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High School Students' Views on the PBL Activities Supported via Flipped Classroom and LEGO Practices

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ABSTRACT

The purpose of this study was to investigate the high school students' views on instructions based on Flipped Classroom Model (FC) and LEGO applications. The case study, which is one of the qualitative research methods, was used within the scope of the study, the duration of which was 7 weeks. In order to choose the research group of the study, one of the purposeful sampling methods, criterion sampling, was used. In this context, the study was conducted with 35 10th grade high school students from two different classes. EGA (ExperimentalGroupA) consisted of 18 students while EGB (ExperimentalGroupB) consisted of 17 students. Within the scope of the study, algorithm instruction with FC and LEGO applications was conducted on EGA and LEGO applications and algorithm instruction in classroom were conducted on EGB. In accordance with the study, processes of focus group discussions and gathering data through observation were carried out. For the analysis of the data that was gathered, content analysis was performed and NVivo 8 was used. In the end of the study, the students were observed to be having great prejudices and reported negative views in the beginning of the study. Upon the initiation of the study, the prejudices and negative opinions were observed to be replaced by positive opinions. Students mentioned a great deal of educational benefits of the study. They stated that with the study, their motivation and interest in the lesson increased thanks to the implementations. Additionally in the group work, students said that they cooperated, exchanged ideas, shared tasks, took responsibility and socialized with their friends. About FC, students gave positive feedback on the communication opportunities of the atmosphere and they stated that they could repeatedly go beyond the class hours with FC, hence came prepared and saved time. Also students stated that FC atmosphere improved opportunities for teacher-student communication.

Keywords

Flipped classroom, LEGO, Robotic, Algorithm instruction, Problem-based learning

Introduction

It is seen that new technological products and developments that came to light each day are involved in the process of education (Ugur Erdogmuş & Cagiltay, 2013). Additionally, it is seen that there is a rapid change in the learning and teaching methods. As a result, with the help of ICTs education processes are made easier and permanent learning is enabled (Isman, 2011). These developments also bring more varying learner characteristics compared to past. The era we are in is called the digital era (Spranger, 2010). Prensky (2001) called the individuals who were born in digital era digital natives. These individuals who were born the digital era always interact with ICTs from the day they were born. Digital native students always carry phones, tablets and other ICT tools with them, trust technology that is present and live with these technologies (Oh & Reeves, 2014). In the classroom, these students develop new roles such as researcher, technology user and expert, reasoning and inference, using information that is learned in real life and self-teaching (Prensky, 2010). Hence it is thought that ICT use will be important for digital native students in acquiring and processing the information and thus, making teaching more efficient. With the inclusion of ICTs in education, the concept that is defined as using necessary information and skills to control education and structuring learning and teaching processes has emerged (Alkan, 2011). In the study conducted by Woolf (2010), it is seen that as a result of education technologies and learning environments, there will be considerable changes in education. In the Horizon Report that is regularly published by NMC, the fast effect of the development in ICTs on education processes can be seen (NMC History, 2014). MOOC, tablets, cloud computing, mobile learning and Flipped Classroom (FC) are some of the subjects that are stated in the report as planned to be included in education in five years (Johnson, Adams Becker, Estrada & Freeman, 2014a; 2014b). In another study, learner analytics, cloud computing, mobile applications and MOOC are examined in the context of teaching technologies as future implementation, inclination and approaches (Baran, 2013). In addition to these, it is among the subjects that draw the robotics which interact with the users physically or verbally and are used for moving objects in virtual or real world are becoming increasingly popular (Johnson et al., 2016). Robotic objects attract many students and today robots that are bought reach students at K-12 level with their feature of programmability for various tasks (Prensky, 2010). Besides, it is emphasized that educational robotic applications boost students' motivation and are useful teaching materials (Ortiz, 2015). LEGO Mindstorms products are among the robotic products that are widely used in educational processes around the world.

FC model which is popular today and becoming more popular, enables the students to perform real-life applications more actively in order to understand the subjects profoundly with project based or problem based learning (PBL) applications within the limited class hour (Johnson et al., 2014a). Teacher adapts a student-centered approach as the primary teaching method instead of directly teaching (Sams & Bergmann, 2013). In other words, with FC, cooperative activities take the place of the normal classes (Chen, Wang, Kinshuk, & Chen, 2014). With the applications related to FC, firstly the subject that needs to be taught in classrooms is converted to teaching materials that are usually videos by the teacher and then published via the Internet technologies. At the same time teacher plans the teaching activity that will be carried out in the class. Accordingly, the planned activity should be a student-centered one. Student gains information and listens to the subject that will be taught by watching/examining the materials that are published outside the classroom. Then, with the teaching activity that teacher planned, classroom environment in which the student is more active is created and with that, it is aimed that the student will learn the subject that s/he studies outside the class in a better way. Just like the developments in education technologies, there have been new approaches to cooperative learning and application described as student-centered in learning-teaching approaches in the last two decades (Cetin, 2013). PBL is one of the recent and popular approaches. PBL basically aims to face the students with situations similar to the ones they might face in their future careers and help them learn to solve these real-life problems (Erdem Gurlen, 2011). The most important point in PBL applications is to eliminate the problems that occur in the process of including students in the learning.

