



Evaluation of project-based learning process of gifted children via reflective journals

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Abstract

The project-based learning approach is a learning model that encourages the active participation of gifted students, supports high-level cognitive activities, requires a wide range of tools and resources, consider academic and social skills together and emphasizes the use of technology. This study is based on the learning experiences of gifted children designed with project-based approach. The study employed a holistic single-case embedded design, one of the qualitative research designs. The study group of the research consists of four gifted students in a Science and Art Center in the South Marmara Region. Criterion sampling, one of the purposeful sampling types, was used to determine the study group. Learning experiences of the gifted children through project-based learning approach were determined via reflective journals. The data in the reflective journals written by gifted students were given with direct quotations within the framework of the main theme and sub-themes, and inferences and interpretations were made. It was found out that gifted children have an advanced level reflective writing ability. It was also observed that participants grounded their projects with real-life problems and made inter-disciplinary connections in their reflections. Besides, bearing the character traits of gifted children, the participants effectively used higher-level thinking skills and cognitive strategies.

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Keywords: Project-based learning; gifted students; reflective journals; academic skills; social skills

1. Introduction

1.1. Introduce the problem

Nowadays, within the scope of 21st century skills, it is aimed to provide the learners with high-level thinking skills such as critical thinking skills and creative thinking in the acquisition of knowledge in cooperation. One of the most emphasized learning approaches in effectively acquiring the 21st century skills is project-based learning (Metz, 2015).

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Project-based learning (PBL) is a teaching model that enables the students to encounter intriguing problems and eventually to produce original products. In project-based learning, in order to perform desired level behaviors, it is crucial to carry out the relevant procedures this approach involves meticulously (Grant, 2002).

Project-based learning is a student-centered teaching method instead of utilizing demotivating strict lesson plans. There are a number of advantages of project-based learning. In literature, the advantages of PBL were mentioned (Curtis, 2002; Dori & Tal, 2000; Solomon, 2003; Zoller, 1991) as follows:

Project-based learning;

- engages the learner in the learning process
- develops self-confidence of the learners in terms of problem-solving
- learners take more responsibility compared to traditional education models
- involves high-level of thinking, problem-solving, group work and individual effort
- is effective in acquiring complex skills
- enables different learning opportunities
- provides teachers with essential feedback about the learning performance
- guides about multiple ways of learning rather than a single way
- improves higher-level thinking skills of students such as data analysis, decision making etc.

PBL is an important triggering motivational factor in high-level learning when thoroughly understanding and internalizing any subject (Bell, 2010). PBL aims to investigate a subject in depth through projects at the PBL center (Wengrowicz, Dori, & Dori, 2014). In this approach, solutions to real-life problems are put forward with a view to hands-on education notion (Tims, 2009). In project-based learning, students try to learn by being in charge of meaningful tasks for them, questioning, putting forward hypothesis, discussing ideas, scrutinizing others' ideas, enabling to come up with new ideas (Krajcik & Blumenfeld, 2006).

During the course of PBL the learner is active and learning activities are sometimes carried out in groups or individually. Projects are mainly formed of complex tasks and the learner must be perseverant until the problem is solved. Throughout the process, the learners are aimed to display a product by making designs, solving problems, performing decision-making tasks (Thomas, 2000). The main success indicator of PBL is performing a product (Krajcik & Blumenfeld, 2006). It is revealed in literature that in educational processes designed with project-based learning, there is significant increase in high-level learning on the part of the learners (Grant & Branch, 2005; Meyer & Wurdinger, 2016).

Other important features of PBL are stated in literature as being based on real-life content, involving a real assessment, enabling opportunities for indirect and planned interference of teachers, having obvious educational purposes, fostering collaborative learning, stimulating thorough thinking on the subject and developing adulthood skills (Thomas, 2000). Besides, project-based learning lets the learners comprehend the importance of inter-disciplinary relations, strengthens the collaboration between the learner and experts, families, and teachers, encourages thinking before taking an action, relates the teaching material with the real life. The purposes of project-based learning are clear. PBL increases the satisfaction level of the learner about the teaching process, and develops research and management skills (Cunha, 2005).

Project-based learning is teaching method, particularly suitable for the needs of gifted children. Teaching through projects provides the gifted children with an active framework on forming different educational opportunities. PBL contributes to producing complex products by means of its developed content and higher-level thinking processes (Gallagher & Gallagher, 1994). In project-based learning, gifted students are in charge either individually or in groups throughout the project. The teachers get the learners to make decisions or to develop questioning skills through challenging questions or issues by assigning the learners complex tasks, asking them to make designs or solve problems. (Jones, Rasmussen & Moffitt, 1997; Thomas, Mergendoller, & Michaelson, 1999). Teachers not only facilitate effective group work in this process but also take on an effective leadership role by supporting the learners academically for them to work on their projects.

Besides the academic improvement of the gifted children, project-based learning also meaningfully contributes to their social and affective development. When research studies on PBL approach were analyzed, it was found out that the project tasks positively affected the learning process, learners participated in the learning activities voluntarily and worked with high level of motivation and that they even had more positive attitudes towards the lessons they dislike, that the tasks motivate them to do research and make observations and that left a significant mark in terms of learning by doing (Maker & Schiever, 2004; Preuss, 2002; VanTassel-Baska, 1994).

