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STUDENT LEARNING, CHILDHOOD & VOICES | RESEARCH ARTICLE

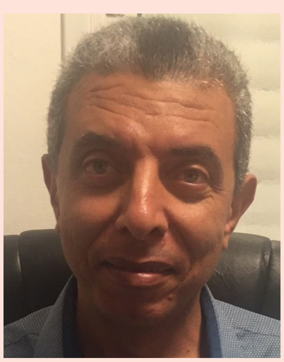
Creativity in unique problem-solving in mathematics and its influence on motivation for learning

Saied Bishara[1*]

Abstract: This research study investigates the ability of students to tackle the solving of unique mathematical problems in the domain of numerical series, verbal and formal, and its influence on the motivation of junior high students with learning disabilities in the Arab sector. Two instruments were used to collect the data: mathematical series were checked by "The Working Paper for Challenging Problem Solving in Mathematics" and the motivation for learning by the questionnaire entitled "The Student's Motivation for Learning". The research involved 50 students with learning disabilities integrating in five regular education classes in junior high schools. The findings fully supported the hypothesis, as well allowing a second hypothesis to arise. It is recommended to use a challenge in the field of mathematical tasks, as the present study found that the use of these contents may contribute to improving the level of motivation for learning, and as a result has implications for a variety of pedagogical realm-contracting effects, such as reducing the phenomenon molt, promoting student achievement, and improving social relations.

Subjects: Development Studies; Education; Mathematics & Statistics

Keywords: creativity in unique problem-solving in mathematics; motivation for learning; students with learning disabilities



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Saied Bishara finished his doctorate at Bar Ilan University specializing in learning disabilities and special education. He works in several colleges and the Open University in Israel. He is currently the head of the Special Education Department at Beit Berl College. He has published studies concerning literacy and math ability of students with learning disabilities.

PUBLIC INTEREST STATEMENT

This research study investigates the ability of students to tackle unique mathematical problems in the domain of numerical series, verbal and formal, and its influence on the motivation of junior high students with learning disabilities in Arab schools in Israel. Two instruments were used to collect the data: mathematical series was checked using "The Working Paper for Challenging Problem Solving in Mathematics" and motivation for learning was examined by the questionnaire entitled "The Student's Motivation for Learning". The research involved 50 students with learning disabilities integrated in five regular education classes in junior high schools.

The findings fully supported the hypothesis, and suggest a second hypothesis. It is recommended to use challenging tasks in mathematics for students with learning disabilities as they may contribute to improving the level of motivation for learning. The results have implications for a variety of pedagogical outcomes.

1. Introduction

Mathematics is perceived as one of the hardest subjects in school since one has to cope with a variety of topics, such as verbal questions, illustration by mathematical representation, and understanding of connections between concepts. In mathematics, one has to master the basics perfectly in order to be able to advance to higher levels (Hirst & Hughes, 2015). The new mathematics curriculum (Ministry of Education, 2006) emphasizes both outcomes and modes of thinking. Therefore, mathematics is not just a rigid subject that requires one solution and one way of solving, but a subject with a broader scope that enables a combination of algorithmic-convergent and creative-divergent task performance.

This is the source of the importance of motivation for learning, which is a consistently planned and directed process for the reaching of a specific solution (Mymon, 2008; Pintrich & de Groot, 1990).

This study investigates the creativity of students to solve unique mathematical problems and its connection with the level of motivation for learning among junior high school students in the Arab sector.

Given the missing information on unique characteristics of the teaching of mathematics and their connection with the motivation for learning of junior high school students with learning disabilities in the Arab sector, this program deals with the definition of creativity in unique mathematical problem-solving, and checks the connection between creativity and motivation for learning among students with learning disabilities. Defining the differences in the characteristics of creativity in solving unique problems may allow a better understanding of the relationship between institutional components and achievements of students and more efficient planning of the curriculum.

The purpose of the study is to measure the ability of students to cope with unique, challenging problem-solving in the field of numerical, verbal, and formal series and the link with motivation for learning in junior high schools in the Arab sector.

