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Childhood Students' Creativity in Mathematics Class in Jordan

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Abstract The objective of the current study was to investigate childhood students' Mathematics creativity from their teachers' perspectives and observations. It intended to answer two main research questions. First: Is there a significant difference at level ($0.05 \geq \alpha$) in early childhood teachers' perspectives of student mathematical creativity with respect to school type, gender and grade level? Second: Is there agreement ration between the teacher mathematical creativity scale rating and observing rating on the same scale for the same child? A group of (31) mathematics teachers randomly selected completed a Childhood Mathematical Creativity Scale on some of their students who were also observed during mathematics classes by the researcher and rated using the same scale. Results indicated that mathematical creativity is not a common aspect for childhood students' on Jordan. Kindergarten teachers rated their student the highest on creativity while third grade were rated the lowest. Also the results revealed that there is no significant difference in children creativity means with respect to school type, gender and grade level form their teachers' perspectives. Also the ratio of agreement between the teacher mathematical creativity scale rating and observing rating on the same scale for the same child was moderate.

Keywords: *creativity, mathematical creativity, early childhood, government schools, UNRWA schools and private schools*

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1. Introduction

The 21st century youths requires many sets of special skills in order to succeed in work and life, and recently more emphasis has been placed upon creativity as a 'universal capability' ([7,32]:7). At the same time, there is increased international recognition of the importance of supporting creativity and creative thinking, at all phases of education. Education has emphasized the importance of promoting favorable conditions for developing creative potential of students; this means that educational systems must transform their objectives, to creativity, fluency in information, communication technologies, and the ability to solve complex problems [20,22]. To accomplish these objectives, students must engage in activities to think and act creatively in all subjects [30]. Also teachers must identify new ways looking at and applying the principles which underpin creativity and thinking skills to learning and teaching. The specific focus on creative thinking arises, in part at least, from Sternberg's [33] assertion that creative thinking may often receive less attention than other aspects of thinking, such as analytical thinking [33].

In the field of thinking and creativity, there are currently a number of differing conceptions and meanings. Human creativity is a rare trait because it is a manifestation of the influence of a number of external and internal variables in one's overall life journey which starts as early as the child begins to build their foundations of cognitive development [34]. Creative thinking is influenced by multiple of factors including philosophy of education, strategies of teaching, age, environment, and knowledge gained in or out of schools [9].

In many nations, mathematical educators are searching for new and effective ways to encourage the students to be creative. For a long time, mathematics and creativity have appeared as incompatible terms even for some educators [13]. Regarding this, in order to develop creativity in mathematics education, teachers and students need much more than solid mathematics knowledge [19]. The visionary of mathematical creativity described by leaders in (NCTM) enable students to confidently engage in complex mathematical tasks, draw on knowledge from a wide variety of mathematical topics, approaching the same problem from different mathematical perspectives and representing the mathematical problems in different ways [22]. All of this in an environment where both teacher and student enjoy mathematics; and where the students feel free to make mistakes and to learn from them. A creative classroom should allow more time for open-ended questioning, digression from the text, and for the development of creative thought [4]. Also teachers should be encouraged to recognize and value the creativity and creative potential in every child, and to nurture this creativity in all students [15]. Singh (1988) defined mathematical creativity as the "process of formulating hypotheses concerning cause and effect in a mathematical situation, testing and retesting these hypotheses and making modifications evaluating unusual mathematical ideas, sensing what is missing from

a problem, and splitting general problems into specific sub problems and finally communicating the results". Others characterized mathematical creativity in the context of problem formation (problem finding), invention, independence, and originality and have applied the concepts of fluency, flexibility, and originality. Also, there is a need to focus on the development of students' mathematical creativity skills: fluency, flexibility, originality and elaboration and attitudes through engaging students in creative, constructive, student centred learning activities [31].