Project-based learning is an interdisciplinary-model by its nature. As content, it focuses on the questions or issues the students need to comprehend in order to distinguish the meaning of the concepts. It creates a constructivist environment for students to create the information they need to solve the problem or answer questions. Students are significantly self-directed in following up on problem solving, and problems are always presented based on real or authentic scenarios. Problem scenarios are incomplete as students do not provide all the information; they need to solve the problem. While researching the problem, students can redefine it and throughout the process solving the problem may take more time than anticipated.

Project-based learning is also closely related with constructivist approach (Grant, 2002). Constructivist designs like project-based learning are regarded as an alternative to traditional teaching methods (Aşan & Haliloğlu, 2005). In that case, what is the driving force on the way from traditional learning to accomplishing project-based learning? Or, in other words, why should we define project-based learning as discovery learning method? As an answer to this question, it is stated that traditional learning methods do not foster individuality sufficiently, does not allow for the student's ideas to a sufficient extent and does not value knowledge required to be used in a challenging task such as learning (Polman, 1998; Thomas, 2000).

In today's classrooms, there is a greater need for an educational environment for the teachers to provide relevant opportunities to gifted children that deal with their needs. Within this context, it is essential that gifted children attain 21st century skills that will considerably facilitate their learning and that are necessary for them to perform tasks in more depth. In this framework this study focused on project-based learning for gifted children. Educators in the 21st century face a number of challenges in the classroom. It is necessary to motivate students and to make plans in order to integrate the curriculum based on the students' abilities, learning styles and individual differences. Project-based learning responds to most of the challenges faced during the teaching process. Why is project-based learning an effective teaching strategy for gifted students? The most striking answer to this question is that PBL allows for independent learning. In a learning environment in which students make choices about the subjects they will study on and which emphasizes the formation of professional products, the fact that learners work on authentic problems makes PBL a natural learning methodology for the gifted children.

Gifted children have a higher level of vocabulary than their peers. Children with this potential learn to read and write before attending to school, can count up to a hundred, and can mentally add and subtract. According to Steiner and Carr (2003), gifted children are different in many respects compared to their average-talented peers. Gifted students have a much wider knowledge base and are more successful in using their knowledge to their advantage. They prefer more complex and more challenging problems. They are faster in problem solving, but they spend more time planning the solution and diagnose problems more effectively. It is suggested that gifted children develop faster in one or more areas and these children have some common features (Smutny, 1998).

A gifted student cognitively develops earlier, learns and comprehends fast, is ahead of his/her peers, is able to solve complex problems, has creative thinking skills, uses different thinking skills and performs high-level cognitive skills. In line with the features they bear, it is a requisite that gifted students are provided with appropriate level learning experiences as of early childhood in order for them to develop holistically. Having the 21st century skills, gifted children, are the most important candidates that

can rise productivity at a considerable extent. Therefore, while educating gifted children, attaining a differentiated and enriched learning environment and equipping them with necessary skills is a major goal.

It is necessary to put into practice a different curriculum and process for gifted children. In this program, respect and enriching the teaching process are strategies and project work is an important means (Tortop, 2015). Sharing the project outcomes, environmental support, increasing the students' interest and expectations through positive feedback about project components will all positively impact success (Calvert, 2010). Sak (2012) states that project work is highly preferred by gifted students as it is a student initiative and that these students need such teaching activities.

Project-based learning enables the gifted students to attain comprehension skills of 'reason-result relationship' to solve real-life problems. Such projects make the students independent and read their materials in their own pace. PBL provides the gifted students with appropriate opportunities for them to be fully stimulated (Tomlinson, 2005). With their high potentials, gifted children are able to come up with practical solutions to problems from different viewpoints and make efforts on the tasks willingly for a prolonged time by thinking critically (Abu, 2018; Erdoğan, 2018; Johnsen, 2004; Langbeheim, 2015).

Within this context, with their individual traits, gifted children can work on a task for a long time. In our country, an institution, Science and Art Center (BİLSEM/ SAC) was established for the purpose of educating gifted children. SAC's have a flexible learning environment in which students can attain various different learning outcomes such as searching for solutions to real-life problems, making products. Disparate from mainstream schools, students in SAC's learn by doing, develop independent study skills, scrutinize real-life problems and work systematically for a long time (Liu, Lou, Shih, Meng, & Lee, 2010).

Through project-based learning, SAC's also make the students gain the skills to do scientific research (Powers, 2008; Raghavan, Coken-Regev, & Strobel, 2001). During PBL, gifted students are active and in charge in a number of steps like systematic data collection, doing research, writing project reports (Mills, 2003; Ocak & Ulusoy, 2010). This study is important in that it aims to analyze the gifted students' experience with regards to project-based learning and reveal their experiences, awareness, and challenges they have faced during the project preparation phase. Projects can only achieve their outcomes if there is an efficient process starting from the initial phase of idea generation to the last phase of evaluation (Özarslan & Çetin, 2015).

The assessment tool in this study is the reflective journals gifted students kept during the course of the project. Reflective journals enable learners to think holistically, make inferences, make connections between the learned materials by expressing themselves in written (Duman, 2012). They are written documents in which individuals define and

evaluate themselves in terms of the learning process. Reflective journals are used for the students to know about themselves more closely or for them to reveal their experiences, awareness about the learning process. The reason why reflective journals are used in education is that they reflect the experiences of learners throughout the learning process (Malthouse & Roffey, 2013). By means of reflective journals, students describe their awareness about their own learning practices (Moon, 2009). While contributing to the improvement of the writing ability, reflective journals also facilitate the development of high-level thinking skills (Gorlewski & Greene, 2011). Despite being used for various purposes, reflective journals also provide opportunities for learning (Farah, 2012; Thorpe, 2004). Journals both enable the students to think on the learning activities and to define what they have learned within the framework of a purpose (Tang, 2000).

