

A Study of Gardner's Theory of Multiple Intelligences in the Field of Elementary Mathematics Instruction

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Abstract: The accomplishments of Gardner's Theory of Multiple Intelligences in elementary mathematics instruction shows the scope of this theory in enhancing the efficiency of elementary mathematics instruction and the mutual effects of mathematics instruction on this theory's applications. Nowadays, the instruction system has been traditionally emphasizing mostly verbal and mathematical intelligence. Tests, assignments and teaching methods all support the verbal and mathematical intelligence and most of the unique talents and abilities of students in other fields are downplayed. Gardner believes that every person possesses different degrees of seven primary forms of intelligence including verbal, logical – mathematical, Bodily-Kinesthetic, visual – spatial, musical, intrapersonal and interpersonal, though Gardner himself introduces directly a separate intelligence for math. However, other kinds of intelligence are effective in teaching mathematical objectives. It seems that success in mathematics instruction requires the use of more types of intelligence.

Key Word: intelligence, multiple intelligence, learning, math instruction

INTRODUCTION

Nowadays, one of the concerns of instruction scholars in the broad area of learning is the issue of teaching and learning mathematics in the fundamental and critical period of elementary instruction. On the other hand, various theories of learning and intelligence in the field of instructional sciences, considering all its advantages and disadvantages, provide the ground from which methods and techniques of teaching-learning are extracted. Mathematics instruction as one of the main branches of theoretical sciences, has been able in the recent years to achieve much progress through the support of robust theories of learning and intelligence. One supporter theories is Howard Gardner's theory of multiple intelligences.

In cognitive psychology and Information processing approach, the relationship between intelligence and learning, thinking, problem solving and other cognitive processes are studied. As Stenburt remarks: "Intelligence consists of a series of thinking and learning skills used in solving academic and life problems" (Sharifi, 2005).

The viewpoint of instruction experts regarding the three subject areas of instruction, math learning and Gardner's theory of multiple intelligences guides us in this investigation.

Howard Gardner, the contemporary psychologist, giving a definition of intelligence for the first time based on the fact that intelligence is an ability to create an effective product or valuable service in a culture and hence challenging the traditional conception of intelligence, categorized eight different species of intelligence. These categories include: verbal-linguistic intelligence, logical-mathematical intelligence, visual-spatial intelligence, bodily-kinesthetic Intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence and naturalistic intelligence (Gardner, 2004).

Nowadays, the instruction system has been traditionally emphasizing mostly verbal and mathematical intelligence. Tests, assignments and teaching methods all support the verbal and mathematical intelligence and most of the unique talents and abilities of students in other fields are downplayed. (Nirou, 2012)

According to Gardner, the students tend to understand in ways to which their cognitive traits are disposed. Teachers can allow students to explore a variety of ways to learn and discover. They can guide students toward self-study (Azarfar, 1386).

Since Gardner has not suggested a specific curriculum or a special instruction system, so there are numerous ways in which the theory of multiple intelligences can be applied in the classrooms and schools depending on the creativity and group-effort. There are different school curriculums that apply the theory of multiple intelligence in teaching students and this is one, among many, of the remarkable features of the theory of multiple intelligences, which does not confine teachers to the use of a specific program or special instruction (Hoerr, 1996).

At the present time, the instructing society needs to apply certain skills in providing, problem solving, data interpretation, data organization, measurement, prediction and applying mathematics to everyday problems. The changes needed in society, density and outburst of quantitative data, and access to computers and computing machines have urged a new definition of priorities in the field of basic math skills. (Husseini, 2012). In the current situation, mathematics instruction moves in line with the descriptive evaluation system in Iran and works interactively with it.

Descriptive evaluation system is an instructional approach based on which the necessary, reliable and documented information is obtained for an accurate and comprehensive recognition of the students in different aspects of learning using appropriate tools and techniques such as folders, tests (with an emphasis on performance test) and observations during the teaching-learning process so that based on them, the descriptive feedback required to help improve learning and teaching in a desirable mental and emotional atmosphere for the students, teachers and parents can be attained. (Hamzehbeigi et al, 2013)

Thus, the present article seeks to extract and explain the accomplishments of Gardner's Theory of Multiple Intelligences in elementary mathematics instruction and meanwhile to provide approaches for a rational and more desirable use of Gardner's multiple intelligence theory in the field of elementary mathematics instruction.

The concept of intelligence and learning:

Basically, the idea of IQ is based on the concept of intelligence. Intelligence can be seen as the ability to learn, to achieve academic levels, and to assume leadership roles in the society. Anesthesia scientists, (like William Stern) who is among the developers of this theory in the early twentieth century, claim that the core of intelligence is innate. Most of the psychologists in U.S and Europe have supported those results as well as the psychologists such as the psychology of

Binet and Terman who have designed certain tools Innate Intelligence Test for individuals. These tools have been analyzed using the latest statistical techniques such as factor analysis developed by Thurstone and Spearman. The analysis suggests that all of the tests measure a key factor called G or general intelligence. This theory states that people have a basic general intelligence which predicts the way individuals learn and deliver what they have learnt in the school (Hashemi, 2012). Considering that the objective of instruction is to facilitate learning, learning can be defined as information processing and gaining new skills or discovery and intuition that affects the behavior. The effect of learning is usually stable on behavior and effects a change in the individual's experiences. Sometimes, learning is used as synonymous with acquiring which comes out of cognition. Learning may be individual or social and group-based giving it a special color. In any event, all learning, be it simple and complex, major and minor, visible and invisible, theoretical or practical leads to a change in the person and realizes his/her latent talents and engenders various abilities in him/her. In this respect, learning can be thought of as getting power from the energy latent in the information which may be observed in the individual's vision, thinking, or behavior. Nonetheless, learning and behavior should not be treated alike and any kind of learning should not be thought of as synonymous with a simple change of behavior (Afzal Nia, 2005).

Gardner's multiple intelligences:

Gardner believes that every person possesses certain degrees of the seven primary forms of verbal, logical – mathematical, bodily-kinesthetic, visual – spatial, musical, intrapersonal and interpersonal intelligence. After the introduction of the seven intelligences mentioned above, Gardner makes mention of another intelligence called naturalistic intelligence which is an ability of the natural world. The idea behind this theory is that every person possesses each of the proposed types of intelligence at a certain degree which is effective in their instruction (Ranjbari et al, 2013).

In this section, three points are important:

1. In the literature, the terms furnished to explain Gardner's theory are different but their general concept is the same and the change of words in the literature does not undermine the essential foundation of the theory.
2. Howard Gardner has mentioned naturalistic intelligences in completion of his theory of intelligence, which is not counted among the seven types of intelligence and alike concepts existing in the literature.
3. Individuals have a relative superiority in one of the multiple categories of intelligence. For example, it is likely that a person is very successful in the field of sports (Bodily – kinesthetic intelligence), but his success in music (musical intelligence) is very small.

Indicators and objectives of elementary mathematics instruction:

Throughout the descriptive evaluation principles, the indicators and objectives in mathematics instruction have been mentioned for the six grade of elementary school, which are as follows for respective grades:

Indicators and objectives of first-grade math:

Row	Indicators	Objectives
1	Positioning	Understanding and recognizing directions and the spatial position of objects and shapes
2	Concept of number and its symbol	Understanding the numbers 0 to 10 and their symbols
3	Counting	Understanding the concept of ordinal numbers and counting them in groups
4	Two-digit numbers	Using unit-decimal Tables and counting numbers from 1 to 100
5	Comparison of numbers	recognition and display of equal and unequal categories
6	Addition and subtraction	Understanding the concept of addition and subtraction, and finding the sum and subtraction
7	Problem-solving strategies	solving problems through guess and testing strategies, sub-problem and systematic thinking
8	The wonderful square	Completing wonderful squares (Sudoku)
9	Problem solving	Solve a one-target problem
10	Using tools	Using non-calibrated ruler and stencil
11	Geometry	Recognition of geometric shapes, understanding geometric the components of geometric shapes and understanding the relationship between shapes in geometric pattern
12	Symmetry	Understanding the concept of symmetry
13	Measuring	Understanding measurements of items such as time, length and mass
14	Statistics and charts	Drawing column charts and enumerating them, enumeration using a tally

Indicators and objectives of second-grade math:

Row	Indicators	Objectives
1	Counting	Expression of two-digit and three-digit numbers
2	Understanding two-digit and three-digit numbers	Understanding the place of the digit in a number and spatial value
3	Comparison of numbers	Understanding how to compare two-digit and three-digit numbers
4	approximate numbers	Gaining the skills in approximating two-digit and three-digit numbers
5	problem solving strategies	solving problems through strategies such as shape drawing, pattern making, pattern-finding, eliminating undesirable states, guessing and testing, sub-problem, simpler problems, and symbolization
6	process addition and subtraction	Understanding the concept of addition and subtraction from left
7	technical addition and subtraction	Understanding the concept of addition and subtraction from right
8	Multiplication	Understanding the basic concept of multiplication
9	Symmetry	Understand the symmetry of the two halves and four parts
10	geometrical shapes	Introduction to geometric shapes and comparing them
11	Measuring	Understanding measurement of items such as time, length and mass
12	Statistics and Census skills	Gaining skills in collecting and comparing data and showing them on a tally
13	Drawing charts and graphs	Learning different types of graphs and charts
14	concept of fraction	Understanding the concept of fraction
15	concept of probability	Understanding the concept of probability

Indicators and objectives of third-grade math:

Row	Indicators	Objectives
1	Counting	Skills in counting five-digit numbers
2	four-digit numbers	Understanding the four-digit numbers and gaining the skills for reading and writing them
3	approximate numbers	Gaining the skills in displaying the numbers on the axis in an approximate manner
4	fraction	Understanding fraction and fractional numbers.
5	Comparison of the fraction	Gaining the skills in comparison of fractions
6	Addition	Gaining the skills in adding four-digit numbers
7	Subtraction	Gaining the skills in subtracting four-digit numbers
8	Multiplication	Understanding the concept of multiplication, the relationship between multiplication and addition and Gaining the skills in multiplying one-digit numbers in one-digit numbers
9	Division	Understanding the concept of division and its relationship with multiplication
10	spatial geometry	Understanding spatial shapes, cubes and Rectangular cubes, cylinder and cone
11	Plane geometry	Understanding concepts such as circles, angles, types of lines, polygons, symmetry patterns and their components
12	Measuring	Understanding measurements such as length, area, mass, time, and value of money
13	Statistics	Gaining skills in organizing and analyzing data, drawing pie chart graphs, and converting charts into one another
14	Probability	Gaining skills in anticipating possible states of an event
15	problem-solving strategies	Gaining skills in using strategies such as figure drawing, modeling, sub-problem, pattern-finding, simpler problems, symbolization, guessing and testing, and elimination of undesirable states

Indicators and objectives of fourth-grade math:

Row	Indicators	Objectives
1	Number and spatial value	Understanding 7-to-12-digit numbers
2	Comparison of numbers	Gaining skills in comparison of numbers up to 12 digits
3	Addition and subtraction	Gaining skills in adding and subtracting numbers up to 12 digits
4	Multiplication	Gaining skills in multiplication of multi-digit numbers in multi-digit
5	Division	Understanding the concept of division and divisibility
6	proper fraction	deepening our understanding of fraction
7	Geometry	Deepening our understanding of concepts such as types of lines, angles, polygons, parallel and perpendicular lines, and symmetry
8	Measuring	Understanding the concept of capacity and measuring values of liquids (liter)
9	Statistics and data collection	Gaining skills in collecting and interpreting information

Indicators and objectives of fifth-grade math:

Row	Indicators	Objectives
1	operations on numbers	Understanding and gaining skills in proper fraction, mixed integer, decimal fractions, decimal numbers, complex numbers, divisibility, comparison of common fractions, comparison of mixed numbers, comparison of decimal numbers, addition and subtraction of fractions and mixed numbers, addition and subtraction of decimals, addition and subtraction of complex numbers, estimates, approximate multiplication, multiplication in mind, multiplying fractions and multiplying mixed numbers, multiplication of decimals, division of fractions and mixed numbers, ratios, proportions, and percent
2	Geometry	Gaining skills in identifying and drawing symmetry line, calculating area, building geometric objects, angle, drawing a triangle, calculating volume, circle.
3	Measuring	Gaining skills in measuring length, mass, area, volume and capacity
4	Statistics and data collection	Gaining skills in calculating the grade point average (mean)

Indicators and objectives of sixth-grade math:

Row	Indicators	Objectives
1	Number	Understanding fraction larger than the unit and mixed numbers, decimals, integers, and approximate numbers
2	operations on numbers	Gaining skills in comparing fractions, doing four main operations on fractions and mixed numbers, doing four main operations on decimal numbers, approximate calculation, priority sequence of operations, and approximating methods
3	Measuring	Understanding the necessity and concept of length, angle, area and volume
4	Ratio, proportion, percent	Understanding the concept of ratio and proportion and their application
5	Statistics and probability	Gaining skills in collecting and recording data and understanding the concept of probability
6	Coordinates	Understanding the coordinates, the notion of symmetry and rotation, and axis
7	Problem solving	applying problem-solving strategies

(Hamzehbeigi et al, 2013)

Achievements of Multiple intelligence in Elementary Mathematics Instruction:

Achievements of Gardner's Multiple intelligence in Elementary Mathematics Instruction shows the scope of this theory in enhancing the efficiency of elementary mathematics instruction and the mutual effects of mathematics instruction on this theory's applications. To avoid prolixity, we pursue the discussion of the topic (the promotion of efficiency in elementary mathematics instruction). The investigation of the relationship between the seven types of intelligence in Gardner's theory and the general indicators of math instruction illuminates the use of Multiple

intelligence theory by elementary math instruction experts in codifying objectives and elementary math instruction curriculum in Iran.

Investigating the tables of indicators mathematics, the general topics of mathematics instruction, and the seven categories of Gardner's multiple intelligence, the following relationships are extracted:

Row	Types of multiple intelligence	Topics and indicators of elementary math instruction
1	logical – mathematical	counting and calculation of the symbolized equations
2	Verbal	Enumerating geometric features and expressing in the classroom
3	visual – spatial	spatial geometry and Plane geometry
4	musical	-----
5	Bodily-Kinesthetic	Building geometric objects
6	interpersonal	Dialogue and problem solving in groups
7	intrapersonal	Using individual problem-solving strategies

Conclusion

Although Gardner directly introduces a distinct intelligence for his mathematics, however, as seen in the table above, other kinds of intelligence are effective in teaching mathematical objectives, too. It seems that success in mathematics instruction requires the use of more types of intelligence. This issue has been proposed by some mathematics instruction experts in the field of multiple senses (instead of multiple intelligences). They believe that a mathematical concept is better taught when the more senses in the student are involved.

Based on the above discussions, as well as deficiencies in elementary mathematics instruction in Iran, the following strategies are proposed to improve mathematics instruction from the perspective of the theory of multiple intelligences:

1. Efforts must be made to present mathematical topics with less distinction so that the defect in a certain intelligence in the student may hurt the mathematical objectives less
2. Efforts must be made to call into attention the types of intelligence that are left untouched in instructing mathematics and other lessons. For example, people's musical intelligence is never formally addressed in Iran.
3. Gardner's theory of multiple intelligences should be used for clearer formulation of the objectives of elementary mathematics.
4. In formulating the objectives of mathematics, its relationship with the objectives of multiple intelligences should be stated directly to reduce different interpretations on behalf of the curriculum planners and thereupon more progress is made in mathematics instruction
5. One should not put aside the other types of intelligence only because the theorist of this theory has proposed logical-mathematical for mathematics
6. Achievements of Multiple intelligence in Elementary mathematics instruction should be scientifically and accurately reported to experts for feedback.

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