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# Difference between Gifted and Regular Students in Mathematical Creativity and Mathematical Self-Efficacy[1]

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The former study results demonstrate that differences between people of creativity and non-creativity lie in differences of the self-efficacies rather than those of cognitive aspects and a man of higher self-efficacy has a tendency to set up a higher goal of achievement and higher self-efficacy influences his or her achievement results as well (Zimmerman & Bandura 1994).

Using the method of mathematical creative responses of open-ended approach (Lee, Hwang & Seo 2003), difference of mathematical self-efficacies has been surveyed in the study.

Results of the survey showed that some students of a high mathematical self-efficacy even had bad marks in the originality or creativity but, in some cases, some students of a low mathematical self-efficacy rather had good marks in the fluency.

Therefore, the response results mathematical creativity ability may be a special ability and not just a combination of self-efficacy ability.

The fluency of the mathematical creative ability may be a combination of mathematical motivation ability that have been surveyed in the study suggest that not only cognitive components but also social and emotional components should be included in a development process of new creative method for teaching and learning mathematics.

*Keywords*: mathematically creativity, mathematical self-efficacy
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# 1. INTRODUCTION

There are some important elements for a student who takes a course on mathematics such as what degree he has attained to his setting goal, how much effort he or she gave to attain to his goal, and how much self-confidence he or she has in his or her ability while performing his/her assignment so as to attaining his goal. When an mathematical assignment is given to students some will give up to solve the mathematical problems and will not intend to take efforts it from the very beginning, however, some will not give up to solve the mathematical problems and take efforts to do it. Such behaviors could be deprived out from the facts that they cannot comprehend the mathematical problems at all or cannot recognize their ability enough. When mathematical exercises are given to students that they will have some degree of self-confidence that they can solve the mathematical problems which will bring them to commence for taking efforts so as to solve the problems, and even that will give them some degree of self-confidence of correctness of their solutions. In such pattern, students' performances which are required for attaining to a given goal and their personnel convections on the abilities could influence to work a given assignment successfully.

The former study results demonstrate us the following aspects. Self-efficacy is a conviction that requires to work out a given tasks successfully (Bandura 1997), and a man of a higher self-efficacy has a tendency to take more efforts in working out a difficult assignment and a hard task successfully and to overcome an obstacle completely as well (Bandura 1997). Gifted students of all social class, ethnicity and gender tend to have high global and academic self-esteems (Ablard 1997; Chan 1988; Chapman & McAlpine 1988; Hoge & Renzulli 1993; van Tassel-Baska, Olszewski-Kubilius & Kulieke 1994; Wright & Leroux 1997) and a man of relatively low self-efficacy has a tendency to doubt his academic ability and not to take efforts and time in solving a difficult assignment (Bandura 1997). Such results bring out us a meaningful assumption that a student's working capabilities could be evaluated by predicting the efforts and correctness for which he has done to solve a given assignment.

## 1. 1. Mathematical creativity

Mathematicians have regarded mathematical creativity as a very important factor that constitutes his or her mathematical capabilities and tried to identify it ever since. Aiken (1973) integrated the sundry records and former studies related to mathematical creativity and then concluded that a definition of mathematical creativity is based on the improvement process and various products. And a series of recent researches tell us that a capability to find out a problem sometimes considers the creativity it-self (Dillon 1988)

and a mathematical creativity in a class room situation could be predicted by using an open-ended approach and problem-to-problem (Yoshihiko 1997) since an open-ended approach makes possible to open the results and a problem-to-problem makes possible to do the process as well.

In the 1980's, the idea to use some form of open-ended problems in classroom spread all over the world, and research on its possibilities is very vivid in many countries (Nohda 1988, 1991; Pehkonen 1995a, 1995b; Silver & Mamona 1989; Williams 1989; Mason 1991; Stacey 1991, 1995; Zimmermann 1991; Clarke & Sullivan 1992; Silver 1993, 1995; Leung 1993; Silver & Cai 1996). Studies are currently under way on the relationship between mathematical creativity and open-ended problems (Kwon, Bang & Song 1999; Byun, 2001; Mun 2002; Lee & Hwang 2003; Lee, Hwang & Seo 2003; Lee, Hwang & Seo 2004).