Reflective journals are used as an important means to determine students' level of awareness about their own learning process. Within this framework, the levels of reflective writing are categorized as descriptive writing, descriptive writing including partial reflection, reflective writing and advanced level reflective writing (Moon, 2009). In this particular study, at which stage and how the gifted students reflect their experiences is revealed. The level of reflection is an important criterion for their self-awareness. The students using these skills are active, independent during the learning-teaching process.

Reflective journal writing is a learning technique realizing an effective learning process through writing a product (Farah, 2012). Reflective journals are written materials students form by adding their intuitions to their learning experiences and thinking about various cases (Thorpe, 2004). Boud (2001) specifies journal writing as a form that allows for the accomplishment of various purposes while completing various tasks. Reflective journal is the most important technique that paves the way for intrinsic learning of the individual. Students can use reflective journals for a number of purposes: writing about their interests, developing their imagination, making connections between the previous knowledge and newly learned knowledge (Farah, 2012). The main point at this stage is the student's documentation of the experiences, putting the knowledge into practice when experiencing similar conditions and executing a reflective process by re-evaluating the experiences (Wong, Kember, Chung & Yan, 1995). Moon (2009) states the various purposes of reflective journal writing in education as:

- Developing an inquiry-based attitude
- Maintaining in-depth learning through critical thinking
- Allowing for the realization of individual learning processes
- Increasing active participation levels of the learners in the learning process
- Developing the notion of self-evaluation
- Developing the notion of intuition

There are some studies that reflective journals promote reflective thinking (Graham, 2003; Spalding & Wilson, 2002;). Reflective journals are an important means to improve students' writing abilities both quantitatively and qualitatively (Kerka, 1996). The reason why reflective journals are used in this study is to document the experiences of the gifted students during project-based learning and to pave the way for a reflective process by asking the students to evaluate their experiences.

1.2. Significance of the Study

According to the United Nations Declaration of Children's Rights, it is a fundamental right that every child to receive education to improve his/her own capacity. However, it is not possible to enable gifted students to demonstrate their best capacity by developing their extraordinary potential with the existing program, tools and equipment, and this requires specially trained personnel, specially prepared programs, special tools and equipment, and appropriate educational environments.

The research studies revealed that the learning environments offered to gifted students should be designed to meet their academic, affective and social needs. In this context, it is very crucial for the gifted students to gain high quality life skills in parallel with their individual traits thanks to project-based learning. It is believed that this particular study will contribute to the literature in terms of revealing the students' experiences through reflective journals using project-based learning approach.

1.3. Purpose of the Study

Project-based learning is a model that promotes active participation of the student, supports the use of higher-level cognitive activities, requires the use of a variety of tools and materials, deals with academic, social skills and life skills simultaneously and emphasizes the use of technology. In this particular study, the experiences of the gifted students while using project-based model are the main focus. The answer to the following question about the use of reflective journals in project-based learning is searched for in this particular study:

How are the experiences of the gifted students in terms of project-based based learning stages?

2. Method

2.1. Research Design

In this particular study aiming at revealing the experiences of gifted students concerning the project-based learning process, because a single analysis case was scrutinized holistically, single-case embedded design was used as a qualitative research

design tool (Stake, 2003; Yin, 2003). Case study is used to scrutinize an issue systematically and comprehensively (Simons, 2009). The main reason why this is a case study is to explore the project-based learning experiences of the gifted students attending Science and Culture Center in terms of the process. Through case study, a qualitative research design tool, it is possible to explore a condition that has not been examined thoroughly before, and to comprehensively understand the condition, redefine and scrutinize it (McMillan & Schumacher, 2014; Stake, 2003).

In this research study, case study was selected in order to the explore the project process of the gifted students in depth. Single-case embedded design was used in the study as there were various cases and each case needed to be dealt holistically. There are some limitations of the study in that it is physically restrained with the project preparation center, the implementation lasted 12 weeks and it is carried out 24 lesson hours each of which was 2 hours and it involved the project-based learning approach steps.

2.2. Study Group

The study group comprises 4 gifted students attending the Science and Art Center in South Marmara region. Criterion sampling, one of the purposeful sampling types, was used to determine the study group. By using purposeful sampling method as part of criterion sampling, individuals and cases concerning the research question were determined (Yıldırım & Şimşek, 2011). The criteria when selecting the sampling group were the completion of the Adjustment and Support Program, attending Awareness of Individual Skills Program (AIS), deciding on the venue of the project preparation. That the participants to the study are 4 female students attending Science and Art Center in South Marmara can be accepted as one of the other limitations of the study.

When deciding on the study group, particular attention was paid to participate in the study voluntarily. In terms of the ethical concerns, the names of the participants were kept confidential and codes like GS1, GS2, ... ,GS4, were used instead. The demographic features of the participants can be seen in Table 1 below:

Table 1. Personal information about the gifted students participating in the study

Participant	Gender	SAC Program Type
GS1	Female	AIS-2
GS2	Female	AIS-1
GS3	Female	AIS-1
GS4	Female	AIS-2

As seen in Table 1, all of the participants of the study were females who took part either in awareness of individual skills 1 or 2 program.

2.3. Data Collection

Data collection of the study has lasted 12 weeks. The participants were asked to reflect their experiences about project-based learning to their journals. The participants voluntarily took part in the study. Throughout the study, gifted students gathered in the project preparation venue for 12 weeks and conducted their projects.

