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MATHEMATICAL HABITS OF MIND IN SOLVING NON-ROUTINE PROBLEMS AND ACADEMIC PERFORMANCE OF GRADE 9 STUDENTS

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ABSTRACT

This descriptive-correlational study aimed to determine the levels of mathematical habits of mind (MHoM) and its components in solving non-routine problems that predict academic performance. It also aimed to determine the strength of relationship among the components of MHoM. The respondents of this study are the 120 grade 9 students who came from randomly selected secondary schools in Iloilo City. The Mathematical Habits of Mind Instrument, a researcher-made instrument was used in this study. Descriptive data analyses made use of the mean and standard deviation while One-Way ANOVA, Pearson's r and multiple regression analysis were used for inferential data analyses. Significance level is set at 0.05. Findings reveal that respondents have satisfactorily-developed MHoM as a whole and in terms of searching for patterns, linking ideas and representation and reasoning deductively and through experiments. They have slightly-developed MHOM in solving problems in many ways and strongly-developed habit of reflecting and self-checking of learning. Coed students have significantly higher ability to solve problems in many ways than private all-boys schools students. Each of the five components of MHoM is significantly related to one another. Habits of searching for patterns and reflecting and self-checking of learning are significant predictors of academic performance. Teachers are recommended to incorporate cooperative learning strategies for students to present their own solution and processes. Students are highly encouraged to be given opportunities to solve problems in more than one way.

Keywords*: Mathematical habits of mind; non-routine problems; academic performance; grade 9 students*

1. INTRODUCTION

Problem solving is regarded as one of the primary skills that students must take with them when they leave the classrooms and enter the real world (Krulik and Rudnick,1996). Limjap (1996) reported that as students are given the opportunity to reflect on their experiences when they are confronted with problematic situations, they learn to construct their own ways of reasoning and this aids them in dealing future problematic situations. For one to appreciate and see the connection of mathematics to real life, students need to be exposed to non-routine problems. Moreover, the inclusion of non-routine problems in class positively impacts academic performance (Arslan and Altun, 2007) and that exposing students to non-routine problems in the school curricula had certain benefits.

The reality, however, is that the Philippines is far behind from other countries when it comes to non-routine problem-solving in particular and mathematics achievement and standards in general. Despite long years of instruction, some research studies (Asman and Markowitz, 2001; Higgins, 1997) show that children are insufficient and not confident in having the aptitudes required for approaching non-routine problems in a successful way. One of the factors seen is that the teaching of Mathematics has been dedicated to the learning of cognitive concepts and mastery (Encio, 2013) by exposing them to routine problems but not for life (Cuoco, Matsuura, Piecham, Stevens, & Sword, 2013). This kills the imaginative and inventive problem-solving abilities of students of associating these skills into other similar problems that require higher order thinking skills.

One of the ways to address this concern is to help students develop necessary mathematical habits of mind (MHoM). MHOM refers to the "the web of specialized ways of approaching mathematical problems and thinking about mathematical concepts that resemble the ways employed by mathematicians" (Cuoco, Goldenberg, & Mark, 1996, 2010; Mark, Cuoco, Goldenberg, & Sword, 2010). It is imperative that students be exposed to problem solving activities that require critical thinking for them to develop desirable habits of mind necessary towards successful and fulfilling problem-solving (Libutaque, 2011).

Some studies were conducted on habits of mind on young children (Goldenberg, Shteingold & Feurzig, 2002), on junior high school students (Andriani, Yulianti, Ferdias, & Fatonah, 2017), and on postgraduate students (Alhamlan, Aljasser, Almajed, Almansour, & Alahmad, 2017) while studies on non-routine problem solving was done on elementary students (Yazgan, 2015) and high school students (Maulana & Yuniawati, 2018), among others. However, literature review suggests that MHoM in solving non-routine problems in the Philippine setting remains understudied and there is a need to ascertain certain habits of mind that predict academic performance in relation to the five (5) components suggested by UPNISMED (in Arellano, 2013). The results of this study may help policy makers, curriculum developers, teachers and other stakeholders determine the present status of the MHoM of students in solving non-routine problems. Programs and measures necessary to address these concerns can be made as well.

Moreover, the results of this study partially addressed the research gap and contribute to the growing body of literature. Due to the above contentions, this study was conducted.