### 1.2. Mathematical self-efficacy

Bandura (1997) says that self-efficacy is a conviction to work out a given assignment successfully which is constituted by a three dimensional space having level, strength, and generality. Most of the studies relating to self-efficacy focus on a level and strength of self-efficacy (Ewers & Wood 1993; Pajares & Miller 1994). However, some recent studies focus on a generality of scholastic self-efficacy for high school students, and the three dimensional space of self-efficacy that was contributed by Bandura (1997) has been studying continually. But recent literatures make an issue on the surface whether a student's practical execution conforms to his own recognition relating to a measurement exactly. And also recent studies suggest an issue that a student's practical execution could not always conform to his own recognition even if he recognizes his high self-efficacy but it conforms to his judgment and conviction in another expression (Ewers & Wood 1993; Pajares & Graham 1999; Pajares & Kranzer 1995). Pajares & Graham (1999) have concluded in their study concerning middle school students that

(1) the students were confident in a judgment of the self-efficacy,
(2) the gifted students were less confident than ordinary ones,
(3) there was no relation to gender.

While working out a given assignment, a student can determine whether he would accomplish it successfully according to a degree of his confidence (or to his capability). Therefore, it could be defined that a self-efficacy would influence on the achievement results. And a man of higher self-efficacy has a tendency to set up a higher goal of achievement (Zimmerman & Bandura 1994; Zimmerman, Bandura & Martinez-Pons 1992) and higher self-efficacy influences his or her achievement results as well (Zimmerman & Bandura 1994). Hackett (1985) analyzed various kinds of the routes, such

as gender, prior preparations to take a course, achievements in mathematics, efficacy in mathematics, uneasiness in mathematics and the like, that influence to select mathematics as his or her major which requires a high degree of mathematical capabilities and found out that a self-efficacy in mathematics has influenced in selection of taking a course and an occupation on mathematics directly in the future by getting rid of his mathematical uneasiness. In order to measure a self-efficacy in a mathematical subject, Hackett and Betz (1989) defined self-efficacy in a mathematical subject as "a student's situational or special judgment on his capability that he will work out a given mathematical assignment or problem successfully. And self-efficacy in mathematics is important for a student who will work out a mathematical subject successfully (Matsui & Ohnishi 1990). It has been analyzed in the study how a self-efficacy in mathematics and a motive (effort) in mathematics influence on a student's mathematical achievement and divergence thinking so as to suggest a new direction in teaching and learning mathematics

### 1.3. A study of purpose and objectives

The purpose of this study was to determine what kind of differences in relationship between mathematics self-efficacy and mathematical creative problem solving ability in middle school students. The specific objectives for this study were:

To investigate whether group differences exits in mathematics self-efficacy and mathematical creative problem solving ability.

To investigate whether gender differences exits in mathematics self-efficacy and mathematical creative problem solving ability.

To investigate what relationship exits between performance on measures of mathematics self-efficacy and mathematical creative problem solving ability.

## 2. METHOD

### 2.1. Design

This study consists of two sub studies a characteristic of the mathematics self-efficacy and mathematical creative problem solving ability and a correlation study. The correlation study was conducted to investigate whether a statistically significant relationship exists between performance on Mathematical Creative Problem Solving Ability Test (MCPSAT; Lee, Hwang & Seo 2003) and on the mathematics self-efficacy (MSEAT; Chen 2002) that are required for middle schools. Therefore, for the correlation study, the two variables were the scores of the MSEAT and the scores of the MCPSAT within each group.

### 2.2. Participants

The participants for this study were 187 Korean middle school students. There were 158 of Daejeon Byeondong middle school (86 males and 72 females) and 29 of the Gifted Education Center of in Daejeon (21 males and 8 females) each as the object.

### 2.3. Instrumentation

The MCPSAT was administered as the test for mathematically creativity. A test booklet, which included detailed instructions and fifty-minute exercise, was provided to each participant. The fives exercises were selected as the open-ended problems for this study. Problem 1 is a sixteen dots problem, a transformed version of the nine dots problem that was used by Haylock (1984) and H. Kim, M. Kim, Bang & Hwang (1997). Problem 2 is a regular hexagon problem, a transformed version of the quadrangle problem that was used by H. Kim, M. Kim, Bang & Hwang (1997). Problems 3 to 5 are the water-flask, marble and classifying several solid figure problems that were used by Becker & Shimada (1997). The MCPSAT exercises are used to generate third indices of creativity: Fluency, Flexibility, and Originality. According to Lee, Hwang & Seo (2003), studies have found the MCPSAT to be reliable: Typical test-retest reliability of the MCPSAT is around .80. In order to evaluate item-internal consistency reliability and discrimination, Cronbach α. was calculated using SPSS 10.0K. Internal validity and difficulty were calculated using BIGSTEPS (Livacre & Wright 1994, 2003) based on Rasch's 1-parameter item-response model.