2.4. Data Analysis

The reflective journals were analyzed descriptively. In descriptive analysis, data were explored and interpreted systematically, and some conclusions were drawn in terms of reason-result relationship. Thus, themes emerging from the descriptive analysis are interpreted by the researcher (Yıldırım & Şimşek, 2011). The data were analyzed thematically and presented with direct quotes. With a view to increase reliability of the analysis, data were analyzed by another researcher and the data were compared accordingly. When quoting directly, the criterion of intensity was used as different viewpoints were reflected; the criterion of explanatoriness was met as the findings met the themes, and the criterion of variety was used as extreme examples were also given place in the analysis part.

For the sake of reliability, Miles and Huberman's (2015) Consensus / (Consensus + Disagreement) x 100 formula was used. The reliability rate between the researchers was found to be 89%. The study can be regarded as internally consistent as the consensus rate between the researchers was 89%; confirmable as the journals were kept to revisit and check when necessary; verifiable as the data analysis results were systematically, accurately and comprehensibly analyzed; transferable and credible as direct quotes of the participants were presented.

3. Results

In this section, themes of the gifted students' experiences reflected in journals were analyzed and quotes were given. At some parts, direct quotes from the journals were presented. The participants were asked to keep journals concerning the stages of their projects.

3.1. The findings of the gifted students' experiences of the project-based learning stages

It was found out in analysis of the reflective journals that gifted students came up with different ways of solutions to real-life problems, actively used higher-level thinking skills and made connections with their previous knowledge. The sub-themes of the analysis were 'deciding on the topic', 'researching the topic and planning', 'producing the product'

and ‘evaluation of the project’. The reflections of the gifted students were given in direct quotes.

In this research the levels of reflective writing are categorized as descriptive writing, descriptive writing including partial reflection, reflective writing and advanced level reflective writing (Moon, 2009). Reflective journals were used to determine the awareness levels of gifted students towards their learning processes for the determined sub-themes. Findings regarding how students reflect on the stage of the project process and reflective writing levels are presented in Table 2.

Tablo 2. Reflective writing levels of gifted students for project-based learning stages

Project Based Learning Stages Sub-Themes	Level			
	Descriptive writing	Descriptive writing including partial reflection	Reflective writing	Advanced level reflective writing
	f	f	f	f
Deciding on the topic	-	-	3	1
Researching the topic and planning	-	-	2	2
Producing the product	-	-	-	4
Evaluation of the project	-	-	1	3

When Table 2 is examined, gifted students are at the level of reflective writing (f = 3) and advanced reflective writing (f = 1) in the sub-theme of determining the subject from the project-based learning stages; they are at the level of reflective writing (f = 2) and advanced reflective writing (f = 2) in the sub-theme of planning and researching the subject; they are at the advanced writing (f = 4) level in the sub-theme of product creation; In the evaluation of the project sub-theme, it is seen that they are at the level of reflective writing (f = 1) and advanced reflective writing (f = 3).

When the reflective journals of gifted students were examined, it was found that none of them were at the level of descriptive writing, which included descriptive writing and some reflection. As a reason, it is thought that gifted students use their metacognitive structures effectively with their characteristic features.

3.2. The findings concerning ‘Deciding on the Topic’

The students’ remarks on deciding their topic of the project are as follows:

“Initially, I drew a project topic pool picture on a paper to decide on the topic when our teacher told me to come up with a topic after telling the stages of the project. I knew that

the topic was supposed to originate from a real-life problem I had been experiencing. I thought about a case that I frequently experienced in my daily life and also for most people in our city. There was a particular problem I felt in Çanakkale where we moved due to my parents' appointment: frequent rain. On rainy days, the fact that we could not put the wet umbrellas into our backpacks after the rain and that we could not carry it properly was a common problem for everyone. Therefore, what can I do with a wet umbrella after the rain? How can I put the wet umbrella into my backpack? Or how can I avoid wetting the floor with my umbrella in a department store or cafeteria? How can I avoid dirtying the floor or slipping? I decided on my topic deriving from these questions. My main question was how I would dry a wet umbrella practically and move on with my daily life" (GS1).

"I was supposed to decide on a topic as the initial stage of project planning. I would do some research about the topic in the following stages and come up with hypotheses. One of the remarks of my teacher was my starting point. She stated that a problem that you experience and want to solve is the most valuable of all. This is because that we are at the center of that problem. It is all about what you experience and how you feel. I have an 84-year old grandmother. She suffers from diabetes and therefore her skin is susceptible to any injury or wound and she bleeds easily due to this sensitivity. My mom used to place band-aid to her wounds constantly against infection. I thought about producing a band-aid that could either heal the wounds or prevent infection. If I solved this problem, I would find a solution not only for my grandmother but also for people suffering from such open wounds" (GS2).

"I listed various items as the possible topics of my project. In fact, there were many things I was curious to find about... Being mushroom lovers and eaters, my father and I always go to the countryside to pick mushrooms. As my father is used to picking mushrooms for a long time, he can identify if the mushroom is poisonous or not. Besides, my dad is an academician at University in the Department of Biology, and he is knowledgeable about the mushroom types in our vicinity and their shapes in detail. I used to think "what if we invent a piece of equipment with which we can practically identify the poison in a mushroom, if any, and see if it that mushroom is hazardous or not." When my teacher mentioned that I was supposed to decide on a topic I was curious or a problem I wanted to figure out a solution for, I came up with this idea" (GS3).

