental calculation (AMC).'' However, AMC is not an expertise monopolized by the abacus veterans, but rather an efficient calculation strategy that can be mastered by children through training. In China, many primary school pupils and preschool children learn AMC as an avocation.

The abacus calculation methods help individuals in learning in number manipulation skills, decimal grasp and digit correlation among other skills. In this regard, students can use the abacus training to calculate arithmetical problems rapidly. Later on, the students can also perform the calculations without using the abacus, by just visualizing the abacus in their minds. Abacus education also helps them develop new and innovative methods of mastering arithmetic, rather than being dependent on just the orthodox methods of learning calculations otherwise taught by the conventional education system. Abacus answers the primary need of the students to make fast and accurate calculation. Hatano (1989) stated that paper and pencil calculations are never taught at abacus, and that children never use an abacus for calculations in regular school mathematics classes.

2.2 History of Mathematic Learning

The Russians' successful launch of Sputnik in 1957 caused concerns for both mathematics and science education in the United States. The American press treated Sputnik as a major humiliation and drew attention to the low quality of mathematics and science education in the public schools. As a response, Congress passed the National Defense Education Act in 1958 in an attempt to increase the number of science, mathematics, and foreign language majors. The New Math movement gained support in the 1960s due to these two events (Woodward, 2004).

The American Mathematical Society supported New Math through the School Mathematics Study Group, which consisted of mathematicians and high school mathematics teachers. Other contributors were the National Council of Teachers of Mathematics (NCTM), the Ball State Project, the Greater Cleveland Mathematics Program, the Minnesota School Science and Mathematics Center, and the University of Maryland Mathematics Project (Osborne and Crosswhite, 1970).

The New Math program had positive and negative effects. The positive impact was that calculus courses were introduced at the high school level, formal mathematics was emphasized, and more students were encouraged to take algebra and geometry. The New Math brought with it several negative side effects: minimal attention was paid to basic skills, New Math was considered abstract, teachers were not trained to teach the content, and many parents were unable to help their children learn it. Public criticism increased because students' abilities to do basic math skills deteriorated (Woodward, 2004).

The 1970s brought a reaction to the changes that New Math had provided, resulting in a back-to-basics movement. This resembled the Progressive Movement of the 1920s. The purpose of back-to-basics was to encourage schools to focus on the basics of reading, writing, and arithmetic (Woodward, 2004). Back to basics also failed because schools had limited resources, and students had limited support at home, especially among low income groups. There was no opportunity for tutoring on basic skills outside of class. These limitations were reflected in low standardized test scores (Klein, 2003).

In response to this situation, the National Council of Teachers of Mathematics (NCTM), with support from the National Science Foundation (NSF), started a project called Priorities in School Mathematics (PRISM) in the mid-1970s to improve the condition of mathematics education. The NCTM addressed the crisis in mathematics education with its document, An Agenda for Action: Recommendations for School Mathematics for the 1980s (Grouws and Schultz, 1986).

An Agenda for Action recommended that problem solving be the focus of school mathematics in the 1980s, along with new ways of teaching. Other recommendations included incorporating technology at all grade levels, stating that the difficulty in paper and pencil calculation should not interfere with learning of problem-solving strategies, encouraging the use of manipulatives, promoting cooperative learning, administering multiple types of assessments, and adhering to specific standards in teaching, and integrating mathematics topics (Grouws & Schultz, 1986). Although this report was insightful, it received little attention because it was largely overshadowed by the report, A Nation at Risk.

The National Commission on Excellence in Education released the report A Nation at Risk in 1983. This report cautioned that educational foundations of society were being eroded by a rising tide of mediocrity that threatened the future of the nation and people. This report, considered an open letter to the American people, called for educators, parents, policymakers, and students to reform public school education, which was in need of urgent improvement (National Commission on Excellence in Education, 1983).

The data, findings, and recommendations of this commission were organized around four major topics: (a) content; (b) time; (c) teaching in English, mathematics, science, social studies; and (d) computer science. The recommendations for mathematics topics included students should be able to (a) understand geometric and algebraic concepts; (b) understand probability and statistics; (c) apply mathematics in everyday situations; and (d) estimate, approximate, measure, and test the accuracy of their evaluations. The commission further recommended equally demanding mathematics curricula for those students who did not plan to pursue a formal education. Other recommendations included that standardized tests be used for accountability, that there be more courses in teacher training, that textbooks have more rigorous content, and that attention be focused on the teacher shortage (National Commission on Excellence, 1983).

In 1986, the Board of Directors of NCTM also recognized a need for national standards and professional organizations for K-12 educators to improve student achievement. Improvement in mathematics education was necessitated by the needs of society to have a mathematically literate workforce and an informed electorate, and to promote problem-solving skills for lifelong learning with opportunities for advancement. So, NCTM established the Commission on Standards for School Mathematics to improve the quality of mathematics education to meet the growing needs of the workforce (Klein, 2003).