**Table 1.** Analysis of Quality of Test Instruments (MCPSAT)*

| Items | | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|---|
| Internal Validity | Infit | 1.05 | 1.10 | 0.85 | 0.90 | 1.08 | 1.00 |
| | Outfit | 1.01 | 1.02 | 0.83 | 0.90 | 1.05 | 0.96 |
| Difficulties | | − 0.22 | − 0.41 | 0.23 | 0.40 | − 0.01 | 0.00 |
| Discrimination | | 0.73 | 0.73 | 0.67 | 0.51 | 0.56 | 1.00 |

* Reliability: Cronbach $\alpha$: 0.80

**Table 2.** Analysis of Quality of Mathematics Self-Efficacy Test Instruments

| Components | Items numbers | Total of the items | Reliability |
|---|---|---|---|
| Mathematical Motivation | 1–15 | 15 | 0.94 |
| Mathematical Self-Efficacy | 1–15 | 15 | 0.96 |
| Mathematical Achievement | 1–15 | 15 | 0.76 |

Self-efficacy in mathematics is a test for measuring a degree of it in taking a mathematical subject that has been used for students in the survey by converting it into the scale system of self-efficacy from Chen (2002). Total 158 students in the middle schools were examined using the testing tool and the reliabilities are listed in Table 2.

**Table 3.** Differences of mathematics self-efficacy and mathematical creative problem solving ability of students with performance for group and gender

| Components | | Group | | | | | | Gender | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Regular Students | | Gifted Students | | $t$ | $p$ | Males | | Females | | $t$ | $p$ |
| | | M | SD | M | SD | | | M | SD | M | SD | | |
| MSEAT | Mathematical Achievement | 0.53 | 0.22 | 0.92 | 0.08 | −9.77 | .000** | 0.62 | 0.25 | 0.54 | 0.25 | 2.191 | 0.030* |
| | Self-Efficacy | 3.71 | 1.67 | 4.14 | 0.74 | −1.38 | .070 | 4.22 | 1.49 | 3.19 | 1.48 | 4.687 | 0.000** |
| | Self-Evaluation | 4.71 | 1.67 | 5.14 | 0.74 | −1.38 | .070 | 5.22 | 1.49 | 4.19 | 1.48 | 4.687 | 0.000** |
| | Effort Judgment | 4.42 | 1.58 | 5.39 | 0.66 | −3.26 | .001** | 4.70 | 1.48 | 4.39 | 1.56 | 1.367 | 0.170 |
| MCPSAT | Fluency | 15.65 | 6.84 | 26.14 | 6.49 | −7.94 | .000** | 17.74 | 8.10 | 16.65 | 7.30 | 0.963 | 0.337 |
| | Flexibility | 10.17 | 3.61 | 14.41 | 3.80 | −5.57 | .000** | 11.07 | 4.14 | 10.50 | 3.68 | 0.986 | 0.326 |
| | Originality | 3.15 | 3.98 | 5.69 | 4.25 | −2.98 | .005** | 3.72 | 4.18 | 3.31 | 4.04 | 0.672 | 0.502 |
| | Mathematical Creativity Index | 28.66 | 12.21 | 46.24 | 12.20 | −7.13 | .000** | 32.51 | 14.54 | 29.89 | 12.55 | 1.318 | 0.189 |

Note. MSEAT=score on the Mathematics Self-Efficacy Ability Test; MCPSAT=score on the Mathematical Creative Problem Solving Ability Test.

### 2.4. Procedure

The research object got tested of MSEAT and MCPSAT. It was performed and evaluated by the operator at the end of first semester. A test booklet and pencils were provided to each participant. The MSEAT and MCPSAT were administered following the instructions in the manual.

### 2.5. Data analysis

In the analysis of data, the frequency and percentage per type to find out the mathematiccal self-efficacy and creativity of seven grade, average, standard deviation, *t*-test. Data was processed through SPSS/PC 10.0K static program for Windows.