"If there is a university in your surroundings, it is more likely to see university students around. I commute with public transportation when travelling between the school, course and house. Waiting on the bus stop, and not knowing if the upcoming bus is fully occupied or if there are any vacant seats worries me a lot. While waiting at the bus stop, you can see after how many stops the bus will arrive from the digital screen, but you cannot see if the bus is crowded. What would you do, if you could know this? You would either decide on waiting for the next bus or the other one or travel by sitting. That's why I decided to

conduct a project about producing a digital screen at the bus stops that can display occupancy rate of the upcoming buses” (GS4).

When the reflections of the gifted students about ‘deciding on the topic’ were analyzed, it was observed that the students were aware of the steps to deciding on the topic and how this would be done. They had an idea about the process of the project, and they came up with real-life problems and these problems pertained to different disciplines.

3.3. *The findings concerning ‘Researching The Topic and Planning’*

The students’ remarks on researching the topic and planning are as follows:

“I did some literature research about this problem in the first place. In the light of literature, I found out that there are worldwide machines used to wrap umbrellas. I researched how these machines worked. During the research, I found umbrellas produced with a case to cover the handle and the main part of the umbrella that gets wet. I noticed that even the cases used were temporary solutions for the wet umbrellas. Yes, they made it more practical to carry the wet umbrella but wrapping the wet umbrella and keeping it wet did not solve the problem for me. It was not enough to carry the wet umbrella with temporary solutions. Therefore, I considered how I could practically make the wet umbrella hygienic and dry. If I could do this, I could also find a solution to the bad smell of the umbrella when kept wet in a case and to unhygienic microorganisms infiltrated on the umbrella due to rain. In my project, I focused on a product (machine) that could be used in various places (cafeteria, shopping mall) or open areas (specific squares, busy streets or bus stops) and that anyone at any age can use easily. I listed my project steps then” (GS1).

“As my project topic, I thought about a band-aid to be used for healing the open sores. I researched the studies about this. As a result of research, I found about a band-aid produced by a material called chitosan found in crustacean like crab and its combination with polylactic acid. This band-aid was particularly recommended for open sores of patients with diabetes and burn injuries. The fact that it was used for open sores had commonalities with my problem. This band-aid was air permeable and because it was dissoluble it prevented infections and healed the sores quickly. In another piece of literature, I understood that with its porous structure silkworm cocoon was also used for the open sores or non-healing wound. What I wanted to do in my project was to design an air permeable band-aid that will not stick to the wound and not rash the wounded skin. I formed the stages of my project. I did some observations by working on various prepartate and observed to find out which structures prevented infection and which ones enabled quick healing of the wounds” (GS2).

“When I decided to do research on the previous studies on my topic, I noticed that this was a serious issue and mushroom poisoning caused the death of many people up to now.

When people picked mushrooms in the nature unconsciously and they were not sure if it is poisonous or not, this could result in death. I also noticed that even the mushrooms whose shape and taste we know, there is no guarantee that it is non-poisonous. This is because mushrooms can take various forms when growing and some forms may be deceptive for people. Furthermore, I found out that the growing conditions of mushrooms and where it is grown mattered. For example, the same type of mushroom could be poisonous when grown in the United States and non-poisonous when grown in Europe. There are some simple methods to identify if mushrooms are poisonous or not. To specify, in a three-stage method, the first stage was to cut the mushroom into two pieces, check its color and fiber. In the second stage only a small piece of mushroom is tasted and checked if its taste is earthy and heavy and finally, I read that edible non-poisonous mushrooms are less than 7,5 cm in size. However, my purpose was to design a reagent, a small machine to practically identify the poisonous enzymes in the mushroom and I wanted ordinary people who would like to eat mushroom to use this machine. With this purpose in mind, I thought about invent a device whose light will be green when the mushroom is edible and red when there is an alarming condition about the mushroom. I also thought about which elements I could use in my device and I started to do planning about how to integrate what I had learned systematically” (GS3).

“The topic of my project was to produce a data set that would tell the occupancy rate in a bus before it arrives at the bus stop. This was because I did not want to commute standing in the bus especially when I felt tired after school. I needed solid data to display which bus or buses that will arrive at the bus stop simultaneously or consecutively is more available so that I could choose in between. I found in my study that the current monitors at the bus stops displayed only what the next bus would arrive and how many stops there are for the bus to arrive. Therefore, taking into consideration the Robotic Coding lessons in Science and Art Center, I thought about building a sensor to doors of the buses to count how many people get on and off and to check via weight sensors, how many people are sitting and standing in the bus. In fact, I realized that I could transfer a piece of information I learned in a different lesson to another context and I could use this information in my daily life or in other lessons. This made me so content and satisfied. With this satisfaction, I drew study circles of the chains. I wrote in each circle what I would do in each stage gradually” (GS4).

When the reflections of the gifted students about ‘researching the topic and planning’ were analyzed, it was seen that students go through an internalized process generally. Besides, it was determined that all of them effectively employed higher-level thinking skills bearing in mind the traits of gifted children. The students scrutinized the research findings considering their strength and weaknesses and expressed their ideas about what they could do with those strength and weaknesses.

3.4. The findings concerning 'Producing the Product'

The remarks of the students about producing the product are as follows:

“Upon the research I did, I decided to design a machine through a research-development project to figure out a solution to the problem. While forming the working principles of my project, I decided to consult experts, academicians in the Department of Physics at University. I figured a machine that could dry and disinfect simultaneously. Then, I drew the prototype of the umbrella drying machine. While drawing the sketches of my machine design, I also considered the swimming suit drying machines in the pools or tumble driers at our houses and their working principles. In order to produce a low-cost product, I designed a prototype in line with my sketch. In my product, I used jet air blowing holes, flexible elastic tapes, an optional tube, a hair dryer with IR heat resource function, a track with telescopic springs and air jet motor. I formed the stages of my project called Drymatic that could end the problem of wet umbrellas. Initially, wet umbrella is placed manually from the top, air jet motor hair dryer is run, the air created by the air jet fan and hair dryer moves in a circular way, the entrance part of jet air fan vacuums in the lower end of the machine. The exit part of the jet fan producing pressure, is built into the upper part of the machine and sweeps the water droplets on the umbrella. The water droplets spring to sloppy section in the lower part and leaks towards the water tank. With the hot air blown from the hair dryer, water droplets evaporate, and umbrella dries and UVC beams are used to disinfect the microorganisms sticking on the umbrella due to rain. Upon designing a prototype that functions with the above principles, besides the drying and disinfection of the wet umbrellas, I also decided to make the umbrellas smell good via the odor tablets placed in the lower part of the machine. In this context, I set up an apparatus that could dry the wet umbrella and disinfect it from microorganisms and when necessary optionally lets the umbrella smell good. When designing the apparatus, I produced my machine that will run with a power supply. I thought about designing a machine that runs with solar power outdoors and can be placed in various parts of the city, and with electricity indoors. I contemplated on drying-disinfecting machine that could dry two or three umbrellas simultaneously functioning at multi levels. This umbrella drying machine could be placed to different parts of the city by making use of renewable energy resources like wind or solar power and would be realized at certain places in the city center and bus stops. As the prototype of my project, I modelled it based on my stages of work and when I tried it, I saw that it worked properly. At that moment, I felt very much delighted because I came up with a solution to an actual problem in our daily life. While producing my product, some different ideas popped in my head. I believe this was because I always questioned when doing research and designing the prototype. For instance, waste water in the water tank in the drying system could be used for watering the plants. A flexible umbrella case that could be adjusted according to the design, size of the umbrella or the number of its wires. Therefore, several umbrellas with different designs could be dried at the same time. What

could be the alternative stages of my project when transferring my ideas to making a product? Or, I thought, what sort of other problems we encounter in our daily life can this mechanism solve? I came up with different problems in different contexts. For example, in regions where there is constant snow or rain in winter, a similar product that can dry and disinfect shoes in some intervals could be designed” (GS1).

“I started to design my product in the light of the research I did about my topic. I planned the stages of my project according to my work plan. I considered a band-aid with a different design and one that involves different content against getting infected or heals the sores quickly when we fall or get wounded. I also thought of which materials could be used in this band-aid. I wanted to design a band-aid particularly for people with diabetes and their open wounds or sores that cannot heal easily. I knew that an open wound is more likely to get infected but when the wound is covered with a band-aid, then the healing process used to get longer. That’s why I decided to design an air permeable and dissoluble band-aid that can heal the wounds and prevent infection. I designed the surface of the band-aid with holes, and I did research about some elements and materials used to heal sores and prevents infection. As a result of the research, I found out that honey and aloe vera, due to their natural features, prevent infection and enable to heal wounds easily. I produced the prototype of the product with aloe vera and honey. At this point, I prepared some prepartate and made observations about controlling and experimenting the product. I observed in my piloting study that in the band-aids including honey and aloe vera there was less microbial growth and quicker healing process. The holes in the band-aid enable lets air in the wound and because honey and aloe vera contacts with the wound easier, the sores get healed quicker and there is less risk of being infected. I was happy to see that I could figure out a solution to a daily problem and most of all I found a cure to my beloved grandmother’s sores” (GS2).

“I decided to make a project on identifying poisonous and non-poisonous mushroom types easily. I especially wanted my project to find a solution to frequent poisoning and death cases resulting in miserable conditions. My purpose was to design a small device. I was planning to device something that will enable us to decide whether the mushroom is poisonous with a reagent like it is done to distinguish acid and base. Upon research I found out that no such device was produced before. This made my task more difficult because I had to know about different categories of living things and how mushrooms are categorized according to their form, types, physiology and metabolism. I also found out in my research that even during their growth period mushrooms had different features. I learned that toxins that mushrooms synthesize, secondary metabolite cause major hazard for human and animal health and I even found out that aflatoxine in some mushrooms bear some features that may cause liver cancer. Mushroom species differ in terms of the region they are grown in. That’s why I started by listing the species of mushrooms in South Marmara region. Then I shortlisted the poisonous ones. I read about what type of poison they include and their effects. I got some help from the experts in the Department of

Biology in Faculty of Science-Literature. What I wanted to do was to produce a reagent from the enzymes of these poisonous mushrooms. Namely, I wanted to devise something to determine a graded apparatus by displaying the poison level from 1 to 10 in red color through testing a very small piece of mushroom. While trying to put my ideas into practice, I learned that accurate results cannot be reached about whether a mushroom is poisonous or not and that mushrooms go through changes during their growth period and their poison level changed in the course of time. That's why I could not actually produce the product I anticipated to design upon my research and implementation stages" (GS3).

"My project topic was to devise an apparatus to display occupancy rate in the bus before it arrives at the bus stop. I thought about two major points related to this. For instance, if the bus is fully occupied, a lot of people are standing in the bus, there could be a button at the bus stop that displays the number of stops remaining till the bus arrives and red light could be on signaling the crowd in the bus. This could be easily done but it could be done but only through subjective observation but not through a system providing objective statistical data. What I wanted to realize was a system that could implement this. Taking into consideration what I learned in Robotics lessons, I came up with the idea of a sensor system placed to the doors of the buses to calculate the number of passengers get on and off. If such systems are used in the shopping malls, they could be used on the buses, too. I placed sensors to the doors of the lego bus. Besides, I would determine the number of sitting passengers by placing some weight to the seats to see if they are occupied or not. I placed 4 pieces of tiny seats in the bus and I placed lego passengers onto each of them. What I thought was to transfer this idea to real life and to reflect the number of sitting and standing passengers. I could put my ideas into practice in the prototype part. However, I also thought of what things would be different or what sort of problems I would experience if I made these calculations in real life in a real bus. For example, I had to decide the kilogram limit to weight sensors I would place to the seats to see above which weight the sensor would identify the passenger. If a child was sitting on the seat or he/she was very thin, and if, for example, I defined the weight limit as 20 kilograms, the sensor would not identify, and I would not reach accurate data. Or if we placed the sensors based on the passengers that get on or off, I noticed that some people used the back door to get on and some used the front door to get off instead of doing the other way around. Although it was against the rules, it was a usual thing in our country. On the other hand, I thought about using body temperature sensors to calculate the number of passengers. I could not test this stage of the idea with the lego but I could test all the other stages in the lego car and saw that it worked. I believe I can use the prototype I developed in real buses to test my hypotheses" (GS4).

When the reflections of the gifted students about 'producing the product' were analyzed, it was seen that all of them are highly reflective in their ideas. When developing their products, each of them used higher-level thinking skills, questioned, connected their previous knowledge with what they had researched. It was also observed

that some came up with alternative practices and solutions besides the topic they had planned to work on in their project. Generally, students used reflective thinking to a great extent in their journals. Besides, they were seen to use metacognitive strategies effectively during the project.

3.5. The findings concerning 'Evaluation of the Project'

Gifted children did self-evaluation throughout their project as it was an individual process for them. In this context, the students' projects were evaluated in terms of their own learning processes. The remarks of the students about project evaluation in the reflective journals are as follows:

"If I am to evaluate the project I implemented, I can say that the process of the project was quite comprehensive, busy even overwhelming for me. My experience throughout the process is so valuable to me. Making inferences on the newly learned information and relating these pieces with my previous knowledge satisfied me a lot. Most of all, as an individual the most precious thing was to produce a product by coming up with a functional, constructive and practical solution to a problem. The reason why the product was functional was because I constantly questioned things throughout the project, made inferences on what I found and I used my creativity by internalizing the topic. I conducted my project successfully. During the process, even though I sometimes had difficulty while running the project I redesigned my work plan and I believe I avoided the possible problems to emerge. The most pleasing part for me was the production of the device. I got some advice from the experts when I had an issue to resolve. This project was so much in the center of my life...I especially came up with the idea of using air jet motor in my project popped into my mind when I was drying my hands in a shopping mall. I related this with my project. My constant evaluation of the project with my perseverance, systematical study and high motivation enabled me to produce my device successfully. The most valuable outcome was that I was aware that I could come up with alternative solutions about my project and improved my previous knowledge of the topic" (GS1).

"When I evaluate my project, I believe that I found an appropriate solution to a health problem of my beloved family member. When my teacher told us about project-based learning, initially I had no difficulty in finding a topic but during the research stage and while trying to find and decide on which structures, I could use in my band-aid I had some challenges. It was so exciting to make observations of the prepartate for the band-aid and to check if there was microbial growth or not. To put it in words, you have an idea about a problem. You construct this as your topic in the project and step by step you follow the process like you are knitting a rug. Sometimes things do not turn out as you have anticipated, sometimes you come up with something different or new. All these enabled me to make new decisions and improve myself in putting all these into practice. And this

project boosted my motivation about trying new things every time and relate what I have learned with my previous knowledge” (GS2).

“I was not able to produce the product I had set to design because I learned that such a machine about mushrooms required much more complex structures. I noticed during the research how little did I know about the specific structures of the mushrooms. I had to sidetrack my working schedule. However, in general terms when I evaluate the process of the project, I noticed that this process improved my decision-making skills. I started to evaluate things in my surrounding by more questioning and by scrutinizing them” (GS3).

“I love doing something with robotic coding. That’s why I related my topic with robotic coding. In fact, the project was so meaningful to me. When I was tired, I used to think which bus was less crowded and which one I had to take. I conducted my project with the legoes and trying even on the tiny models of the was unbelievably impressive. While pondering on doing robotic coding and using sensors throughout my project I frequently asked myself questions of ‘how?’ and ‘why?’. I tried to figure out a solution to a daily problem through robotic coding. There were times I had issues about material supply because the sensors I would use cost a lot. If I am to evaluate the process of the project in general terms, I can say the best part was to do robotic coding, to relate something I like such as using lego sets with my project” (GS4).

It was noticed that gifted students mainly used self-evaluation when evaluating the process of their project. The students stated what they were challenged with, what they put into practice easily, what they liked throughout the process quite consciously. In terms of the personal benefits, it enabled the students to evaluate themselves, define their own weaknesses, to assess and evaluate and analyze the project qualities, its requirements, the extent to what was realized. In this context, whether the students succeeded in this process, to what extent they realized what they had anticipated, what they acquired, contributed to their development as a feedback mechanism. Students put forward the negative and positive conditions throughout the process quite genuinely.