2. The teaching of mathematics: means and approaches

Mathematics is perceived as a tricky, tedious, and boring subject by almost everybody from the beginning of their school life. The reasons for these difficulties and the lack of interest stem from the specific type of subject and the ways of teaching. The teaching of mathematics to children with learning disabilities is particularly difficult and the need to teach the required content according to the curriculum is a difficult task and therefore, the need to use extensive visual aids and adapted teaching methods to facilitate the learning of the material required by the curriculum designed by the Ministry of Education (Gazit, 2000; Geary, 2004).

The mathematics curriculum of the Ministry for elementary school is structured in a hierarchic manner from first to fifth grades.

(1) Acquisition of terms and structures in arithmetic and geometry.
(2) Development of required skills in each of the subjects (arithmetic and geometric insights, mastery of mathematical skills, solution of verbal problems, coping with investigation tasks, understanding attributes and connections of the terms, and knowing the mathematical language and using it correctly).
(3) Preventing failure and a sense of failure and making the students like the subject. In order to generate success, one has to take into account the functioning of the child in different mathematical topics, as well as in other subjects. It is important to know whether the child has failed in all subjects or only in one. This piece of information can help understand the sources of his difficulties, (Gazit, 2000; Kashti, Arieli, & Shlansky, 1997).

The findings about the level of achievements being the lowest in the world raised many questions: How can new teaching technologies become incorporated in the teaching of mathematics? How can the applied practical nature of mathematics be emphasized? Mathematics is one of the most important subjects in school from kindergarten to high school, and it is obligatory for the acquisition of the Matriculation Certificate (Eylon & Linn, 1988; Fischbein, 1997; Kashti et al., 1997; Ministry of Education, 2006).

In the United States, beginning in 1920, there were five approaches to teaching mathematics: practice and training approach (1920–1930), focusing on developing computational capability through repetition; significant teaching approach (1930–1950), which advocated the development of an understanding of the concepts and procedures; new mathematical approach (1960–1970), emphasizing the formal structural aspects of mathematics; access to sources of return (1970–1980), which focused on mastery learning basic skills; and problem-solving approach (1980–1990), which tried to develop the learner's ability to describe a problem using a mathematical model which can be solved. Changing approaches to teaching mathematics was due to a lack of satisfaction with the level of achievement. The findings regarding the low level of achievement raised many questions, including how to integrate new educational technologies in teaching mathematics and how to emphasize the practical and functional nature of mathematics (Geary, 2004).

3. Creativity in mathematical solutions

Creativity in education deals with fluency, flexibility, new connections, imagination, use of means, and questioning. Creativity is a way of learning that enables the learner to make connections between unrelated elements, identification of important problems, asking questions that stem from curiosity, open to new ideas, reluctance to accept regular norms, along with flexibility and originality, new categorization, and organization of those norms.

Creativity in mathematics is expressed through the following: new formulation of non-complicated problems, discovery of ways and means to their solution, and discovery of original methods of solution to unusual problems. One of the ways of creating situations of original thinking is to present the students with open questions that require creative thinking and allow more than one possible answer. For instance, instead of asking "How do we divide 12 apples in 3 bowls equally?", and the algorithm is unequivocal, we can say, "How do we divide 12 apples among a number of bowls?"; there is more than one answer, and the student will have to make assumptions before choosing the right answer from different answers (Yee, 2005).

Problem-solving is at the core of mathematics; it includes also solving of exercises which are not based on an algorithm. Littlewood (1953) said that a good mathematical riddle is better than a dozen mediocre exercises. A mathematical riddle is a challenge to the mind and humans seek challenges and enjoy coping with challenges. This statement is even more justified for learning disability students who need maximum encouragement and support.

4. Mathematical problems, both unique and routine

The presentation of an unconventional problem enables the testing of the student's ability to apply the material on a level that is not the usual algorithm and procedure practiced in class. According to Gazit (2004), the use of an enigma or a challenging problem in class will not only enhance the thinking process, but will also increase motivation and interest of the students on all levels. Therefore, the purpose of dealing with extraordinary problems (Giron, 2009) is focus on the process of solution and the broadening of the points of view of the students for mathematical topics and ideas by the means of:

(1) Problems with a variety of possible solutions.
(2) Problems that enable extraction options and encourage methodical solutions.
(3) Problems that enable the discovery of a pattern.

(4) Problems that have not been studied in class directly.
(5) Problems that encourage the finding of multiple solutions.