## 3. RESULTS AND CONCLUSIONS

### 3.1. Comparative study

Table 3 provides the means and standard deviations for scores on the MSEAT and MCPSAT of students with performance for group and gender. The aim of the present study is an attempt to examine the differences of mathematics self-efficacy and mathematical creativity of students with performance for group and gender among a Korean sample. The result of *t*-test (see Table 3) showed a significant difference on the performance scores on two tests (MSEAT) and (MCPSAT), both favoring gifted. And the result of t-test (see Table 3) showed a significant difference on the performance scores on each component of the MSEAT and MCPSAT. Statistically significant difference was found on the component of Mathematical Achievement ($t = -9.77$, $p = 0.000$), Effort Judgment ($t = -3.26$, $p = .001$), Fluency ($t = -7.94$, $p = 0.000$), Flexibility ($t = -5.57$, $p = 0.000$), Originality ($t = -2.98$, $p = 0.005$) and Mathematical Creativity Index ($t = -7.13$, p = 0.000). No statistically significant difference was found on the component of Self-Efficacy ($t = -1.38$, p = 0.070) and Self-Evaluation ($t = -1.38$, p = 0.070).

The result of t-test (see Table 3) showed a significant difference on the performance scores on two tests (MSEAT) and (MCPSAT), both favoring gender. Statistically significant difference was found on the component of Mathematical Achievement ($t = 2.191$, $p = 0.030$), Self-Efficacy ($t = 4.687$, p = 0.000) and Self-Evaluation ($t = 4.687$, $p = 0.000$). No statistically significant difference was found on the component of Effort Judgment ($t = 1.367$, $p = 0.170$) and each component of the MCPSAT showed slight but not significant differences between males and females.

**Table 4.** Correlation between the mathematics self-efficacy and the mathematical creative problem solving for gifted and regular students

| Components | | MSEAT | | | | MCPSAT | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Self-Efficacy | Accuracy | Self-Evaluation | Effort Judgment | Fluency | Flexibility | Originality | Mathematical creativity Index |
| MSEAT | Mathematical Achievement | – | 0.555** | 0.555** | 0.270** | 0.477** | 0.432** | 0.232** | 0.449** |
| | Self-Efficacy | | – | 1.000** | 0.203** | 0.091 | 0.096 | 0.119 | 0.105 |
| | Self-Evaluation | | | – | 0.203* | 0.091 | 0.096 | 0.119 | 0.105 |
| | Effort Judgment | | | | – | 0.181* | 0.139 | 0.038 | 0.190* |
| MCPSAT | Fluency | | | | | – | 0.915** | 0.455** | 0.914* |
| | Flexibility | | | | | | – | 0.493** | 0.892* |
| | Originality | | | | | | | – | 0.642* |
| | Mathematical creativity Index | | | | | | | | – |

Note. MSEAT=score on the Mathematics Self-Efficacy Ability Test; MCPSAT=score on the Mathematical Creative Problem Solving Ability Test; ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

### 3.2. Correlation Study

The aim of the present study is an attempt to examine the correlation between the mathematics self-efficacy and the mathematical creativity for gifted and regular students among a Korean sample.

The Pearson product-moment correlation coefficient r was computed between MSEAT and MCPSAT. There was statistically significant relationship between the score of the Mathematical Achievement and each component of the MSEAT and the MCPSAT. On the other hand, each component of the MCPSAT showed slight but not significant relationship between MSEAT and MCPSAT except to Mathematical Achievement.

### 3.3. Conclusions

The findings of this study indicated statistically significant differences between gifted students and regular students on the scores of MSEAT and MCPSAT. Overall, the findings suggest that gifted students are more mathematics self-efficacy and mathematical creativity ability than regular students as measured by the MSEAT and MCPSAT. The gifted students appear to be better at the all component of the MSEAT and MCPSAT. And the findings suggest that males are more mathematics self-efficacy and mathematical creativity ability than females as measured by the MSEAT and MCPSAT. However, no statistically significant difference was found on the component of Effort Judgment ($t$ = 1.367, $p$ = 0.170) and each component of the MCPSAT showed slight but not significant differences between males and females.