In spite of the strong theoretical arguments in favour of mathematical creativity, there has been little systematic effort to document features of mathematical creativity on the classrooms. It is clear that future research is needed to investigate childhood students' Mathematics creativity in Jordan from their teachers' perspectives and observations using descriptive design. It intended to answer two main research questions. First: Is there a significant difference at level ($0.05 \geq \alpha$) in early childhood teachers' perspectives of student mathematical creativity with respect to school type, gender and grade level? Second: Is there agreement ration between the teacher mathematical creativity scale rating and observing rating on the same scale for the same child?

1.1. Researches Related to Creativity

Many studies have been done on creative thinking. A review of these studies shows that they can be grouped into two categories: first, experimental studies that have investigated how creative thinking is affected by methods such as active learning techniques, project-based learning and problem-based learning have shown that student centered methods have a positive effect on creative thinking (Suzen, 2007; Stephens, 2010). Other experimental studies have shown that creative thinking techniques such as, creative problem solving, divergent thinking techniques and brainstorming have a positive effect on creativity as well as academic success [5,6,24].

Descriptive studies in the second group can be divided into two subgroups: studies that evaluate the attitudes of preserves teachers towards creative thinking, and studies that evaluate creative thinking with regard to factors such as age, gender and grade level. A study by Newton and Newton [25] determined that the level of creativity in preserves teachers was deficient in some ways and that these teachers were unable to understand all the different dimensions of issues that required creativity. The study concluded that there is a strong and positive relationship between creative thinking and effective teaching. Ersukmen performed a study to identify the attitudes of science and technology teachers towards creativity and practices related to creativity, finding that the teachers were aware of concepts such as creativity and the characteristics of creative individuals [8]. The teachers also knew about techniques needed for creative education and were applying them as much as possible. Halakova measured the various dimensions of creativity in preserves science teachers using Torrance Tests of Creative Thinking and found a significant relationship between fluency and flexibility [12]. Studies that investigated other factors of creativity (gender, grade level and school type) arrived at different conclusions.

Studies by Gungor [11], Konak [17], and Potur and Baykul [29] found that there was no significant difference between genders when it comes to creative thinking. However, Atay [1] found that gender affects the dimensions of fluency, flexibility and elaboration. Oztunc (1999) found a significant difference between genders with regard to creative thinking.

In a study that investigated creative thinking based on class level, Konak [17] found a significant difference. In addition, Gungor [11] found a significant difference between the subdimensions of creativity in class levels. In studies evaluating creative thinking based on the type of the school, Potur and Baykul [29] found a significant difference, while a study by Oztunc (1999) did not find any significant difference.

GÜNEŞ & AYSEL KÖKSAL [10] in their study that aimed to determine how teachers' creativity affects their students' creative development, 90 preschool and elementary school teachers and 90 pupils were assessed for creative thinking. The children's sex was not correlated with creativity scores. There were small, significant relationships between various measures of preschool teachers' and students' creativity.

In summary, it can be said that experimental studies on creativity have generally shown that creative thinking techniques and methods which involve active participation on the part of the student have a positive effect on creative thinking, while descriptive studies evaluating creativity based on variables such as gender, type of school , and class level have produced conflicting results.

1.2. Rationale of the Study

Creative thinking skills are thought of as an important goal in developed countries at all education levels, from preschool to the university level. For an individual to think creatively, he or she should be able to come up with new ideas and solutions. Mathematics classes are fundamentally important for helping students develop the ability to solve problems in different situations [22]. Since creative people can take society further by developing original ideas and products, creative thinking has become part of math education in 21st century [20,22]. While creativity may be considered necessary for schooling, the wider social context in which it will operate needs further investigation. This is particularly true when the very notion of creativity and its nurturance has not been considered relevant in conventional education [3]. Educators believe that creative thinking is influenced by multiple factors including environment, teaching strategies, age and knowledge gained in or out of schools [9,15,34]. Extant literature suggests that teacher have a crucial role to play in an understanding of the concept of creativity and developing it within their classes. Therefore this study may clarify some features about creativity among children and could provide leadership and educational policies to update childhood curriculum in the direction of the development of creativity and creative thinking.

2. Method

2.1. Participants

The population of the study consists of all the teachers and their students for grades from kindergarten through third grade for the first semester for the year (2015-2016).