According to Nevo (1997), the creative process is imperceptible; one can only guess about its existence from the solution. It is easier to point out what the process is not. From this point of view, the creative process is not identical to the regular thinking processes or to systematic ways of acquiring knowledge. In the next chapter, ways of solving challenging problems in mathematics will be presented.

5. Motivation for learning among students with learning disabilities

Motivation is important to all children of all ages and all levels. It is divided into:

(1) Intrinsic motivation, which includes curiosity and mastery, and self-perception as a person of efficacy for learning.
(2) Extrinsic motivation, which includes the need for social recognition and for receiving feedback and help from the teacher (Ben-Tov, 2000).

Motivation for learning is a process that arouses, directs, and preserves a behavior for the achievement of a special goal (learning), and it reflects the complex reasons that cause one to act in a certain way in a given situation. Thus, students endowed with motivation for the learning of mathematics are driven by the need to achieve the goal, such as understanding the learning material and answering the questions. Research studies show that students who set themselves goals of mastery of the material perceive the task as interesting, challenging, and important; tend to engage in meta-cognitive activities to adopt more cognitive strategies; and invest more efforts into tasks (Mymon, 2008; Pintrich & de Groot, 1990).

A learning disability, according to the definition of the Israeli Ministry of Education (Ministry of Education, 2004), is based on NJCLD, 1994, and includes two diagnostic conditions:

(1) There is a significant gap between the student's learning achievements and those expected from him according to his age and class level.
(2) There is a significant gap between the student's learning achievements and his objective intellectual achievements from his IQ tests.

Thus, the accepted definitions, including those of the Ministry of Education, are based on two kinds of gaps: the first is the gap between the actual achievements and the ones expected from the student according to his age and the level of his class. The expected achievements are detailed in the curriculum. Therefore, the diagnosis must be based on the mathematics curriculum. In the absence of a validated and standardized diagnosis, one must use an informal diagnosis based on the way and the extent to which the student fulfills the general and specific goals of the curriculum according to the level of his class.

The second gap mentioned in the definition is between achievements and ability. However, there is ongoing criticism against this parameter (Eylon & Linn, 1988; Fischbein, 1997; Geary, 2004). Moreover, passing an ability test to every student with difficulties seems unrealistic and unnecessary from the point of view of the process of decision-making for the optimal way of helping the student progress in his studies.

It is important to emphasize that there is a lack of accurate tests, tests that would assess the level of knowledge of the student with learning disabilities in each and every topic. In any case, a student with learning disabilities must first be assisted to acquire the basic material and only later, if possible, to acquire the higher level of the material (Avisar, 2004).

The findings of this study refer to a population of students with learning disabilities that study in mixed classes of regular education who can cope with certain topics of the mathematics curriculum. The importance of the research study stems from investigating quality teaching that uses challenging problems in mathematics; this approach can improve the self-image and motivation of students with learning disabilities, and the teaching of mathematics can greatly benefit from it (Avisar, 2004).

6. Creativity in the solving of unique mathematical problems and motivation for learning of students with learning disabilities

Difficulties in the teaching of mathematics are not a new thing and have been at the forefront for many years. However, it can be taught even to a child with learning disabilities. Slow progress can be due to lack of developmental stimuli, low motivation for learning, speech impairments, slow reactions, etc. (Bulotsky-Shearer & Fernandez, 2011).

Children with learning disabilities need special teaching methods that would enable location and implementation of suitable didactic ways that would help repair the disability or reduce its damage. The use of active learning in the teaching of mathematics, according to selected topics, enables the ability to perform operations from memory, mechanical operations, and problem-solving. This approach also strengthens the student's self-image, and the processes of friendship and relations with others (Berg, 2000).

Recently, there is an increase in the awareness of the needs of students with learning disabilities in Israel. The expression of this tendency is in comprehensive diagnostic testing and in helping with coping with tests according to the results. There is also a need to concentrate the energies of pedagogical and assisting teams in schools to cooperate and to try to cope with the most difficult cases among the students (Clements, 2000; Hirst & Hughes, 2015).

The presence of students with learning disabilities in a regular class makes it heterogeneous and problematic. Teachers from the general education are not equipped with tools and do not have the training to cope with special education children, things that might leave each of these children with their own problems.