2.3 Innovative Behavior

Innovative behavior is an important factor in the effective functioning and ongoing survival of organizations (e.g., Amabile, 1988; Kanter, 1988; Oldham & Cummings, 1996; Shalley, 1995; Van de Ven , 1986; Woodman et al., 1993). Innovative behavior has been defined as an individual's behavior that aims to achieve the intentional generation, promotion, and realization of new and useful ideas, processes, products, or procedures within a work role, group, or organization (Farr & Ford, 1990; Kanter, 1988; Scott & Bruce, 1994; West & Farr, 1990; Woodman et al., 1993). Given this definition, innovative behavior is somewhat similar to creative behavior or creativity (i.e., the production of novel and useful ideas concerning products, services, processes, and procedures; Amabile, 1988). However, innovative behavior is clearly different from creativity, because this construct also involves the implementation of an idea (de Jong & den Hartog, 2010). According to Pieterse et al. (2010), creativity is a crucial element of innovative behavior, most evident in the beginning of the innovation process when problems are recognized and ideas are generated in response to a need for innovation (de Jong & den Hartog, 2010). Thus, innovative behavior includes both the generation and implementation of ideas.

Furthermore, innovative behavior is a largely discretionary behavior (i.e., extrarole behavior), and is not formally recognized by most current organizational reward systems3 (Ramamoorthy, Flood, Slattery, & Sardessai, 2005). Nevertheless, employees engaging in such behaviors might help their groups and organizations effectively achieve innovative objectives (Ramamoorthy et al., 2005). In this regard, innovative behavior has some similarity to organizational citizenship behavior (OCB) (Jafri, 2010). The main difference is that innovative behavior serves as a problem-solving approach used by employees to cope with intensified task requirements or to break down current organizational routines while OCB merely concerns helping others and moving beyond the normal expectations in the job (Robbins & Judge, 2009). As such, innovative behavior may help employees improve their fit with higher job requirements by creating, promoting, and implementing ideas (Janssen, 2000). In the next section, I will discuss a multi-stage process of innovative behavior.

3. Conceptual Framework

3.1 The Use of Abacus and Mathematic Learning

Hatano (1989) wrote that paper and pencil calculations are never taught at abacus juku, and that children never use an abacus for calculations in regular school mathematics classes. Hatano therefore called school mathematics and juku abacus learning "two microworlds of computation". In the microworld of elementary school mathematics, educators distinguish between calculations (keisan or) and mathematics. Paper-and-pencil calculations at school are called written math. Since both abacus and paper-and-pencil calculations have the same goal (a correct answer), we may presume that procedures learned at school and juku are related. Hatano concluded that "development of mathematical cognition can be conceptualized as a process of interaction between non-school and school math procedures", and that abacus learning has "limited instructional value" because it emphasizes proficiency (speed) over comprehension (conceptualization).

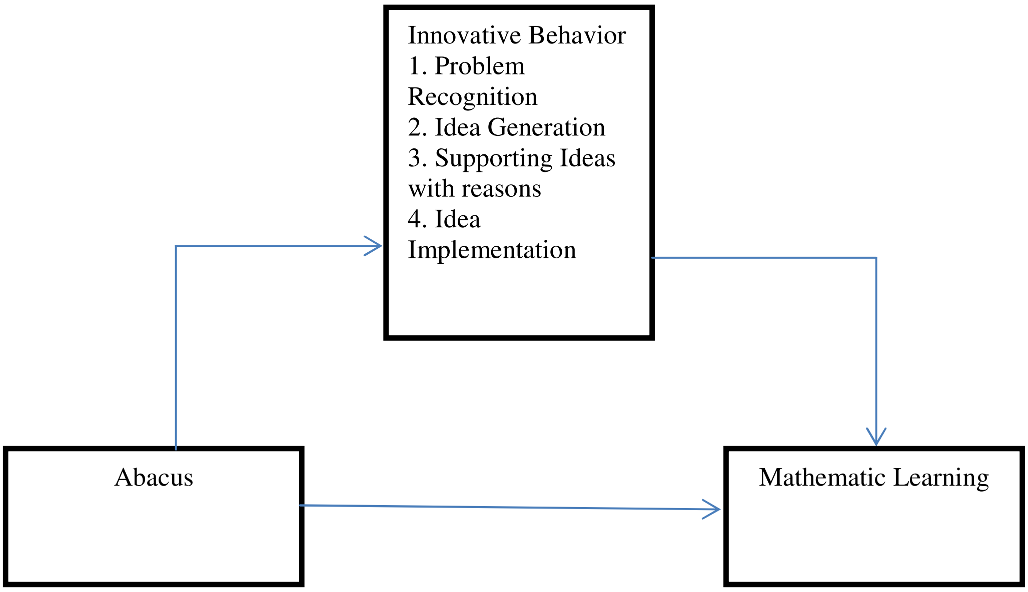
Previous research on the relationship between mathematics and abacus has focused on "skills." For example, Stigler, Chalip, and Miller (1986) concluded from their research on Taiwanese 5th graders that children studying abacus developed a "mental abacus" that changed their "representations of mental calculation". Specifically, they related abacus training to special conceptual representations of mathematical knowledge and to calculations skills. In another study in Taiwan, Miller and Stigler (1991) found that a higher level of abacus calculation skills resulted in formation of a mental abacus, and that abacus training changed children's reaction times in mental calculations. What is a "mental abacus?" It is a specific type of mental calculation when the individual imagines or visualizes rows of abacus beads while solving problems. Mental calculation itself can take various forms depending on the individual, e.g., visualizing actual numbers while making a calculation. Researchers, however, have not studied whether children who use a mental abacus exclude or downplay other forms of mental calculation or strategies.

