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# The effect of teaching with the mathematics activity based on purdue model on critical thinking skills and mathematics problem solving attitudes of gifted and non-gifted students

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## Abstract

The purpose of this study is to design an example activity based on Purdue Model (PM) about “The Arithmetic of Conscious Consumption” (ACC) unit for 7 th grade gifted students (GS) and non-gifted students (NGS) (25 G, 22 NG) in our country and to investigate the effects of this activity on critical thinking skills (CTS) and mathematical problem solving attitudes (MPSA) of these students. Eventually, it is concluded that the activity designed based on PM is more effective than the activities included in the National Education curriculum (NEC) on CTS and MPSA of G and NG students.

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## Introduction

In the recent years, researches made in Turkey related to GS are in an increasing way. But, It is also not enough for them. These children shouldn't be given rein and there shouldn't be said that because these children have superior abilities, they can make everything by themselves. Thanks to a good education, they can reach to a condition of succeeding well things. But in the condition of being neglected, they can give raise to a big disaster for their countries. These gifted brain power should be appreciated and these people should be employed in our country.

Firstly, the most important thing is to determine GS and their range of abilities (Kerem and Kınık, 2004). Parents and teachers should also be made conscious of their children's abilities to be determined in the early period. The goal is the education that planned to their needs and abilities they have.

According to the multi dimensional description of giftedness, cognitive talents like early development of brain, rapid understanding and learning in a high speed, high cognitive abilities for rapid learning of concepts, always being in front of time, explicit curiosity, improved vocabulary according to the age, producing creative ideas and methods for solving complex problems, problems being interested individually, convergent and divergent thinking, sensitivity to problems, tendency of individuals according to the hard tasks could be thought to be the indicators of giftedness in childhood and adulthood (Heller and Schofield, 2008).

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A person could be talented. However, addition of the feature of superiority onto their talents is related to their performance which individuals show in using the potential they have. Giftedness is not a concept to be able to be expressed. This is because; the individual characteristics which community needs are added to this concept constantly. In connection with, this concept is in change. The most important thing is to keep in step with this change and meet GS' needs. However the concept changes, by looking at historical development, the principal characteristics which GS have can be determined and the needs of GS can be met by making studies orientated to those students (Budak, 2008). The education of this potential for the community has the priority because of being a strategical human resource and education of this potential should be dealt with an importance in all respects (Bilgili and Dalkiran, 2004).

The main purpose in the education of gifted and talented students is to help them to improve their potential intelligence to an higher level of performance. A good education for GS cannot be imposed. Then, the second aim is to encourage and motivate their free will studies for success in a high level. In this position, this aim is to improve individual enhancement of every talented people to a maximum level (Feldhusen and Kolloff, 1986).

Gallagher (1998) thinks that the arrangements made educationally for GS are transmutation of content presented and thinking strategies that students learned. It is important that educational needs of GS should be met according to their characteristics and requirements (Dağlıoğlu, 2004).

According to Hollingworth, an adult's intelligence and a child's emotions combine in a child's body and this position meets this child with difficulties (Robinson and Clinkenbeard, 2008). If the educational opportunities that they deserve provide them, their contributions will be great to the society (Güzel, 2004).

PM uses first stage for teaching main thinking skills such as flexibility, fluency, originality, maturation, imagination and asking question. It uses second stage for teaching more complex thinking strategies such as logical deduction, critical thinking and creative problem solving. Third stage of the model has independent, individual learning and project activities for initiating early development of children (Feldhusen and Kolloff, 1986).

The aims of PM are as follows (Feldhusen and Kolloff, 1986):

1. Improving the main thinking skills of GS,
2. Helping GS to improve their individually understanding by making little groups attraction between them,
3. Helping GS to be more efficient and independent,
4. Helping GS to improve their mental and creative skills with educational activities

One of the abilities that individuals should have for accommodating today's conditions and medium-and long-term conditions in the world, is CTS (Akar, 2007). Development of CTS in mathematics lessons can be possible with being given lessons according CTS or with being applied student centered approach (Günhan, 2006).

The mathematics attitudes of student come into existence and take form with learning experiences. If learning mathematics becomes meaningful, related and enjoyable, it forms positive attitudes. For this reason, in-class learning activities should evoke admiration and interest. Also, these activities should build up trust of the students (Ministry of Education, 2006).