Contents in mathematics are identified with hard rules, terms, and principles, and the students are required to remember rules, principles, terms, ways, comparison, relations, theorems, and formulae even if they cannot understand them. Therefore, in order to be able to cope with rules and formulae, they must remember a lot; otherwise, they will have difficulties to progress through the extensive material. On the other hand, a child defined as needing special education with learning disabilities has different characteristics from any other child in society: some have visual-spatial deficits, some have problems with hearing processing, memory problems, motor and language deficits, social and emotional, cognitive, and meta-cognitive difficulties. These characteristics make the study of mathematics harder for the child with learning disabilities, hence the importance of unusual teaching approaches that include challenges in mathematical tasks in order to simplify and suit the teaching material to the special students and increase their motivation (Berg, 2000).

Inclusion of creativity in unique mathematical problem-solving might simplify the acquisition of the learning material for the student and enhance understanding and internalization. It is impossible to teach topics such as fractions, percents, and geometric forms without the help of suitable aids that enable illustration and solutions. The teacher must create a learning environment that supports and encourages the student according to his abilities (Kashti et al., 1997).

As mentioned before, the level of creativity in unique mathematical problem-solving is closely related to motivation for learning. Motivation for learning is the force that arouses and pushes the student toward the achievement of his goal. That is why he has to behave adequately and purposefully, persistently, and continually (Mymon, 2008; Pintrich & de Groot, 1990).

In conclusion, many educational aspects are hidden in the teaching of mathematics to special education children. In addition to the variance in the characteristics of special education students, there is also the issue of the various environmental factors that influence the teaching of mathematics to students with learning disabilities, hence the need to establish what methods will bring the best results within the shortest period of time. This study will investigate the method of creativity in unique mathematical problem-solving and its relation to the increase of motivation for learning among students with learning disabilities in junior high schools in the Arab sector in Israel, things that will contribute also to the improvement of results in the acquisition of mathematics. We may presuppose that the use of creativity in unusual mathematical problem-solving will cause a rise in the levels of motivation for learning and in the improvement of students' achievements (Agran & Wehmeyer, 1999; Avisar, 2004; Bishara, 2005; Margalit, 2003).

7. Methodology

7.1. Hypotheses

(1) Differences will be found in solutions to unique mathematical problems between number series and non-number series, such as letter series and geometric series, among students with learning disabilities.

(2) A positive relation will be found between the quantity of correct solutions to unique mathematical problems and the level of motivation for learning of the students with learning disabilities.

7.2. The participants

Five mixed seventh-grade junior high school classes were sampled randomly from a large number of junior high schools. Each included approximately 10 students with learning disabilities who studied together with regular students. Hence, the sum total of the sample was about 50 students from the junior high school population in the Arab sector. Participation consent was obtained by writing to the students' parents to agree to their children to participate in the study. Children's parents who refused aren't involved in the study.

All the students who were diagnosed with learning disabilities study in various regular junior high school institutions in the central area in the Arab sector. They are all within the normal range of intelligence, but have difficulties with carrying out or finishing tasks. These children suffer from memory, understanding, and carrying out directions difficulties. They display problems of orientation in space, directions, and spatial relationships. In the language skills aspect, their vocabulary is poor and limited; they know letters and short words, but do not master the combination table (compound nouns, prefixes and suffixes, etc.). They have difficulties with expressing themselves orally and in writing; they are impulsive in their answers and actions. In mathematics, they master the addition and subtraction operations, but have difficulties with multiplying and division. They also find abstract thinking and solving verbal problems difficult, as well as terms of measurement and quantity. The socioeconomic background of the subjects' families is average; most of their mothers are homemakers and their fathers earn an average salary.

The socioeconomic condition of these pupils was middle class. Their mothers were mostly housewives and their fathers were employed in jobs that paid an average wage. The participating pupils were assessed as LD pupils. Cognitively, these pupils were within normal range in terms of their thinking ability but demonstrated difficulty with attention and focus, easily distracted, and slow in executing and completing tasks. Language wise, their vocabulary was limited; they identified letters, reading short words, but made distinctive spelling errors. In math, they mastered the four basic operations: addition, subtraction, multiplication, and division and were also proficient in the decimal structure of numbers. At the same time, in spite of their proficiency with the multiplication and division rules, they demonstrated difficulty executing calculations connected with these basic proficiencies. They also had difficulty with abstract thinking and in solving word problems.