The Pearson product-moment correlation coefficient r was computed between MSEAT and MCPSAT. There was statistically significant relationship between the score of the Mathematical Achievement and each component of the MSEAT and the MCPSAT. On the other hand, each component of the MCAT showed slight but not significant relationship between MSEAT and MCPSAT except to Mathematical Achievement. There was statistically significant relationship between the score of the MCPSAT and the MCPSAT for middle students.

This suggests that mathematical creativity ability may be a special ability and not just a combination of self-efficacy ability. The fluency of the mathematical creative ability may be a combination of mathematical motivation ability. It has been concluded that not only cognitive elements in mathematical creativity but also motivation in mathematics will be increased to improve a mathematical creativity.

Therefore it will be necessary to include not only cognitive components in mathematical creativity but also motivation components ones when developing a program to increase a mathematical creativity in the future.

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# APPENDIX 1. MATHEMATICS SELF-EFFICACY

1. A newspaper reported that about 18,189 trees had been planted in the park. What is the number of trees rounded to the nearest hundred?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

2. In a discus-throwing competition, the winning throw was 61.60m. The second-place throw was 59.72m. How much longer was the winning throw than the second-place throw?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

3. Tow group of tourists each have 60 people. If 3/4 of the first group and 2/3 of the second group board buses to travel to museum, how many more people in the first group board buses than in the second group?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

4. Anna had a bag of beads. She gave half of them to James and then a third of the beads still in the bag to pat. She then had 6 beads left. How many beads were in the bag to start with?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

5. A class has 28 students. The ratio of girls to boys is 4:3. How many girls are in the class?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

6. In a quadrilateral, two of the angles each have a measure of $110^0$, and the measure of third angle is $90^0$. What is the measure of the remaining angle?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

7. A shaded rectangular picture is pasted on a sheet of white paper as shown below. What is the area of the white paper not covered by the picture?

Answer_____

A. How much effort did you put in to solve this problem?

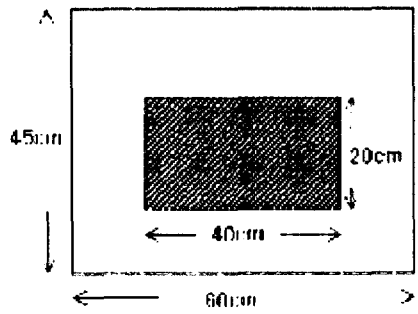
1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)




8. What does 6000 minus 2369.4 equal? Please show your work.

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

9. A group of students has a total of 29 pencils and everyone has at least one pencil. Six students have 1 pencil each, 5 students have3, and the rest have 2. How many students have only 2 pencils?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

10. If the price of can of beans is raised from 600 to 750 wons, What is the percent increase in the price?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8

(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

11. Sangchul, Heuisug, and their mother were eating a cake. Sangchul ate 1/3 of the cake. Heuisug ate 1/4 of the cake. Their mother ate 1/3 of the cake. How much of the cake is left?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

12. The numbers in the sequence 2, 7, 12, 17, 22, ... increase by fives. The numbers in the sequence 3, 10, 17, 24, 31, ...increase by sevens. The number 17 occurs in both sequences. If the sequences are continued, what is the next number that will occur in both sequences?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

13. Four children measured the width of a room by counting the number of paces it took them to cross it. The chart shows their measurements. Who had the longest pace?

| Name | Number of Paces |
|---|---|
| Chulheui | 12 |
| Younghee | 9 |
| Soonhee | 7 |
| Sangchul | 8 |

Answer_____

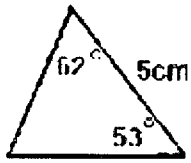
A. How much effort did you put in to solve this problem?

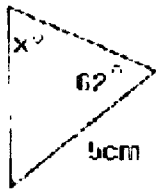
1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

14. These triangles congruent. The measures of some the sides and angles of the triangles are shown. What is the value of x?




| Name | umber of Paces |
|---|---|
| Stephen | 12 |
| Arlene | 9 |
| Ana | 7 |
| Carlos | 8 |

15. A drawer contains 28 pens: some white, some blue, some red, and some gray. If the probability of selecting a blue pen is 2/7, how many blue pens are in the drawer?