The participants of this study were selected using stratified random sampling techniques. The participants were (31) teachers, and (111) students from different types of school, grade level and gender. Table 1 specifies participant's distribution.

Table 1. Number of Students, teachers, schools participates in the study

Grades	Teachers	Students	Gender	No. Of Students	School Type	No. Of teachers	No. Of Students
K-2 grade	5	16	Male	48	Government	5	20
1st grade	11	42	Female	63	UNRWA	11	39
2nd grade	9	31			Private	15	52
3rd grade	6	22					
Total	31	111		111		31	111

The students' ages ranged from five to eight years old. The Government schools are funded by the government and administered by publicly elected government bodies. These schools are required to admit all students and must follow the government program development and curriculum. The UNRWA schools are funded by the United Nations and it follows the government program development and curriculum. The private schools are funded through tuition, donations and private grants. Admission in private schools is selective and somewhat competitive. Private schools have mainly two programs: national program follows the government curriculum, and Foreign Program that have more freedom in designing curriculum and instruction. Teachers in government, UNRWA, and national program in private school for this study received quite similar training programs with regard to mathematics as mandated by the government. Permission for teacher participation was obtained followed official steps. Teacher's who participated in this study were informed about the purposes of the study. Each teacher who participated in this study was asked to select randomly at most four of his students to be rated using the mathematical creativity scale twice; once by the teacher himself, and the other by the researcher through class observation. Since these students who were selected by the teacher will be observed by the researcher during the classes, therefore the number has to be low.

Total of (111) students were rated. Then (20) students were observed during mathematics classes by the researcher for (4) classes each to complete the mathematical creativity scale by the researcher. Whitebread et al. [35] identify two particular benefits of observation in the context of research young children, both of which apply equally to contexts involving creative thinking. First, observation in naturalistic, everyday contexts affords opportunities to record social processes as well as individual activity. Second the implicit narrative structure of naturalistic observation affords observers the potential to look at possible processes, such as as individual instances, of creative thinking.

2.2. Measures

A scale models are research approaches that aim to describe a situation in the present or past [16]. A Mathematical Creativity Scale (MCS) was constructed to answer the first study questions. The first section included general information such as student's name, gender, class level, and school type, whereas the second section included a scale to measure mathematical creativity. The items distributed into two dimensions. The dimensions are: creative activities (e.g. Child engages in deliberate systematic investigation, develops a plan of action) and Independency (e.g Child is self-directed, self motivated). The scale was constructed based on the following stages: Review the literature related to mathematics creativity, selected those items related to the previous dimensions, and modified to be meaningful and useful in the context of Jordan. Based on this review, the researcher put a list of (20) items as a primary version for the (MCS). Stage two: The primary version of the (MCS) was reviewed by a sample of faculty members specialized in the field of mathematics education, early childhood education, and educational psychology. It is also reviewed by a sample of teacher who teaches these grades. Data received from the specialist and teachers were reviewed and changes were made so the final version of the (MCS) consisted of (13) items. Each item on the scale scored from 1 to 3: 3= excellent quality,2= medium quality and 1=poor quality.

To obtain the (MCS) reliability, it was administered to sample of (30) teachers from the same population. The reliability coefficient (Cronbach α=0.91) have been established, and this was considered acceptable for the purpose of the study. Finally the (MCS) administered to fifteen kindergarten teachers who were randomly selected from the population of the study.

Data were analyzed using descriptive statistics. Multivariate Linear Model Test were also used to determine whether there is a significant difference at the level ($0.05 \geq \alpha$) in childhood teacher perspectives of student mathematical creativity with respect to the three dependent variables: school type, gender and grade level. To answer the second question a ratio of agreement between the teacher rate on (MCS) and the observabing rate on (MCS) for the same child was calculated.

3. Results

3.1. Descriptive Data and Inter-Correlations

In order to answer the first question related to the difference in childhood mathematical creativity with respect to school type, gender and grade level, the means and standard deviations were calculated for each class level. As shown in Table 2 this analysis revealed that KG2 teachers rated their student the highest mean (22.81) with standard deviation (4.90), while the third grade students have been rated the lowest on (MCS), where their mean is (19.86) and the standard deviation is (3.71) . The means and the standards deviation for the 1st and 2nd grades were (21.16, 21.93) and (5.76, 5.12) respectively. To find if the difference between means of each dependent variable of the study were significant at the level ($0.05 \geq \alpha$), multivariate Linear Model Test was used. Table 3 shows the result of this test which indicate that there is no

significant difference at the level ($0.05 \geq \alpha$) in teacher perspectives of student mathematical creativity with respect to school type, gender and grade level; as the value of F to the variables grade, gender and school are (.423,.257 and 1.037) respectively., and these values are not statistically significant at the level ($0.05 \geq \alpha$). These findings indicate that mathematics creativity in early childhood is not a common aspect in Jordan. Such creativity rating might be a function of many factors. When comparing the means of teacher's perspectives of students' mathematical creativity, it reveals that as the grade level increased, the creativity ranking of the students decreased.

Table 2. The Means and Standards Deviation of the Groups of the Study

Groups	No.	Mean	Standard Deviation
Kg	16	22.81	4.90
1st	42	21.16	5.76
2nd	31	21.93	5.12
3rd	22	19.86	3.71

Table 3. Multivariat Linear Model Test Between-Subject Effect

Source	Sum of Squares	df	Mean Square	F	Sig.
Grade	33.368	4	11.123	.423	.737
Gender	6.749	1	6.749	.257	.613
School	54.544	2	27.272	1.037	.358
Error	2734.711	104	26.295		
Corrected Total	897.586	110			

Computed using alpha=.05

To answer the second question of this study: Is there a agreement ratio between the teacher rate on (MCS) and the observable rate on (MCS) for the same child. An agreement ratio for each child observed by the researcher was calculated, and the average for each grade is computed. Figure 1 shows that the agreement ratio. The results indicate that the highest ratio of a agreement was for the KG2 students, and as the grade level increased, the ratio decreased.

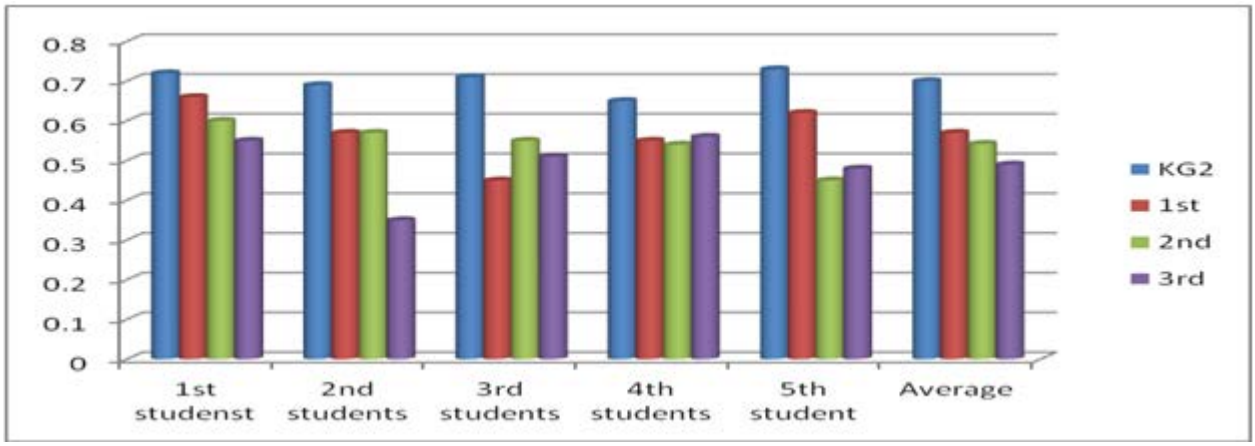

Figure 1. Agreement ratio between the teacher rate on (MCS) and the observable rate on (MCS) for the student

4. Discussion

This study set out to investigate the early childhood Mathematics teachers' perspectives on student creativity. The finding of the study regarding students' creativity due to gender revealed that there is no significant difference with respect to gender; this means that gender does not have a significant effect on creative thinking. The findings supported by the studies of Gungor [11] Konak [17], and Potur and Baykul [29] that found no significant difference between genders when it comes to creative thinking. However, Atay [1], Ozben and Argun [26] found that gender affects some dimensions of creativity.

The finding of the study regarding students' creativity due to grade level revealed that there is no significant difference; this means that grade level does not have significant effect on creative thinking. Previous studies of Konak [17], Gungor [11] found a significant difference in creativity which not support the study results, and this may be rationalized by the difference of the sample; our sample were children aged (5-8) years while theirs' were students aged (12-17) years. The results reveal that as the grade level increased the creativity raking decrease. This is supported by prior research, Behar believe that after large schooling, children become cautious about expressing their ideas creativity [4]. A creative classroom should allow more time for open-ended questioning, digression from the text, risk taking, curiosity, and for the development of creative thought, all of this in an environment where both teacher and student enjoy mathematics; and where the students feel free to make mistakes and to learn from them. [2,4]. Besides to give the children numerous opportunities everyday to talk openly, to express their thoughts and stories, so that they feel that their opinions are important and valued [28]. Also the researcher notice while he observing the students, that teachers do not provide students with multiple opportunities to create and solve problems, instead posing questions that require one quick answer. This is supported by prior research which states that children are allowed to use multiple resources and are given ample time to explore, discover, and rediscover many solutions to a problem [14,15]. This type of teaching is expensive—it takes time, patience, tolerance for ambiguity and mess.

However, this type of teaching is also immensely rewarding and essential.

The finding of the study regarding students' creativity due to school type revealed that there is no significant difference; this means that grade level does not have significant effect on creative thinking. Previous studies of Potur and Baykul [29] found a significant difference, while a study by Oztunc (1999) did not find any significant difference. Some researchers believe that creativity in the classroom seems to be encouraged or discouraged depending upon the educational philosophies of the teachers, schools, and families [14,21]. This supported by the researcher observation while staying in some schools to observe the students to complete (MCS) score. He notice that mathematics teachers for grades l, 2, and 3 are more burdened with paper work and record keeping, and there is more pressure to drill skills and prepare for tests , so there was little time for exploration and less time for creativity. For children to have mathematical creativity, they should consistently and confidently engage in complex mathematical tasks, draw on knowledge from a wide variety of mathematical topics, approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress, solve the problems, ask and answer the questions, and create new solutions [4,22,31].

Also the results of this study indicate that the ratio of agreement between teachers' perspectives and the researcher observation was decreased as the grade level increased. This means that teaching and learning rarely get beyond the knowledge and leaves no room for creativity or creative thinking. These findings indicate that many factors could have contributed to this result, one is what Mayfield's found in his study for 573 third graders that teacher ratings of intelligence corresponded to student achievement on standardized tests but they were unable to judge student creativity [18], also Gear (as cited in [18]) found many examples of inaccuracy of teacher judgments when rating gifted students. Jackson wrote "A teacher's perceptions of creativity are too limited and biased to be the only catcher (Jackson, 2005: 2).

5. Recommendations

Several interesting themes and implications of this research emerge: first teachers must engage youngsters in creative, constructive, student centred learning activities. Moreover, it would be highly beneficial for Ministry of Education in Jordan to design teacher preparation towards improving students' mathematical creativity. Most of studies that are especially incoherent with this study's result, sub-dimensions of creative thinking were investigated. In this study total score was evaluated as creative thinking score. Namely, sub-dimensions that are flexibility, fluency, originality and elaboration were not analysed. Total scores cannot provide the information about sub-dimensions of creative thinking. So, a study that will be made by using sub-dimensions can provide many interesting results. Besides further research should consider different grade level and on-site observations of teachers' activities and interaction during math classes to encompass a number of core features, including the posing of questions, risk talking, being imaginative self-determination and intentionality.

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