2. METHODS

This descriptive-correlational study endeavored to ascertain the levels of mathematical habits of mind (MHoM) and its components that best predict academic performance of Grade 9 high school students. This study also ascertained the levels of the academic performance of students with respect to their MHoM level and the degree of relationship of its components.

Descriptive research (Estabrook & Findley, 1991) is a non-experimental research dealing with relationship of variables and developing generalizations, principles or theories. This study is descriptive since it made use of mean and standard deviation to describe the level of MHoM and its specific components when respondents were taken as a whole and when grouped according to school type and academic performance.

On the other hand, correlational research studies the relationships among two or more variables studied without any attempt to influence them (Fraenkel and Wallen, 2009). This study is also correlational in nature since it seeks to establish the relationships existing between the specific components of MHoM that could best describe the larger population from which the sample was drawn.

The respondents of this study were the Grade 9 high school students of randomly selected high schools within Iloilo City, Philippines. The distribution of the respondents is reflected in Table 1.

Table 1

Demographic Profile of the Respondents

Category	n	%
A. Entire Group	120	100
B. School Type		
Private All-boys School	43	36
Public CoEd School	41	34
Private CoEd School	36	30

This study made use of the Mathematical Habits of Mind (MHoM) Instrument which consisted of two parts: (1) Non-Routine Problem Solving Instrument and (2) The Habit of Reflecting and Self-checking of Learning Instrument. The scale from the study of Libutaque (2011) as shown in Table 2 was used to determine the respondents' levels of MHoM.

Table 2

A Five-point scale in determining the Over-all and Specific Levels of Mathematical Habits of Mind (MHoM) of Students

Scale	Description
3.50 - 4.00	Very Strongly-developed
2.50 - 3.49	Strongly-developed
1.50 - 2.49	Satisfactorily-developed
0.50 - 1.49	Slightly-developed
0.00 - 0.49	Not developed

Note: Source: Libutaque (2011)

To determine the levels of the academic performance (based on 1st quarter numerical and/or literal Mathematics grades) of students with varying MHoM levels, the following scale in Table 3 was used:

Table 3

A Guide in Categorizing Students' Academic Performance

Letter Grade	Equivalent Numerical Value (%)	Qualitative Description
A	90 and above	High
P and AP	80 – 89	Average
D and B	79 and below	Low

Validity and reliability issues were addressed. Research protocol was strictly followed. The researcher then administered the data-gathering instrument to the respondents. The first quarter/grading period grades of the respondents were retrieved from their respective mathematics teachers.

The researcher then subjected the grades and scores to appropriate statistical analyses. Mean and standard deviation were used for descriptive data analyses. For inferential data analyses, ANOVA, multiple regression analysis, and Pearson's r were used. All data were processed using the Statistical Package for Social Sciences (SPSS) version 21 set at 0.05 significance level. To interpret the results of Pearson's r, the following scale in Table 4 was used.

Table 4

A Guide in Interpreting the Results of Pearson's r

Strength of Association	Coefficient, *r*
Weak	±.1 to .3
Moderate	±.3 to .5
High/Strong	±.5 to 1.0

Note: Source: Cohen (1992)

3. RESULTS

Respondents' level of mathematical habits of mind reached the "Satisfactorily-developed" level as a whole and when grouped according to school type.

Table 5

Level of Mathematical Habits of Mind (MHoM) of Grade 9 Respondents When Taken as an Entire Group and When Grouped According to School Type

Grouping Variable	Mathematical Habits of Mind (MHoM)		
	SD	*M*	Description
A. Entire Group	0.40	1.95	Satisfactorily-developed
B. School Type			
All-Boys School	0.52	1.85	Satisfactorily-developed
Public Coed School	0.33	1.98	Satisfactorily-developed
Private Coed School	0.26	2.03	Satisfactorily-developed

Legend: Very Strongly-developed (VSD) (3.50 - 4.00), Strongly-developed (StD) (2.50 - 3.49), Satisfactorily-developed (SaD) (1.50 - 2.49), Slightly-developed (SlD) (0.50 - 1.49), Not developed (ND) (0.00 - 0.49)

Respondents' level of "solving problems in many ways" and "reflecting and self-checking of learning" have reached the lowest and highest levels, respectively while their other 3 habits of mind reached the "satisfactorily-developed" level.

Table 6

Level of the Components of Mathematical Habits of Mind When Respondents are taken as an Entire Group

Habit	Mathematical Habits of Mind (MHoM)		
	SD	*M*	Description
1. Searching for Patterns	0.58	2.06	Satisfactorily-developed
2. Linking Ideas and Representation	0.55	1.86	Satisfactorily-developed
3. Reasoning Deductively and through Experiments	0.59	1.87	Satisfactorily-developed
4. Solving Problems in Many Ways	0.31	1.21	Slightly-developed
5. Reflecting and Self-Checking of Learning	0.41	2.74	Strongly-developed

Legend: Very Strongly-developed (VSD) (3.50 - 4.00), Strongly-developed (StD) (2.50 - 3.49), Satisfactorily-developed (SaD) (1.50 - 2.49), Slightly-developed (SlD) (0.50 - 1.49), Not developed (ND) (0.00 - 0.49)

The respondents' level of the components of MHoM vary when they are grouped according to school type.

Table 7
Level of Components of Mathematical Habits of Mind (MHoM) When the Respondents are Grouped According to School Type

Habit	All-Boys Schools			Public CoEd School			Private CoEd School		
	SD	M	Desc.	SD	M	Desc.	SD	M	Desc.
1. Searching for Patterns 2. Linking Ideas and Representation	0.74	1.96	SaD	0.54	2.11	SaD	0.41	2.12	SaD
3. Reasoning Deductively and through Experiments	0.74	1.80	SaD	0.46	1.85	SaD	0.36	1.93	SaD
4. Solving Problems in Many Ways	0.73	1.75	SaD	0.55	1.93	SaD	0.43	1.95	SaD
5. Reflecting and Self-Checking of Learning	0.32	1.08	SlD	0.30	1.27	SlD	0.24	1.32	SlD
	0.52	2.67	StD	0.38	2.75	StD	0.32	2.82	StD

Legend: Very Strongly-developed (VSD) (3.50 - 4.00), Strongly-developed (StD) (2.50 - 3.49), Satisfactorily-developed (SaD) (1.50 - 2.49), Slightly-developed (SlD) (0.50 - 1.49), Not developed (ND) (0.00 - 0.49)

Respondents have at least "Slightly-developed" level of mathematical habits of mind. Those with "Slightly-developed" and "Satisfactorily-developed" habits of mind generally have "Average" academic performance. With the exception for "Reflecting and Self-checking of Learning", those with "Strongly-developed" or "Very Strongly-developed" habits of mind have "High" academic performance, particularly in Mathematics. It could be observed that very few reached the "Very Strongly-developed" habits of mind.

Table 8
Levels of the Academic Performance of the Respondents with Varying Levels of the Components of Mathematical Habits of Mind (MHoM)

Habits	Very Strongly-Developed				Strongly-developed				Satisfactorily-developed				Slightly-developed			
	n	SD	M	Desc.	n	SD	M	Desc.	n	SD	M	Desc.	N	SD	M	Desc.
Entire Group	-	-	-	-	8	3.74	93.63	H	95	4.62	85.60	A	17	5.22	82.12	A
Components																
1. Searching for Patterns	1	-	97.00	H	28	4.69	89.61	H	74	4.25	84.89	A	17	5.41	81.65	A
2. Linking Ideas and Representation	2	5.66	93.00	H	14	5.41	91.21	H	78	4.24	85.62	A	26	4.90	82.12	A
3. Reasoning Deductively and through Experiments	-	-	-	-	17	5.71	89.82	H	67	4.87	85.91	A	36	4.32	83.14	A
4. Solving Problems in Many Ways	-	-	-	-	-	-	-	-	21	4.54	88.81	A	99	5.15	84.96	A
5. Reflecting and Self-Checking of Learning	2	0.71	97.50	H	84	4.51	86.36	A	34	5.60	83.15	A	-	-	-	-

Note:

Letter Grade	Equivalent Numerical Value (%)	Qualitative Description
A	90 and above	High (H)
P and AP	80 – 89	Average (A)
D and B	79 and below	Low (L)

When grouped according to school type, Grade 9 students significantly differ in their habit of "Solving Problems in many Ways". However, they have similar mathematical habits of mind in the other 4 habits.

Table 9

One-Way Analysis of Variance showing the Significant Differences in the Components of Mathematical Habits of Mind (MHoM) when Respondents are Grouped According to School Type

Habits		Sum of Squares	df	Mean Square	*F*	*p*-value
Mathematical Habits of Mind (MHoM)	Between Groups	0.69	2	0.34	2.22	0.113
	Within Groups	18.04	117	0.15		
	Total	18.73	119			
Components of MHoM						
Searching for Patterns	Between Groups	0.67	2	0.34	0.97	0.381
	Within Groups	40.54	117	0.35		
	Total	41.21	119			
Linking Ideas and Representation	Between Groups	0.36	2	0.18	0.59	0.557
	Within Groups	36.04	117	0.31		
	Total	36.40	119			
Reasoning Deductively and through experiments	Between Groups	1.02	2	0.51	1.47	0.233
	Within Groups	40.56	117	0.35		
	Total	41.58	119			
Solving Problems in Many Ways	Between Groups	1.33	2	0.66	7.83*	0.001
	Within Groups	9.91	117	0.09		
	Total	11.24	119			
Reflecting and Self-Checking of Learning	Between Groups	0.40	2	0.20	1.16	0.318
	Within Groups	20.40	117	0.17		
	Total	20.80	119			

Note: *$p \leq 0.001$

Coed schools, public and private, have significantly better/higher habit of "Solving Problems in many Ways" than their Private All-boys School counterparts.

Table 10

Post Hoc Test (Scheffe) Showing the Differences in the Habit of Solving Problems in Many Ways when Respondents are Grouped According to School Type

School Type	School Type	Mean Difference	*p*-value
Private All-boys School	Public CoEd school	0.19*	0.011
Private All-boys School	Private CoEd school	0.24**	0.002
Public CoEd school	Private CoEd school	0.05	0.793

Note: *$p<0.05$, **$p<0.01$

All components of Mathematical Habits of Mind are positively and significantly-related with one another.

Table 11

Pearson's r showing the Strength of Relationship among the Components of Mathematical Habits of Mind (MHoM)

Habits	Searching for Patterns	Linking Ideas and Representation	Reasoning Deductively and through experiments	Solving Problems in Many Ways	Reflecting and Self-Checking of Learning
Searching for Patterns					
Linking Ideas and Representation	0.82***				
Reasoning Deductively and through experiments	0.73***	0.79***			
Solving Problems in Many Ways	0.66***	0.61***	0.62***		
Reflecting and Self-Checking of Learning	0.29**	0.29**	0.22*	0.23*	

Note: *$p<0.05$, **$p<0.01$, ***$p\leq0.001$

The habits of Searching for Patterns and Reflecting and Self-checking of learning are components of Mathematical Habits of Mind that are significant predictors of academic performance.

Table 12

Multiple Linear Regression Analysis using Stepwise Method Showing the Components of Mathematical Habits of Mind (MHoM) that Predict Academic Performance

Habit	*r*	r^2	r^2 Change	*F* Change	*p*-value
Searching for Patterns	0.52	0.27	0.27	43.91***	.000
Searching for Patterns and Reflecting and Self-checking of learning	0.57	0.32	0.5	8.37**	.005

Note: **p<0.01, ***p≤0.001

Model	β	*t*	*p*-value
Constant	69.39	25.39***	.000
Habit of Searching for Patterns	-4.05	5.72***	.000
Habit of Reflecting and Self-checking of Learning	2.88	2.89**	.005

Note: **p<0.01, ***p≤0.001

4. DISCUSSION

Descriptive Data Analyses:

It can be seen in Table 5 that the Grade 9 respondents have MHoM that is "Satisfactorily-developed" when taken as a whole and when grouped according to school type. Table 6 reflects that the respondents have strongly-developed habit of reflecting and self-checking of learning while their habit of solving problems in many ways is slightly-developed.The other three components (searching for patterns, linking ideas/representation, and reasoning deductively and through experiments) reached the "Satisfactorily-developed" level. The same is true when they are categorized according to school type as reflected in Table 7. In all the five components, it is clear that respondents from Private CoEd School consistently have the highest mean while respondents from all-boys schools have the lowest mean. The levels of the academic performance of students vary alongside the MHoM as reflected in Table 8.

Inferential Data Analyses:

Table 9 shows that there is a significant difference in a component of MHoM when respondents are grouped according to school type. Post hoc analysis (Scheffe) showed that coed students (public and private) have significantly higher habit of solving problems in many ways than private all-boys school respondents. The significant difference may be attributed to the presence of female respondents in private coed school and public coed school. Guarian, Stevens and Daniels (2009) noted that brain-based differences play a significant role in the academic set-up since girls mature faster than boys and this could significantly affect the habit of solving problems in many ways of the respondents. Girls, in general, are better in multi-tasking and channeling their responses into speaking or writing while boys need more time to process information and express themselves freely. No significant differences exist in the MHoM of the respondents as a whole and in terms of the other four components.

Table 11 shows that though each of the components of MHoM have varying strengths of relationships, still they are significantly-related with one another. This suggests the inter-relatedness or relationship of one component to the other in such a way that one component relates to all the other components of MHoM.

Table 12 shows that two variables entered in the regression equation as predictors of academic performance. It appears that 27% and 7% in the variation in the academic performance is accountable to the students' habit of searching for patterns and reflecting and self-checking of learning, respectively. This means that the combination of these two components could account for 32% of the variation of academic performance of students.

The *p*-value associated with the *t* for the habit of searching for patterns and habit of reflecting and self-checking of learning is significant at 0.01. This means that both the habit of searching for patterns and habit of reflecting and self-checking of learning can significantly predict academic performance. The prediction equation of the line using the coefficient β is

$$Predicted\ (AP) = 4.05(SP) + 2.88\ (RSL) + 69.39$$

where *AP* = Academic Performance, *HSP* = Habit of Searching for Patterns , and *RSL* = Habit of Reflecting and Self-checking of Learning.

It is important to note that the study posed certain limitations in terms of generalizability. The results of the study may apply only to Grade 9 high school students within the research locale. Moreover, since only the first grading period grades (numerical and letter) were used as basis of respondents' academic performance, then there is a need to acknowledge the limitation of the query to such and further studies are needed for validation and comparison purposes. With respect to the findings of this study, the it could be concluded that the development of the MHoM is

independent of the type of school one is affiliated with. Students are exposed in a way to opportunities to develop the habits of searching for patterns, linking ideas and representation and reflecting and self-checking of learning but not so exposed to solving problems in many ways and thus, they were not able to develop this habit.

Coed school students have more developed MHoM than private all-boys schools. Students have developed MHoM in varying degrees regardless of academic performance and type of school he/she is affiliated with. Grade 9 students have similar experiences in terms of searching for patterns, linking ideas and representation, reasoning deductively and through experiments, solving problems in many ways, and reflecting and self-checking of learning regardless of type of school they are affiliated with but coed school students are better at solving problems in many ways than private all-boys schools students. Each of the components of MHoM is related to the other components of MHoM. The habit of searching for patterns and reflecting and self-checking of learning can help students get higher grades.

It is recommended that students try to accustom themselves to and persist in solving non-routine problems to further improve their habits of mind and specific components. Students should likewise try exploring other possible ways to solve a problem and not be contented with solving it with only one strategy. Teachers may try to incorporate the use of non-routine problems as part or enrichment to lessons. Teachers should likewise provide opportunities for students to be exposed to problems that may be solved in many ways. They should encourage a community of learners who help hand-in-hand to develop all the five components of the MHoM of students. DepEd and CHED may monitor the progress of the development of the MHoM of students especially in solving non-routine problems. Curriculum developers and managers can explicitly include non-routine problem-solving as one of the courses in the Mathematics degree program with emphasis on the development of the mathematical habits of mind (MHoM) so that pre-service and in-service teachers could be equipped with the knowledge and disposition to help their students develop necessary MHoM. Pre-service teachers and students taking BSEd major in mathematics could also be encouraged to attend seminars and training-workshops regarding problem solving and how they can use their knowledge to further facilitate the learning process. Other researchers may conduct similar studies to determine the level of MHoM and its components to elementary schools and to schools outside of Iloilo City. Qualitative and/or mixed method studies may also be conducted. They may also do a similar study that includes other variables such as sex, socio-economic status, and school location, among others.

REFERENCES

[1] Alhamlan, S., Aljasser, H., Almajed, A., Almansour, H., & Alahmad, N. (2017). A systematic review: Using habits of mind ti improve student's thinking in class. Higher Education Studies, 8(1), ISSN 1925-4741.