Answer_____

A. How much effort did you put in to solve this problem?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

B. How confident are you that you solved this math problem correctly?

1 2 3 4 5 6 7 8
(none) (a little) (a lot) (all)

## APPENDIX 2. OPEN-ENDED TEST

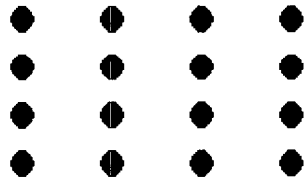
Name: _____, Date of Birth: _____, Sex: Male__ Female__
School: _____

< Attention >

Please read the following explanation before getting to the questions below. Every question allows multiple answers. The time given is 50 minutes.

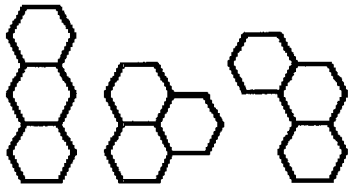
(1) Write a maximum of 15 answers that you think are pertinent to the question.
(2) Give answers that are different from but not similar to one another.
(3) Give answers that cannot be easily found.
(4) Present answers in as exact and detailed way as possible.
(5) If you need more space to write, get another answer sheet from the teacher.
Do not turn to the next page until instructed by the teacher.

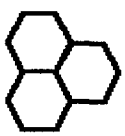
1. As shown below, there are sixteen dots that are arranged with 1cm spaces between them.



Draw lines between the dots to make as many figures as possible with the area of 2 cm2. (If two or more figures are overlapped when turned around or over, they are considered as identical. No figure should be split in two or have one point in common with another.)

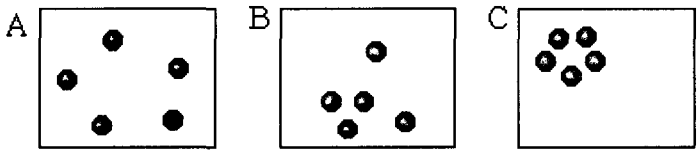
2. As shown in the Example below, 3 sheets of paper in the shape of a regular hexagon can be joined together along the sides in 3 ways.



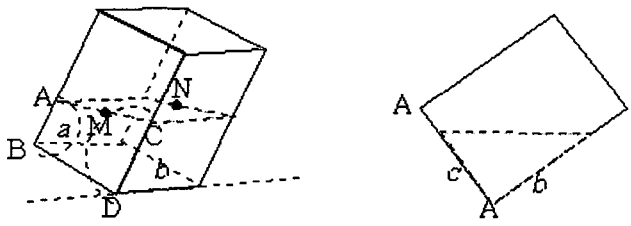
 and  are considered as identical.

Then, make all drawings of how to join together 6 sheets of paper in the shape of a regular hexagon along the sides, as in the Example below. (If two or more figures are overlapped when turned around or over, they are considered as identical.)

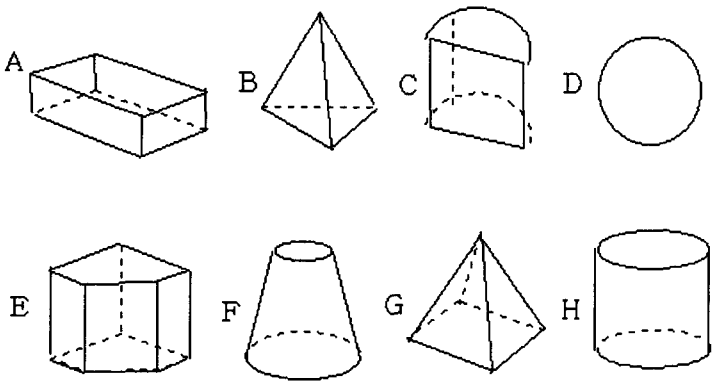
3. Three students, A, B, C, each threw five marbles, which came to rest as shown. In this game, the winner is the student with the smallest scattering of marbles. The degree of scattering seems to decrease in the order A, B, C. Devise as many ways as you can to express numerically the degree of scattering.




4. A transparent flask in the shape of a right rectangular prism is partially filled with water. When the flask is placed on a table and titled, with one edge of its base being fixed, several geometric shapes of various sizes are formed by the cuboid's faces and the surface of the water. The shapes and sizes may vary according to the degree of tilt or inclination. Try to discover as many invariant relations (rules) concerning these shapes and sizes as possible. Write down all your findings.




5. Consider the solid figures as shown. Choose one or more figures that share the same characteristics with figure B and write down those characteristics.




[Solution]

| Characteristic | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |