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An Application of the Three Stage-Purdue Model in Physics Education in Turkey

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Abstract: This study is about science education for the gifted students in one of the Science Art Centers in Turkey. The effect of the Three Stage Purdue Model on the physics education of 11, 12 and 13 year-old gifted students was investigated. Studies were conducted with 16 students who were found to be gifted in physics in laboratories for 5 months and development of each student was observed and recorded. The results of the observation demonstrated that the Three Stage Purdue Model had contributed to the development of the participant students' use of their abilities in physics and that the model was successful.

Key words: Gifted education, enrichment models, three stage purdue model, physics laboratory activities

INTRODUCTION

On average, only 2 to 3% of human population is generally found to be gifted. Education of the gifted is very important because a gifted brain can influence the world both in positive and negative ways. When the development of human beings is analyzed from the past until today, it is seen that the ones who gave way to this development were gifted and talented people. The events such as the use of atomic bomb in 1945 and the launch of Sputnik to space in 1957 made, the importance of the identification and education of gifted and talented people clear. Gagné (1999) summarized the nature and origins of human abilities, gifts and talents in 22 conditions and invited professionals and academicians in this field to analyze them. Gagné categorized the 22 conditions and he put forward them in three groups: (i) the nature of human abilities, (ii) individual differences and their origins and (iii) the specific case of gifts and talents. This detailed work is important for the gifted ones to be recognized by us. We do not know which special steps should be taken for the hidden abilities to be revealed. However, we know the circumstances under which a gifted child will not develop her/his abilities: an oppressive environment with no support and encouragement (Christian, 2001). Therefore, determining the giftedness and giving them appropriate education is very important.

There are several models for the education of gifted students. Some of these models are Autonomous Learner Model (Betts, 1999), The Enrichment Triad Model (Renzulli, 1999, 2000; Garcia-Cepero, 2008). The Schoolwide Enrichment Model (Renzulli and Reis, 1994; Renzulli, 2005), The Three Ring Conception of Giftedness (Renzulli, 2003), The Three-Stage Purdue Model (Feldhusen and Kolloff, 1986) and Integrated Curriculum Model (Van Tassel-Baska *et al.*, 2000; Thorburn and Collins, 2006). VanTassel-Baska and Brown (2007) compared the effectiveness of the curriculum models used in the education of the gifted and set 15 criteria for this comparison such as student learning impact, application to actual curriculum, teacher, receptivity, ease of implementation.

Enrichment programs and activities are being frequently used in gifted education (e.g., Neu *et al.*, 2004; Lee and Olzewski-Kubilius, 2006; Stake and Nickens, 2005; McCoach, 2003; Stake and Nickens, 2005; Hertzog, 2003). Studies on developing creative thinking (Memmert, 2006) and gifted students with learning-disablities (Hannah and Shore, 2008; Nogueira, 2006) are examples of such use. Stake and Mares (2001), who studied and evaluated the efficiency of the enrichment programs implemented in the education of the gifted, reported the benefits of these programs. According to this study, benefits of the program are more obvious when the students who participated in such a program before are registered in the program again. Among of the enrichment models, the Three-Stage Purdue Model is considered to be the ideal one for elementary school level. The aims of the Three-Stage Purdue Model are to develop the cognitive skills of the gifted, form small group interaction with the other gifted ones, help them develop intellectual and creative abilities and help them be independent and active learners (Feldhusen and Kolloff, 1986). The stages of the model can be summarized as:

Stage 1: Short creative and critical-thinking exercises (at the beginning of the year)
Stage 2: Creative problem solving (throughout the year)
Stage 3: Independent study

There are several research on Three Stage Purdue Model. The characteristics of the gifted science students and their concomitant needs are associated with the stages of the three stage model (Hoover, 1989). This association is useful in terms of adjusting the comprehensibility of the model's steps and the activities during practice. Hoover presents an example of how the three stage model could be applied to the content of plants for the elementary education. The long term effects of the Purdue model had been investigated and 6 years later a research was conducted with the learners educated in accordance with this model and their parents. The results of the study showed the benefits of the applied model (Moon *et al*., 1994). The Purdue Three-Stage Model has been used not only in the education of gifted students, but also in the training program prepared for the staff working in the education of the gifted in order to contribute to their development in this field and it has proved to be effective (Moon, 1996).

It is known that education for gifted Turkish people was first given in schools named as Palace Schools during Ottoman Empire (Enç, 2005). Studies about the education for gifted people started in 1960s in the period of republic. These studies started as private classes and homogenous talent group exercises. The first science high school was opened in 1964 and their number has reached up to 66. In 1995 Science-Art Centre (SAC) affiliated with the Ministry of Education was established and they began to fill in the gap in the field of gifted people's education in Turkey as a centre trying to follow and apply the new theories in the area. Currently there are SACs in 25 different cities of Turkey as of 2005. Primary and secondary school students selected as gifted go to these centers and receive further education during after-school times. The ministry of education formed the guidelines for the selection and education of gifted children but details for the educational process were left to the teachers who attended a special in-service training. Since a project based program is taken as the basis for the education of the gifted in Turkey, Three-Stage Purdue Model was considered to be the most appropriate model. A common problem of science education in Turkey is the insufficiency of science process skills and laboratory applications. However, a research emphasizes the fact that laboratory activities are necessary for effective science teaching (Gezer and Bilen, 2007). The stages of the Purdue model are reasonably appropriate in both eliminating these insufficiencies and enriching the education of the gifted students.

The current study is about the application of the three-stage Purdue Model in physics teaching and about the obtained results in one of the SACs mentioned above. The purpose of the study is to investigate effect of the Three Stage Purdue Model on the physics education of 11, 12 and 13 year-old gifted students. In their studies searching the effectiveness of the models used in the education of the gifted, VanTassel-Baska and Brown (2007) pointed out the insufficiency of the evidence on the Purdue Model. The result of the practice realized in Turkey and mentioned below will provide diversity in the studies conducted on this model.

MATERIALS AND METHODS

This study was conducted with 16 students selected out of 2823 students receiving education in the primary schools in Turkey in 2004. In the past various studies were conducted on identifying and selecting gifted students (e.g., Pfeiffer, 2003; Hartas *et al*., 2008; Arancibia *et al*., 2008; Callahan, 2005; Baldwin, 2005; Ruban, 2005; Gorse, 2007; Pfeiffer and Petscher, 2008; Pfeiffer and Jarosewich, 2007; Van Tassel-Baska *et al*., 2007; Bracken and Brown, 2006). Although selection of the gifted students is not a part of this study, the routine application will be mentioned briefly. First, teachers are asked to give the names of the students who they think are highly or specially talented. The students who are in the lists are taken into a group test consisting of multiple choice questions by the ministry and the ones who score 65 out of 100 points are given a mental performance test (WISC-R) (Wechsler, 2004). Students who are determined as gifted at the end of these tests are enrolled to a SAC. Students are divided into groups to enable their presence in the SAC during after-school times. The orientation education is given to these groups for 6 weeks. The aim of the orientation education is to enable students know each other, their teachers and the SAC. Furthermore, by preparing meetings with the guardians of the children, information is given about the SAC and the education process within the center. After the orientation education, the support education starts. In the support education, students who are divided into groups of 3-5 perform activities in 9 different fields and start to discover their talents. In the other side, the teachers who are watching the students in every field during the activities start to identify the students who are talented in their fields. Students who are working as groups in the support education perform the activities in turn. That is, while a group is performing an activity in a field, other groups are also performing activities in other fields (Fig. 1).

After the support education finishes, the next step is to pass to a program which makes individualistic talents clearer. The study mentioned in this study was made in this phase. The numbers of the students who participated every step was determined in the Table 1 for the year 2004 in which this study was carried out.

During the activities in the SAC laboratory and activities outside the laboratory, the selection of the

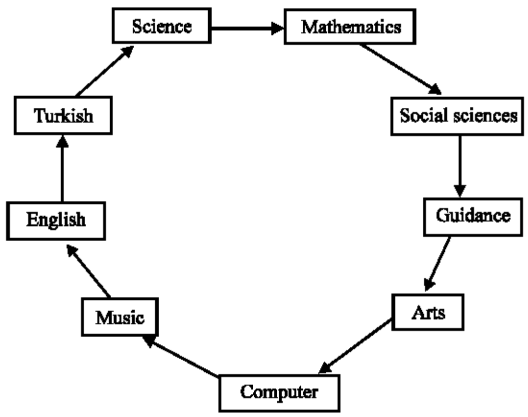

Fig. 1: Activity chain in the support education

Table 1: The numbers of the students in the gifted student selection phase within the year of 2004

	No. of students			
Age	What school teachers recommend	Ones that entered into group test	Ones who entered into WISC-R	Enrolled in SAC
11	303	235	27	5
12	406	371	44	13
13	45	45	19	12
Total	754	651	90	30

students who were gifted in physics or who liked studying physics were conducted according to the criteria determined by the researcher. These criteria are as follows:

- Interest in physics subjects
- Speed of understanding physics subjects
- Ability to develop physics subjects
- Paying attention to the details of the subjects related to physics
- Having distinctive opinions on events related to physics
- Not being satisfied with what is learned but want to learn new things
- Trying to associate the events she/he sees around with physics subjects
- Asking interesting questions about physics

Taking these criteria into account, a portfolio was prepared for each student and 16 students interested in and gifted at studying physics were selected. Number of the selected students according to their ages is shown in Table 2.

Activities to be performed with the 16 selected students were planned according to the ministry's science course curriculum for each age group. After having science class with their teachers at normal classes, the

Table 2: Age distribution of gifted students who are enrolled in the SAC and who are talented and enthusiastic about physics

	Age			
	11	12	13	Total
Gifted students enrolled in SAC	5	13	12	30
Gifted students interested in physics enrolled in SAC	3	7	6	16

Table 3: The physics subjects for students who are 11 years old determined by the SAC

1st phase	
Sound	Origination of sound
	Emission of sound
	Characteristics of sound
	Echo
Light	Transparent and opaque substances
	Emission of light
	Formation of shadow
	Formation of daytime and night
	Solar and lunar eclipse
Mirrors	Reflection of light
	Reflection, principal focus and axis of concave mirror
	Image formation by a converging mirror
	Reflection, principal focus and axis of convex mirror
	Image formation by a convex mirror
Refraction of light	Refraction of light
	Convex lenses
	Images formed by convex lenses
	Concave lenses
	Images formed by diverging lenses
2nd phase	
Electrostatic	Charged body
	Force between charged body
	Electroscope
	Transition of electric charges
Electricity	Voltaic cells
	Conductors and electric current
	Electrical energy and heat
	Ohm's law
	Simple electrical circuits
	Complex electrical circuits
	Batteries
3rd phase	
Motion and force	Forces and its effects, gravity
	Friction
	Parallel forces
	Resultant forces
	Friction and surface relationship
Energy	Transformation of energy
Lever	Lever with two arms
Inclined planes	Inclined planes
Pulleys	Fixed pulley
	Movable pulley
	Pulleys systems
	Tackles

students came to the SAC and performed activities related to the subjects they learned at school. These activities were performed by a teacher from the SAC who had training related to gifted students in physics.

The data collection took 5 months. During this period, the students came to the SAC and participated in 8-12 activities in a manner which is appropriate to their school curricula. Physics subjects according to ages were shown in Table 3.

The activities were organized according to the stages of the Purdue model. In the first phase tools were introduced to the students and the realization of the experiment was shown. While the teacher made the experiment, the students helped him/her. In the second phase, the experiments were made with the students. The students can choose the experiment tools and utilize them now. In the third phase, while the teacher was present to interfere when necessary, the students conducted the experiment themselves and they designed authentic experiments. Students worked in groups of 2-3 students in these phases. In the last phase, the students were asked to develop projects other than the planned activities. Starting from the very beginning of the study, students were given information about project developing and encouraged about it. While developing projects, the students worked alone or in groups of two.

The tasks which the students performed during each activity, their conversations between themselves and their teachers, questions they asked, students' answers to questions, students' study methods and behaviors were collected in a portfolio together with observational notes. The data were marked quantitatively on a scale of 5 according to a rubric in the following six categories:

Interest in subjects: Student's interest in subjects related to physics was graded.

- Uninterested
- Poorly interested
- Moderate interest
- Interested
- Very interested

Ability to form new information: Students' effort for reaching new information by the aid of what they learned was graded.

- Can not form new information
- Can form new information by help
- Can form new information when clues are given
- Can form new information
- Can form new information very rapidly

Ability to interpret subjects and related events: Students' distinctive interpretations were graded during the activities.

- Doesn't interpret
- Interprets but is effected by his/her other friends and his/her environment
- Sometimes makes distinctive interpretations
- Makes distinctive interpretations, doesn't get effected by his/her environment
- Interprets perfectly, effects its environment

Making analysis: Students' skills of quantitative measuring, causal link associating and systematic thinking were graded.

- Doesn't make analysis
- Barely makes analysis
- Sometimes makes analysis
- Generally makes analysis
- Always makes analysis

Associating different subjects: Students' ability of associating different physics subjects was graded.

- Very poor
- Poor
- Moderate
- Good
- Very good

Improving learned information: Students' effort to improve and apply the information learned was graded.

- Very poor
- Poor
- Moderate
- Good
- Very good

For every activity performed, students' scores that they obtained from categories were shown in Table 4.

The generalizability coefficient for the reliability between the measurements was separately calculated for each category and for the first four activities (Table 5). The reason why this calculation was done for the first four activities is that there were activities in which each

Table 4: The form of evaluation for students who are talented in physics and who are enthusiastic about physics

	Activities											
Categories	1	2	3	4	5	6	7	8	9	10	11	12
Interest in subjects												
Ability to form new information												
Ability to interpret subjects and related events												
Making analysis												
Associating different subjects												
Improving learned information												

Table 5: Generalizability coefficients calculated for each category

Categories	Generalizability coefficients
Interest in subjects	0.68
Ability to form new information	0.80
Ability to interpret subjects and related events	0.65
Making analysis	0.59
Associating different subjects	0.47
Improving learned information	0.79

student participated with no absence. As for other activities, some students were not able to participate in them due to their excuses.

RESULTS AND DISCUSSION

The selection criteria for giftedness in physics were found to be mostly successful. The 1st, 2nd and 6th students who were identified as gifted in physics in the beginning were found not to be gifted or interested in studying physics at the end of the whole study (Fig. 2). The students' development of using abilities in physics is shown in Fig. 2. According to Fig. 2, all of the students, except for student No. 2, have shown positive development between initial and final states.

Seven out of the 16 students who attended the activities produced a successful project as an indication of stage 3. The projects can be summarized as: student No. 4, a book holding device to prevent arms from getting tired; student No. 5, recycling of the used X-ray films and their usage as transparencies; student No. 7, a model football pitch with rotary tribunes; students No. 9 and 10, turn on-turn off lights system with remote controller; student No. 11, TV with 3 screens for making possible that everyone watches his/her favorite programs and School bag with anorak tool; student No. 12, system that helps fume out of the chimney.

As it can be shown from Fig. 1, there is an obvious difference between the initial and final states of some students (i.e., No. 4, 5, 7 and 11). These four students were also in the successful project group. In general, it can be said that the activities had positive contributions for the students.

According to Stake and Mares (2001), pre-post difference scores are not sufficient for the evaluation of the effectiveness of the enrichment programs. Longer time periods are necessary for the evaluation of such programs.

Scores were recorded in the form shown in Table 4 for every student in every activity. The scores that the student No. 2 and 4 obtained from activities for each category are shown in Fig. 2-7. The student No. 2 who did not show an improvement and the student No. 4 who showed a great improvement according to Fig. 2 are taken

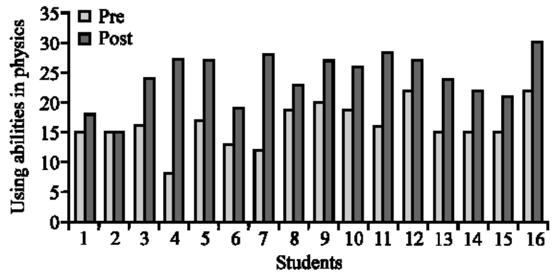

Fig. 2: Development of using abilities in physics

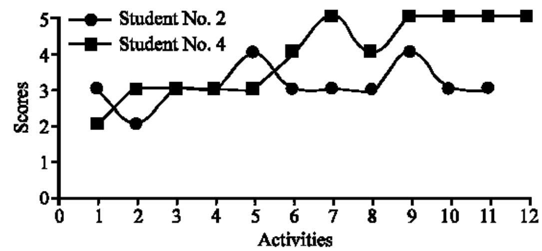

Fig. 3: The scores that the student No. 2 and 4 got in the category of interest in subjects for all activities

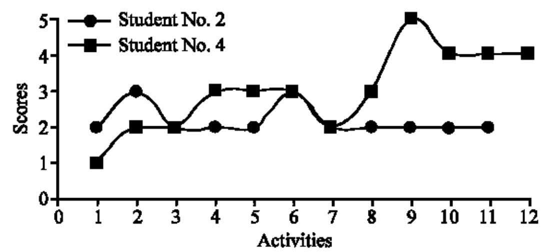

Fig. 4: The scores that the student No. 2 and 4 got in the category of ability to form new information for all activities

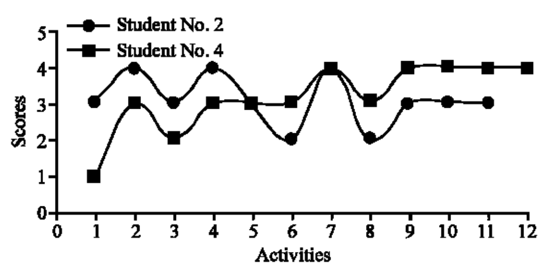

Fig. 5: The scores that the student No. 2 and 4 got in the category of ability to interpret subjects and related events for all activities

as examples. These graphs demonstrate the changes in the scores of two students selected for 6 categories studied during time.

When Fig. 3-8 are examined, it may be concluded that the student No. 2's interest in physics subjects is

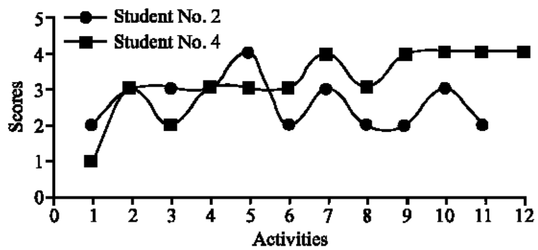

Fig. 6: The scores that the student No. 2 and 4 got in the category of making analysis for all activities

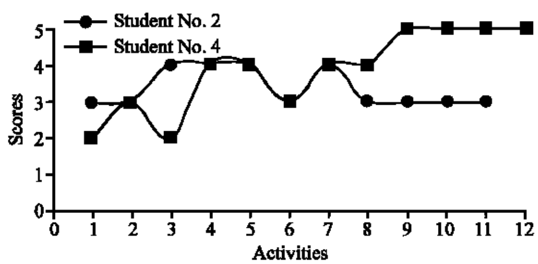

Fig. 7: The scores that the student No. 2 and 4 got in the category of associating different subjects for all activities

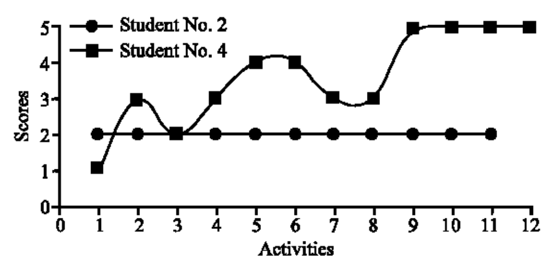

Fig. 8: The scores that the student No. 2 and 4 got in the category of improving learned information for all activities

moderate, he/she can form new information by help, he/she can sometimes make distinctive interpretations, he/she barely makes analysis, his/her associating different subjects is moderate and he/she is poor in improving the information learned. For the student No. 4, it can be said that he/she is interested in physics subjects, he/she can form new information when clue is given, he/she can sometimes make distinctive interpretation, he/she can sometimes make analysis, his/her associating different things is good and he/she is good in improving the information learned. These comments may also be made for other students.

CONCLUSION

This research was conducted on gifted students aged 11-13 the above given results show the successful application and benefits of the three stage model. The fact that this model is appropriate for this elementary level and its stages can be practiced in a flexible way proves that it is a proper model for the education of gifted students in SACs in Turkey. The activities which are practiced in the field of physics with this model can be enlarged to the other fields when the study of the gifteds' education which is quite new in Turkey becomes more systematic.

There are some problems in the education of the gifted children in Turkey. The process of identifying the gifted students starts with the determination by school teachers of the names of the students that they consider to be gifted. This situation makes it difficult to identify the gifted in one sense. Because teachers may not be able distinguish between hard-working and gifted students. The challenge in this field in Turkey is the high number of the students involved. Studies subject to this article may contribute to every student regardless of whether he/she is gifted or not. However, high number of students brings along problems in terms of time, space and economy. For this reason, in order to render the process of establishing the gifted more efficient, training of school teachers on the gifted may be the solution of this problem.

We think that one of the main problems in Turkey is the qualification examinations that are applied at the end of grades 8 and 12 and the examination system. This situation effects the education of the gifted students negatively. Because of test anxiety, the importance of activities done at the SAC is not being fully acknowledged. The parents also consider these activities performed in the SAC as a waste of time for their children. Another negative effect of the examination system is the fact that, besides the lack of science process skills, students are in preparation for multiple choice exams which excludes performance.

The enrichment activities in the education of the gifted children affect the students' social activities negatively. Doing homework takes a long time and hence leaving less time for games and their families (Moon *et al*., 2002). The effects of the activities in the SAC on the students' social life should also be investigated in future studies.

Despite all these problems, development in using abilities in physics together with project activities (stage 3) can be considered as a success of the model. We think that the current curriculum reform, which is recently being implemented in Turkey, will affect the education of the gifted positively and the quality of gifted education will increase.

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