[2] Andriani, S., Yulianti, K., Ferdias, P., & Fatonah, S. (2017). The effect of mathematical habits of mind learning strategy based on problem towards students' mathematical creative thinking disposition. IJAEDU-International E-Journal of Advances in Education, 3(9).

[3] Arellano, E. (2013). Mathematical Habits [PowerPoint presentation and handouts]. 3rd Regional Mathematical Investigation Seminar-Workshop, West Visayas State University, La Paz, Iloilo City dated April 20, 21,& 27, 2013.

[4] Arslan, C & Altun, M. (2007). Learning to solve non-routine mathematical problems. Elementary Education Online, 6, pp. 50-61.

[5] Asman, D., & Markowitz, Z. (2001). The Use of Real Word Knowledge in Solving Mathematical Problems. Proceedings of the 25th Conference of the International Group for the Psychology of Mathematics Education, Utrecht, Netherlands.

[6] Cohen, J. (1992). A power primer. Psychological Bulletin, 112(1): 155 – 159.

[7] Cuoco, A. & Levasseur, K. (2003). Mathematical Habits of Mind. In The National Council of Teachers of Mathematics (NCTM) (2003). Teaching Mathematics through Problem Solving: Grades 6-12. NCTM, ISBN 0-87353-541-3, 27-37.

[8] Cuoco, A., Goldenberg, E. P., & Mark, J. (1996). Habits of mind: An organizing principle for mathematics curricula. Journal of Mathematical Behavior, 15(4), 375–402.

[9] Cuoco, A., Goldenberg, E. P., & Mark, J. (2010). Contemporary curriculum issues: Organizing a curriculum around mathematical habits of mind. Mathematics Teacher, 103(9), 682–688.

[10] Cuoco, A., Matsuura, R., Piecham, M.B., Stevens, G., & Sword, S. (2013). Mathematical habits of mind for teaching: using language in algebra classrooms. The Mathematics Enthusiast , ISSN 1551-3440, 10(3), 735-776.

[11] Encio, K.J. (2013). Joining forces of math and virtue. The Infinity, 3(1), ISSN# 2244-3290, 17

[12] Estabrook, R. and Findley, D. (1991). Teacher evaluation: Curriculum and instructional considerations. Retrieved from ERIC database. (EJ440379)

[13] Fraenkel, J. & Wallen, N. (2009). How to design and evaluate research in education. New HigginsYork: McGraw-Hill Companies, Inc.

[14] Goldenberg, E. P. Shteingold, N., & Feurzig, N. (2002). Mathematical habits of mind for young children. Education Development Center, Inc.

[15] Guarian, M. , Stevens, K., & Daniels, P. (2009). Successful single-sex classrooms: A practical guide to teaching boys & girls separately. San Francisco: Jossey-Bass.

[16] Higgins, K. M. (1997). The Effect of Long Instruction in Mathematical Problem Solving on Middle School Students'Attitudes, Beliefs and Abilities. Journal of Experimental Education, 66(1), 5-24.

[17] Krulik, S. & Rudnick. J. (1996). The new sourcebook for teaching reasoning and problem solving in junior and senior high schools. Boston, MA: Allyn and Bacon.

[18] Libutaque, M. (2011). Mathematical investigation (mi) approach in teaching algebra in the development of problem-solving and proof-writing skills and mathematical habits of mind. Unpublished Doctoral Dissertation. West Visayas State University, La Paz, Iloilo City.

[19] Limjap, A. (1996). A constructivist- based instructional systems design for undergraduate discrete mathematics . Unpublished Doctoral Dissertation, De La Salle University, Manila, Philippines.

[20] Mark, J., Cuoco, A., Goldenberg, E. P., & Sword, S. (2010). Contemporary curriculum issues: Developing mathematical habits of mind. Mathematics teaching in the Middle School, 15(9), 505–509.

[21] Maulana, F. & Yuniawati, N.T. (2018). Students' problem solving ability in non-routine geometry problem. Internaational Journal of Information and Education Technology, 8(9).

[22] Yazgan, Y. (2015). Sixth graders and non-routine problems: Which strategies are decisive for success?. Educational Research and Reviews, 10(3), ISSN 1990-3839, pp. 1807-1816.