When the evaluative remarks of the students were checked, it can be inferred that students effectively used metacognitive strategies. In terms of the metacognitive strategies, students, when necessary, they actively and constructively designed their targets by monitoring their own cognition and behaviors. At this point, students employed metacognitive strategies by planning their targets, what they would do and by managing time. Within this context, it was determined that gifted students generally employed reflective writing techniques.

4. Discussion and Conclusion

In the education of gifted students, the project-based learning supports students’ life-long learning, facilitates independent learning, working and feeling of success, enables

them to use problem-solving techniques, learning about and developing stages of scientific method, provides scientific study habit improves their life skills particularly self-control skills (Croft, 2003). In project-based learning students complete their project tasks by working together on a project dealing with a real-life problem (McGrath, 2002; Wolk, 2001). Students decide on how to approach their own problems and what activities to carry out. They gather information from various resources, learn by analyzing and synthesizing the pieces of information. When they are in charge with the project and get satisfaction with it, they become learners that understand more easily and they learn by doing (Winn, 1997). In this particular study, the journals of the gifted students about the process of the project were analyzed. The journals were analyzed in terms of the sub-themes of 'deciding on the topic', 'researching the topic and planning', 'producing the product' and 'evaluation of the project'. In all the stages of the project, it was found out that gifted students actively employed metacognitive strategies. The fact that the students planned their projects by being aware of their cognitive strategies, monitored the progress throughout, and made evaluation made them use metacognitive strategies. When the literature was reviewed, it was seen that there was positive correlation between their reflective thinking and metacognitive skills, and that reflective thinking activities increased the metacognitive strategies of learners (Alexander, 1991; Cengiz, 2014; İdris, 2010). The review of literature also put forward that due to the traits of gifted children, because they are academically successful, they use metacognitive strategies and self-regulation strategies more effectively (Aktan, 2012; Börekci, 2018; Budak, 2016; Zimmerman, 2001).

It has also been demonstrated through studies that the project-based learning process that is carried out with gifted students meets the different needs of these students resulting from their different characteristics, ensures the effective use of higher-order thinking skills, and allows the use of different materials with different method (Gökdere & Ayvaci, 2004; Özarslan, Çetin, & Yıldırım, 2017).

In order to respond to different pedagogical needs for gifted students, it is necessary to have the content knowledge of the project-based learning process. The students' experiences are essential at this point. In the process of project-based learning, it was found out that they experienced what they had learned in various stages and made relations between the previous knowledge and the newly learned one. In the research study, the students reflected that taking charge of the learning process, being active at stages like doing research, assessing the data made them gain various skills. The contributions of project-based learning to the students were stated in various pieces of literature (Girgin, 2009).

When the gifted students' journals were analyzed, it was pinpointed that students learned things with a high-quality and temporarily. This particular finding of the study matches with the findings of Akkuzulu (2011), Çavuş & Özden (2012), Eker & Coşkun

(2012), Erdurdan-Avcı (2008), in their own studies. The literature propounds that reflective journals foster the efficiency of reflective thinking; provides opportunities for understanding their own feelings and opinions and fosters self-perception; creates an effective teaching process and lets the students use their own cognitive strategies (Andrusyszyn & Davie, 1997; McCrindle & Christensen, 1995; Nelken, McAdoo & Manwaring, 2009; Roderick, 1986).

In the research, it was observed that one of the gifted students related his project with robotic coding as he really liked robotic coding. When the literature about gifted students and robotic coding was analyzed, it was found out that students reconstruct meaning from what they have learned, related the experience with the process of learning, and that they do situational assessment better (Kırkan, 2018). In a similar vein, relating project-based learning process with robotic coding contributes to reflective thinking skills of the students (Göksoy & Yılmaz, 2018). Zengin (2016) put forth in her study that 64% of the gifted students discovered their talents about robotic systems via the related activities and 96% volunteered to do robotic coding activities.

In this particular research, it was observed that reflective journal experience of the gifted students contributed to their own development by analyzing their analytical thinking and problem-solving skills. This finding is parallel with various research findings (Chandrasekaran, Stojcevski, Littlefair, & Joordens, 2012; Hart, 2019; İdin & Özdemir-Şimşek, 2016; Lam, Cheng, & Choy, 2010; Mioduser & Betzer, 2007; Nacaroğlu, & Arslan, 2019; O'Rourke, 1998; Summers & Dickinson, 2012). Besides, it was determined that gifted students are engaged in writing activities willingly, with self-confidence and express their feelings and opinions more genuinely, clearly and intelligibly. This finding bears a resemblance to the studies of Walker (2006) and Williams (2008).

In their journals, students wrote about their challenges or the negative conditions, issues about time management or planning. Their cognitive strategies in such conditions and how they commented on the learned knowledge by in-dept internalization were all prevalent in the journals. In project studies with gifted children, they stated various issues they faced. These issues are lack of effective time-management, systematic planning of the collected data, inability to produce a product. When conducting a project, literature must be reviewed thoroughly and detailed data must be collected in line with the topic (Çetin & Şengezer, 2013).

One of the most crucial parts of the project is the concrete production of the product (Bell, 2010). In the research, only GS3 did not manage to produce a product. The students expressed in their journals that they had expert opinion during the process. It is essential that different materials be used, and expert opinion be received during the project (İdin & Özdemir-Şimşek, 2016).

5. Suggestions

In light of the findings of the study, studies in which gifted students reveal their experiences through reflective journals can be conducted considering different learning approaches. Mixed-method designs can be conducted through reflective journals that foster the use of metacognitive strategies like analytical thinking and problem-solving skills and researching about the cognitive skills and creative thinking levels. Similar research studies can be carried out with different age groups and different students attending SACs.

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