3.2 Innovative Behavior Is A Multi-Stage Process

Innovative behavior is a multi-stage process of problem recognition, idea generation, building support for ideas, and idea implementation (Janssen, 2000; Kanter, 1988; Pieterse et al., 2010; Scott & Bruce, 1994). The scope of innovative behavior ranges from idea generation to implementation of new ideas that have an impact on products and processes across the entire organization. In addition, Dorenbosch, van Engen and Verhagen (2005) empirically suggested innovative behavior involving a multi-stage process, such as idea generation and idea implementation.

Individual innovative behavior begins with recognizing problems, which are frequently stimulators for the generation of novel and useful ideas. In this stage, employees explore new business opportunities and identify problems or performance gaps in existing products and services (de Jong & den Hartog, 2010). Secondly, problem recognition leads to idea generation, which is the production of ideas in any domain. Since idea generation involves activities of producing novel and useful ideas (Amabile, 1996; Woodman et al., 1993), this stage can be also understood as employee creativity per se (Pieterse et al., 2010). The third process of the innovative behavior consists of building support for ideas (Janssen, 2000). That is, once individuals have generated an idea, they have to engage in social activities to find colleagues, investors, and stakeholders surrounding an idea, or to build a coalition of supporters (i.e., CEOs), who potentially provide the necessary power behind it (Kanter, 1988). The final process of the innovative behavior involves idea implementation by producing a process, prototype, or model of the innovation that can be eventually applied within an individual work process, a group, or an entire organization (Kanter, 1988). Therefore, innovative behavior is viewed in this paper as a multistage process, with different activities and different individual behaviors required at each stage. Therefore, innovative behaviour in this study is measured by four stages namely recognition of problem, idea generation for the problem, support for the idea, and implementing the idea (Scott & Bruce, 1994).

Conceptual Framework



The conceptual frame work of this study suggests that abacus can influence on mathematic learning; in this regard, innovative behaviour which consists of four elements namely problem recognition, idea generation, supporting ideas with reason, and idea implementation might mediate the relationship between the use of abacus and mathematic learning.

4. Discussion

Research on attitude has a long history in mathematics education. The construct finds its origin in the field of social psychology in connection with the problem of foreseeing individuals' choices in contexts like voting, buying goods, etc. In the field of mathematics education, research on attitude has been motivated by the belief that 'something called "attitude "plays a crucial role in learning mathematics ' (Neale, 1969), but the goal of highlighting a connection between a 'positive' attitude and achievement has not been reached. Ma and Kishor (1997), after analyzing the correlation of attitude/achievement in 1 13 classical studies, underline that this correlation is not statistically significant: they explain this to be caused by the inappropriateness of the observing instruments that were used (in our opinion not related to attitude, but also to achievement).

The attitude construct gains renewed popularity with the re-evaluation of affect in the learning of mathematics: in the classification of McLeod (1992) it is considered together with beliefs and emotion one of the constructs that constitute the affective domain (De Bellis and Goldin, 1999) propose values as a fourth construct. Even if the meaning of the various terms is not always agreed upon, or made explicit (Pajares, 2005) there is consensus on the fact that emotions and beliefs deeply interact: as regards attitude, an emotional component is generally explicitly recognized in the construct, often together with a cognitive component, mainly identified with beliefs.

The lack of theoretical framework that characterizes research on attitude toward mathematics is partially shown by the fact that a large portion of studies about attitude do not provide a clear definition of the construct itself: attitude tends rather to be defined implicitly and a posteriori through the instruments used to measure it (Daskalogianni and Simpson, 2000). Research indicates that teachers' beliefs about mathematics and the teaching and learning of mathematics have powerful impact on their teaching, related their all knowledge structures (Ernest, 1989).

5. Conclusion

Teaching techniques in Iran, for example, have remained somewhat stagnant. This reality, coupled with the lack of employment opportunities for many educated Iranians, has resulted in a restive youth population and emigration of some of the best minds in the country (Torbat, 2002). The Ministry of Education also admits to a teaching shortage, particularly in secondary education, caused by a lack of interest in the profession. Other indications of liberalization in the educational system included a slight opening of opportunities for students to study abroad and the reinstitution of a private school system. By the year 2010, enrolment in private schools rose from 5 percent to 10 percent. The future of education in Iran is difficult to assess because the country continues to undergo cultural changes, although the Ministry's stated commitment to decentralization is promising. In this regard, this study considered the effects of using abacus on learning mathematic through innovative behavior in the elementary schools of Iran. In addition, this study presented innovative behavior as to realize problems, create ideas, provide support for the ideas, and implement the ideas (Bruce, 1994).

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