7.3. Research tools

The data were collected via two tools: a worksheet with challenging problems in mathematical series (Hakim & Gazit, 2011) and a questionnaire entitled "Motivation for Learning to the Student" (Roeser, Midgley, & Urdan, 1996).

7.3.1. The worksheet for solving challenging problems in mathematics

The worksheet for solving challenging problems in mathematics is taken from the research study of Hakim and Gazit (2011); it was based on the worksheet that served Gazit and Patkin (2009) research study.

The worksheet (Hakim & Gazit, 2011) includes five challenging unusual problems from the domain of mathematical series, which are intended to test the ability of students to solve unique mathematical problems. The students were requested to fill in the next number in the blank (a $n + 1$) of each series. They were also given the option of drawing or writing the answer with words.

The five series were divided into four types:

(1) Numerical series which are neither arithmetic nor geometric:

The first series: 1, 3, 7, 15, 31, ____

The next number is 63. This is a series where the differences between parts grow twice as the series proceeds (2, 4, 8, 16 …). On the surface, the problem looks simple, but it requires changing patterns of thinking and looking for another model of relations between numbers.

(2) Numerical series:

Second series: 1, 3, 4, 7, 11, ____

The next number is 18. It is a series in the style of a Fibonaci series, when each part is equal to the sum of the two numbers before it. In this series, one can calculate the differences like in the first one, and check if there are differences between two following numbers, starting from the second and the third numbers, equal to the previous number. However, in contrast to the previous series, the difference between the first and the second numbers is not important, only the addition of each two numbers that equals the next ($1 + 3 = 4$; $3 + 4 = 7$; $4 + 7 = 11$; $7 + 11 = 18$). Here too, breaking old thinking patterns is necessary.

(3) Letter series:

Third series: S, M, T, W, T, F, ____

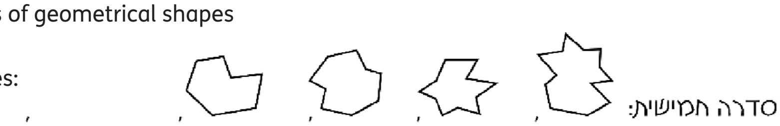
The next letter in the series is "S". The letters are the initials of the days of the week: Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. This is an unusual series because it doesn't deal with numbers. There is only one solution, but the series requires to change thinking habits related to numeric series and to look for a pattern suitable for letters. We need to think associatively on a high level, and even bi-associatively, in order to find remote connections, and this is identified with creative thinking.

(4) Series that combines geometrical forms with words:

Forth series: Circle, Ellipse, Parallelogram, Rhombus, ____ The next shape should be anything with a letter that follows after "R" in the alphabet (such as square or trapeze). This is not a usual series either because it is formed of geometrical shapes and their names. It requires divergent thinking that seeks new patterns of relations between shapes and words. In addition, this series has several possible answers that enable fluency, variety, and originality, which are features of creativity.

(5) Series of geometrical shapes

Fifth series:



The next shape has five sides because the number of sides decreases by 2 from one to the next. This series is unusual because it contains shapes and not numbers, but it has still got a numerical component. But the series demands the discovery of a pattern that is not mentioned explicitly.

7.3.2. The questionnaire of motivation for learning to the student

The questionnaire of motivation for learning to the student (Roeser et al., 1996) was processed for Hebrew by Mevarech, Kremersky, and Ritz (1997). The questionnaire is composed of questions based on mastery of tasks and questions based on performance level of avoidance or approaching. The questionnaire includes 17 questions that check motivation for learning on a five-point Likert scale (1 = disagree; 5 = agree).

In the test of reliability of internal consistency (Cronbach's alpha) that was carried out for the present study for the 17 items of the scale in general and for the three sub-scales of the test of motivation for learning, the scales were found reliable: general scale (items 1–17), (Alpha = 0.76), mastery of tasks (items 1, 4, 7, 10, and 15), (Alpha = 0.58), performance—avoidance, (items 9, 12, and 13) (Alpha = 0.62), and performance—approaching, (items 8, 11, 14, and 16) (Alpha = 0.58). A number of items were taken out of the avoidance and the approaching scales in order to raise the alpha values.