The purpose of this study is to design an example activity based on PM about ACC unit for 7 th grade GS and NGS in our country and to investigate the effects of this activity on the CTS and MPSA of these students.

Problem sentence can be expressed as: "Does the developed activity based on PM, in teaching ACC, have an influence to the CTS and MPSA of GS and NGS? Sub-problems are as follows:

1. Is there any significant difference between CTS of GS and NGS in control group (CG) and experimental group (EG) before and after the application?
2. Is there any significant difference between MPSA of GS and NGS in CG and EG before and after the application?

Thanks to the activities based on PM, it has been thought that the students learn more effectively the subject on which they worked, and by using their former knowledge outside some memorized formulas, they will be able to find easily the solutions of some problems that they will meet. The research is of importance in that the model used for gifted students is applied to NGS. PM is generally applied to Science lessons. But in this research the model was

applied to mathematics. In this case, there was looked into being able to applied this model to mathematics lessons. Also, this research is of importance in that this model was used to GS and NGS.

The studies made referring to PM showed that the model is effective on creative thinking skills (Kolloff and Feldhusen (1984)) and achievements (Moon, Feldhusen and Dillion (1994), Ünlü, Tarhan and İnceç (2007), Ünlü (2008) ) of children. But there was no studies found about the effects of this model on MPSA and CTS of children.

The study of Görecek (2007) named “Ortak yuvamız mavi gezegenimizi tanıyalım ve koruyalım ünitesinin proje destekli öğretiminin öğrencilerin başarılarına ve tutumlarına etkisi” showed that achievement and attitudes scores of EG made project supported teaching are significantly higher than CG’s.

The study of Scott (2008) named “Perceptions of students’ learning critical thinking through debate in a technology classroom: a case study” got data through a survey about the ideas of children on the method of debate made in classroom for increasing CTS. At the end of research, it was concluded that students think the method of debate is a useful activity for understanding the subjects foreseen, getting new knowledge and increasing CTS.

The study of Demirel and Turan (2010) named “The effects of problem based learning on achievement, attitude, metacognitive awareness and motivation” researched the effect of teaching with Science and Technology lesson based on problem based teaching on achievements, attitudes, cognitive awareness and motivations of children. The study was made experimentally with two different groups in 6th stage. The results showed that achievement, attitude, cognitive awareness and motivation scores of EG made problem based teaching are significantly higher than CG’s.

## Methodology

In this study, we used pre- post test model with a control group. While the unit ACC was taught by the activities developed based on PM to 12 NGS and 11 GS included in EG, the same subject was taught by using the activities included in NEC to 10 NGS and 14 GS included in CG. The universe of the study consists of the 7<sup>th</sup> grade students from primary schools in Fatih county of Istanbul. The sample of the study consists of 25 GS and 22 NGS from 7-B and 7-C classrooms from Beyazıt Ford Otosan primary school in the same county of Istanbul.

CCTSLX and MPSAS were applied before and after the application to two groups and the results of them were analyzed. The validity and reliability of CCTSLX was made by Assoc. Prof. Dr. Cüneyt Akar. MPSAS intended to measure the attitudes of primary school students related to solving mathematics problem was composed of 19 items and developed by the lecturer Dr. Orhan ÇANAKÇI. It consists of two dimensions called as “Teaching” and “Enjoyment”.

The research took 9 weeks. In the first stage of the model activities was made within the scopes of main and integrated scientific process skills. In the second stage of the model group work was made. Without making discrimination, GS and NGS were grouped in the way of being equal GS and NGS in all groups. They were demanded to find alternative solution ways and decide the most efficient solution way for problems by making collaboration, debate and brainstorming. In the third stage individually, free project work was made by them.

## Results

Table 1. Independent Samples t-test Comparison Related To CCTSLX Post Test Scores Of GS In CG and EG

Groups	N	Average	sd	fd	t	P
Control	14	37.357	9.270			
Experimental	11	46.363	7.990	23	-2.558	0.018

According to Table 1 ( $t_{(23)} = -2.558$ ,  $p=0.018<0.050$ ), there is a significant difference between CCTSLX post test scores of the GS in CG and EG. Because the average of EG is higher than CG’s, the significance is in the direction of EG.

Table 2. Independent Samples t-test Comparison Related To CCTSLX Post Test Scores Of NGS In CG and EG

Groups	N	Average	sd	fd	t	P
Control	10	30.800	4.939	20	-2.225	0.038
Experimental	12	38.416	9.811			

According to Table 2 ( $t_{(20)} = -2.225$ ,  $p=0.038<0.050$ ), there is a significant difference between CCTSLX post test scores of the NGS in CG and EG. Because the average of EG is higher than CG's, the significance is in the direction of EG.

Table 3. Independent Samples t-test Comparison Related To MPSAS Post Test Scores Of GS In CG and EG

Groups	N	Average	sd	fd	t	P
Control	14	69.142	15.047	23	-4.038	0.001
Experimental	11	88.909	6.714			

According to Table 3 ( $t_{(23)} = -4.038$ ,  $p=0.001<0.050$ ), there is a significant difference between MPSAS post test scores of the GS in CG and EG. Because the average of EG is higher than CG's, the significance is in the direction of EG. Also, there is a significant difference between MPSAS enjoyment dimension post test scores of GS ( $t_{(23)} = -3.950$ ,  $p=0.001<0.050$ ) and MPSAS teaching dimension post test scores of GS ( $t_{(23)} = -3.089$ ,  $p=0.005<0.050$ ) in CG and EG. In both of the results, the significance is in the direction of EG.

Table 4. Independent Samples t-test Comparison Related To MPSAS Post Test Scores Of NGS In CG and EG

Groups	N	Average	sd	fd	t	P
Control	10	55.6000	7.64780	20	-9.442	0.000
Experimental	13	83.9167	6.45908			

According to Table 4 ( $t_{(20)} = -9.442$ ,  $p=0.000<0.050$ ), there is a significant difference between MPSAS post test scores of the NGS in CG and EG. Because the average of EG is higher than CG's, the significance is in the direction of EG. Also; there is a significant difference between MPSAS enjoyment dimension post test scores of NGS ( $t_{(20)} = -8.337$ ,  $p=0.000<0.050$ ) and MPSAS teaching dimension post test scores of NGS ( $t_{(20)} = -5.952$ ,  $p=0.000<0.050$ ) in CG and EG. In both of the results, the significance is in the direction of EG.

## Discussion and Conclusion

After literature had been searched, a study related with the subject "Does the developed activity based on PM, in teaching the ACC unit, have an influence to the CTS and MPSA of GS and NGS?" could not be found. It also supports the idea that this study would contribute to the field. It is concluded that the developed activity based on PM is more effective than the activities from the NEC over CTS and MPSA of GS and NGS.

The reason of being low of critical thinking post test scores of control group is that the activities included in National Education curriculum are not led students to think, reason, ask and question. The reason of being high of critical thinking post test scores of experimental group is that the activity based on PM includes debates, collaborative teaching, teaching CTS based on lesson, listening students' ideas about all subjects, enabling students to play active roles, individually made project work and enabling students to create products. Because of being project supported, the activities would increase concern of students related to the lesson and enable them to have positive attitudes on solving the problems related to the lesson by leading students to create solutions, making them to present their products by themselves, making them to relish creating something individually.

The research is coinciding with Görecek (2007) in that it shows the positive effect of project supported model on attitude and it is coinciding with Scott (2008) in that it includes debates which have an important role to increase critical thinking skills. Also, because the activities include problem based teaching which has an important role on attitudes of students, the research is coinciding with Demirel and Turan (2010).

## Recommendations

It is recommended that the activities based on PM should be designed related to all primary mathematics curriculum and the effects of these activities on achievements and thinking skills of GS and NGS should be searched. Also it is recommended that by giving some knowledge about the model, with a pre-service and in-service teaching, teachers of all fields should be designed activities based on PM.

It is recommended that there should be cared about debate, asking question and questioning and that different solution ways of problems should be wanted from students. Also, it is recommended that students should state the solutions with their reasons and they should apply these problems to the different problems and they should be faced with day time problems.

It is recommended that in the activities based on model should be made both horizontal and vertical enrichment. At the last stage of the activity students should find the project topics and teachers shouldn't be budged from their guidelines. Also, students should be given feedback shortly after project presentations.

It is recommended that at the second stage of the model without distinguishing GS and NGS should be included in the same groups and in a long period the research should be made and qualitative data should be gathered.

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