Based on these findings, grades were calculated for every student, one for every item, one for the general scale, and three grades for the sub-scales. The grades were calculated by working out the average of every item included in each category. The range of the grades of the measures is between 1 and 5 and the higher the grade, the higher is the motivation for learning.

7.4. Procedure

The study was conducted during the 2014–2015 academic year in five mixed classes of seventh grade, that include students with learning disabilities, in junior high schools in the Arab sector in the center of Israel. The researcher visited each school separately and approached the students by first asking them to solve the worksheet of series and then to fill out the motivation for learning questionnaire.

8. Findings

In order to check the relation between creativity in unique mathematical problem-solving and the level of motivation for learning among students with learning disabilities of junior high school mixed classes in the Arab sector in Israel, averages, standard deviations, Cochran's *Q* test, and Pearson values were calculated (Figure 1).

8.1. Differences in unique mathematical problem-solving between numerical series and non-numerical series

The first hypothesis was that there would be differences in the solving of unique mathematical problems between numerical and non-numerical series, such as letter series and geometrical series. Table 1 shows averages and standard deviations for the correct answers on the five series.

Figure 1. Creativity as a means of solving unique problems and motivation for learning.

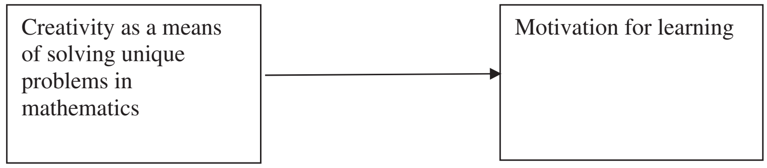


Table 1. Averages and standard deviations for each series separately (*N* = 50)

Number of the series	Type of series	Average	Standard deviation
1	Numeric	0.84	0.37
2	Numeric	0.92	0.27
3	Verbal	0.52	0.50
4	Verbal	0.66	0.48
5	Geometric	0.76	0.43

Notes: For each series, grade 1 means correct and 0 means fail. Therefore, the average number represents the extent of correct answers (for example, 0.84 = 84% of correct answers).

The averages of the numerical series 1 and 2 show a very high level of performance (0.84 and 0.92); in contrast, the verbal series, 3 and 4, show low results (0.52 and 0.66); the formal series, 5, presents average performance level (0.76).

In order to check whether the correct answers divide up equally, a Cochran's *Q* test was performed. This non-parametric test compares the division in dependent samples. This test checks whether the division of values is identical in dichotomy-dependent variables. The test is also suitable for binary variables, where number 1 means success and 0 means failure.

The findings indicate that, as hypothesized, there is a statistically significant difference among the division of values in the five series. Cochran's Q (4) = 27.73 $p < 0.001$.

In order to find out the source of the difference, a series of McNemar tests were conducted between pairs of dependent samples.

The findings showed significant differences between 4 out of 10 comparisons of series in the division of correct answers:

Between series 1 and 3, McNemar's X square ((1) = 8.04; $p < 0.01$).

Between series 2 and 3, McNemar's X square ((1) = 15.04; $p < 0.001$).

And 4, McNemar's X square ((1) = 6.86; $p < 0.01$).

Between series 3 and 5, X square ((1) = 6.05; $p < 0.05$).

In the numeric series, (1 and 2), the number of correct answers was significantly higher than in the verbal series, (3 and 4), and in the formal series, (5), the number of correct answers was significantly higher than in the verbal series (3).

In conclusion, the pattern of findings proves true in Hypothesis 1 that predicts differences in solving unique mathematical problems between numeric and non-numeric series.

According to the hypothesis, the number of correct answers in numeric series problems was significantly higher in comparison to the verbal series. In addition, it was found that the number of correct answers in the formal series was significantly higher than in the verbal series. However, no significant difference was found between the numeric and the formal series.

8.2. Correlations between creativity in solutions to unique mathematical problems and motivation for learning

The second hypothesis checked the correlation between the amount of correct answers to unique mathematical problems and the level of motivation for learning of students with learning disabilities in junior high mixed classes in the Arab sector in Israel. According to the hypothesis, the higher the amount of correct answers, the higher the level of motivation.

Pearson correlations between the amount of correct answers on each series and the general index of motivation for learning were calculated in order to verify the second hypothesis. In addition, correlations were calculated between the amount of correct answers for each of the five series and the three sub-measures for motivation for learning. Table 2 shows the results.

Table 2 shows significant positive correlations between the grades on the series and the general grade on motivation for learning, exactly as expected in the hypothesis (the range of the significant correlations was 0.24–0.58).

Likewise, according to the hypothesis, positive correlations were found between the grades of the five series and the grades of the three sub-divisions of motivation for learning: mastery of task, the significant correlations range between 0.23 and 0.40; avoidance, 0.24–0.42; and approaching, 0.24–0.45.

In the Steiger's Z test for the calculation of significant differences between correlations, it was found that the correlation between series 5 (formal) and the general measure of motivation for learning ($r = 0.58$; $p < 0.001$) was significantly higher than the correlation between series 1 (formal) and the general measure of motivation for learning ($r = 0.24$; $p < 0.05$).

In conclusion, the patterns of the findings confirm the second hypothesis. The hypothesis says the higher the number of correct answers to unique mathematical problems, the higher the levels of motivation for learning. This was found in the general measure of motivation for learning and in the three sub-divisions: mastery of tasks, avoidance, and approaching. It must be mentioned that the correlation between the formal series 5 and the general measure of motivation for learning is significantly higher than the correlation between the numeric series 1 and the general measure of motivation for learning.

9. Discussion and conclusion

The aim of the study was to check the connection between the ability to solve challenging mathematical problems in the domain of numerical and non-numerical series and the level of motivation for learning among students with learning disabilities in mixed classes of junior high schools in the Arab sector of Israel in the central area.

Table 2. Pearson correlations between the grades of the series and the measures of motivation for learning ($N = 50$)

	Motivation for learning			
Series	**Mo general grade**	**Ti mastery of task**	**Va avoiding**	**Tion approaching**
1. Numeric	0.24**	0.27*	0.12	0.22
2. Numeric	0.29*	0.23*	0.42***	0.31*
3. Verbal	0.36**	0.27*	0.25*	0.26*
4. Verbal	0.43***	0.38**	0.24*	0.24*
5. Formal	0.58***	0.40**	0.32*	0.45***

*Level of significance at $p < 0.05$.

**Level of significance at $p < 0.01$.

***Level of significance at $p < 0.001$ (one tailed).

The first hypothesis predicted differences in results between numerical and non-numerical series, such as letters and geometrical shapes.

The findings confirmed the first hypothesis: it was found that the number of correct answers on the numerical series was significantly higher than the one on the verbal series. In addition, the number of correct answers on the geometrical series was also significantly higher than the ones on the verbal series. However, not according to the prediction of the hypothesis, there was no significant difference between the correct answers of the numerical series and the geometrical ones.

In general, mathematical thinking is identified with numbers and shapes, while language belongs to directions and questions, and it is perceived as a separate component of the problem. Therefore, in the series domain, only the numeric ones are being taught.

One may say that the more usual the series is and more identified with regular mathematical thinking, the higher percentage of success it will generate; on the other hand, the less usual the series is, it will require creative thinking that will decrease the percentage of success. In solving such problems, there is need to break usual patterns of thinking and seek more original ways of solution.

Also in research literature, creative thinking in mathematics is attributed great importance. One of the ways of generating creative thinking is the presentation of problems with open answers. For example, if you ask students how they would divide 12 apples in three bowls, the solution is clear cut; but if you ask how to divide 12 apples equally, there is more than one solution, and the student will have to make presuppositions before offering an answer (Yee, 2005).

Researchers Hakim and Gazit (2011) point out the fact that the more unusual the series and the more creative thinking required, the number of correct answers decreases and so does the ability to cope with the problems. But the students who do succeed in solving the problem gain a high sense of competence, satisfaction, and motivation. Students with learning disabilities need this type of questions that raises their personal moral and strengthens their motivation to learn on.

Problem-solving is the core of mathematics and part of the problems are exercises that do not have an agreed algorithm in their solution. Mathematical riddles are challenging and people seek challenges and enjoy coping with them.

The second hypothesis predicted correlation between the amount of correct answers to unique mathematical problems and the level of motivation for learning of students with learning difficulties in mixed classes of junior high schools in the Arab sector in Israel. For example, the higher the amount of correct answers to unique problems, the higher the level of motivation for learning will be.

The findings confirmed the second hypothesis, as well. It was found, according to the hypothesis, that the rise in the amount of correct answers correlated with a rise in the level of motivation for learning. It was true about the general measure for the grade on the problems and the three sub-grades on control of the task, avoidance, and approaching. It should be mentioned that the correlation between the fifth formal series and the general grade on motivation for learning was significantly higher than the correlation between the first numerical series and the general grade on motivation for learning.

In the research literature, the problem is described as a verbal situation that contains different data. A problem includes mathematical factors such as numbers' shapes and structures that repeat themselves. In order to reach a solution in the case of a usual mathematical problem, the student should present it in a well-known mathematical model. In contrast, an unusual problem enables implementation of the learning material in a way that does not recycle an algorithm or a procedure practiced in class. According to Gazit (2004), mathematical riddles and challenges for the brain in school will enhance the development of thinking processes and represent a factor that increases motivation and interest for all students on both levels: regular and with LD.

Motivation for learning arouses, directs, and preserves a behavior of people destined to attain a goal; it reflects the sum total of causes that make a man behave in a certain way in a certain situation. Therefore, students who are motivated to learn mathematics will sense the need to understand the learning material and to solve the problems. Studies show that LD students who set themselves the goal to master the tasks, who perceive the task as interesting, challenging, and important, tend more than others to deal with meta-cognitive activities, to activate more cognitive strategies, and to invest more efforts into the task (Fey, 2000; Mymon, 2008; Pintrich & de Groot, 1990). Geary (2013) also noted that to use unique problems in mathematics that stimulate thinking, it causing a deeper understanding course material, development of memory, and increases the motivation to deal with questions and self-learning.

In conclusion, one may say that the more unusual the series and the more creativity it requires, the smaller the amount of correct answers and attempts to cope it will achieve. This phenomenon can be attributed mainly to the fact that in the school curriculum, there is not enough space for problem-solving strategies, so that the students would use them in unusual problem-solving like in problems with series. The inevitable conclusion is the need to broaden the use of unusual mathematical problems on all levels in school and the need to dedicate more time to the development of creative thinking. Success in unusual tasks raises the moral and the motivation for learning among LD students.

10. Pedagogical consequences and recommendations

What was tested in the framework of this study was the ability of students to cope with the solving of challenging unusual problems from the field of series, and not only numerical, vs. the levels of motivation for learning among students with learning disabilities in junior high schools in the Arab sector in Israel.

It is recommended to use self-regulated learning methods in the subject of math in elementary schools. It is important to incorporate engaging and thought-provoking algebraic questions in the learning process using a variety of thinking strategies to solve problems, while developing a proficiency in dealing with numbers, evaluation strategies, and with a conversation style that develops awareness toward the creative thinking process. It is also recommended to check the answer after the solution in a methodical way and act to develop mathematical thinking that relies on handling mathematical problems from a logical and creative perspective.

One of the ways to encourage and develop self-regulation in solving complex math problems among pupils with learning disabilities is to work in small groups. During group work time, the pupils will attempt the solution together and acquire creative and efficient math thinking skills.

One of the methodological conclusions that emerges from this study is the need to take into account the pedagogical characterization of the contents of the learning material in order to stress the importance of the unusual ones, to follow the progress of the LD student vis-à-vis himself, and to develop varied and flexible materials. All of the above are meant to serve as facilitators for the teaching in the field of mathematics and for the increase in motivation for learning other subject matters as well.

Moreover, from the pedagogical point of view, it is recommended to use the method of unusual challenging problem-solving in school for LD students since our findings show that this method increases motivation for learning and hence it can reduce the number of dropouts, increase achievements, and improve social relations among the students.

11. Limitations of the study

Due to the limitation of the scope of this study, not all organizational variables have been checked; they might have been connected to characteristics of mathematical content that might influence the increase of motivation for learning.

It is also necessary to draw comparisons between the various sectors in Israeli society that represent essentially different sociocultural world views that might reflect upon perceptions of challenging problems in mathematics and motivation for learning.

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