In today's learning environments, generally constructivist learning approach is the basis. In the process of students interacting in FC environment, performing activities according to the situation that is determined with LEGO applications, it is thought that constructivist learning approach can be supported and believed that learning and teaching activities can be done more effectively by supporting this process with PBL applications. Especially because nowadays students are digital natives, it is believed that Facebook that will be used as FC environment, LEGO applications, FC Model and PBL approach that will be applied will be more effective in using digital native characteristics. Furthermore, it is of importance to minimize problems that emerge in respect of integrating students in the process of learning. At this point, the effects of the use of LEGO applications and problem-based learning applications along with the FC environment are to be identified with a view to increase motivation of students and to ensure them to take part at the center of the learning process. Nevertheless, there has been no study to analyze the effects of problem-based teaching applications on learning and teaching processes when they are realized through use of a combination of robotic applications such as LEGO and environments such as FC, among today's popular technologies, which, in addition to other factors, has necessitated a study on this subject. So, the study aims to examine the opinions of high school students on problem-based teaching activities supported with FC Model and LEGO applications.

With this purpose, the study seeks answers to the following questions, (1) What are the students' views on problem-based LEGO applications? and (2) What are the views of students on PBL activities supported via FC?

Theoretical background

LEGO applications during education

LEGO education department stated that children should be supported to become systematically creative, active and cooperative learners in the manifesto they published (LEGO Education, 2010). They developed LEGO Mindstorms products to carry out educational LEGO applications. Learning environments that are created in LEGO applications include constructivist approach (Cayir, 2010; Danahy et al., 2013). According to constructivist approach learning occurs by learners' active participation in the process of making meaning and is described as an active process which is developed by the experience of learners (Tufekci Aslim, 2013). In this context, LEGO applications as education tools enables students to learn actively, create a constructive environment, physical objects and find ways to make meaning of abstract concepts (Chambers, Carbonaro, & Murray, 2008).

Some of the benefits of LEGO applications for educational process are as follows:

- LEGO enables each student to create different solutions to the same problem, that is, help them improve their problem-solving skills (Cavas et al., 2012; Danahy et al., 2013; Lin et al., 2009).

- As a sharable structure, it makes inquisitive, cooperative and constructive learning easier (Chambers et al., 2008; Koc Senol, 2012; Ozdogru, 2013).
- It is one of the most suitable tools for improving learners' creative thinking (Lin et al., 2009).
- It allows students to improve their group work and communication skills (Aufderheide, Krybus & Witkowski, 2012).
- It enables students to be more independent and confident learners (Church et al., 2010).
- Students get the chance to get deeper information, think limitlessly and practice their ideas (Cayir, 2010).
- Students from every age become the active leaders of their own learning by making robots (Danahy et al., 2013).
- Students' motivation increases (Aufderheide et al., 2012).

Flipped classroom (FC) model

Learning environments are moved to more dynamic and social areas in order for students to be able to work in groups to solve a problem or discuss (Johnson et al., 2014b). FC is one of the models that enable learning environments to such areas. The purpose of the model that makes the applications of student-centered approaches easier is to create active environments in the classroom (Brown, 2012). Within FC, class materials are used outside the classroom and class hour is used for student-centered activities to make the subject clearer and reinforce learning (Mason, Schuman, & Cook, 2013).

In FC environment, generally videos are prepared as pre-class learning materials (Long, Logan, & Wough, 2016). In these videos, the content is organized in such way that students can study before the class. The videos can be prepared with interactive factors (question-answer, attractive items, etc.) as well as in the form of plain narration (Temizyurek & Unlu, 2015). It is suggested that videos are made interactive with Web 2.0 tools (Basal, 2015). Besides the videos in FC environment, Bergmann and Sams (2012) pointed out that materials such as books and documents could be added. In this context, it is believed that teacher has important roles of preparing materials for FC environment and classroom activities.

Teacher roles in FC environment differ from those in traditional classes. Here, teacher gives the lesson content to the students via videos and helps them understand the subject that students study through the videos with the help of activities that include cooperation and interaction (Mok, 2014). So, FC provides students with individual or cooperative problem-solving activities in classroom on the subject that students study outside the classroom (Gencer et al., 2014). FC applications throughout the world are observed by many researchers and applications for K-12 level are carried out (Chen et al., 2014). As a result of these applications with FC Model, teacher is no longer the one who presents the information and students are the ones who manage the learning process (Brown, 2012). Also because this model uses technology to which today's digital native students are used and class hours are saved for activities, it is thought that FC Model is suitable for digital native learners.

FC Model improves learning outcomes, support active learning and high level thinking (Baepler, Walker, & Driessen, 2014). At the same time FC supports technology use for teaching outside the school (Herreid & Schiller, 2013), gives responsibility of gaining knowledge to the learners (Butzler, 2016). FC application also boosts motivation (Strayer, 2012; Turan, 2015), and improves student learning performance (Hung, 2015). In addition to these, with FC, students find the opportunity to learn individually and in this context they can adjust their own studying time flexibly (O'Flaherty & Philips, 2015).

Method

Case study which is one of the qualitative research methods was used in the study.

Participants

To choose the research group, criterion sampling which is one of the purposeful sampling methods was used. In the context of criterion sampling, completely voluntary students of vocational high school that suited the criteria of having more than one 10th grade classes of Computer Technologies Department (CTD) and at least two classes that take Basics of Programming class from the same teacher took part in the study. So, the study was conducted with the Experimental Group-A (EGA) that consisted of 18 students and Experimental Group-B (EGB) that consisted of 17 students, 35 students in total from two different classes. 9th grade students having been educated at different classes are selected to CTD as regards their arithmetic scores. 10th grade students starting to be educated at CTD don't know each other at the beginning of the semester.

Data collection tools

Focus group interview form

A 10-item semi-structured focus group interview form was created by the researchers. After 7 weeks-of-work and observation, the form was reorganized (see Appendix 1). Lastly, an 11-item interview form for EGA and a 9-item interview form for EGB were created.

Observation

The works were recorded on camera and observations were made by the researchers. The camera recordings were watched and observation records were edited and then observation data was produced.

Implementation area

Implementation is made in a computer lab in the high school (see Figure 1).

Figure 1. Implementation area

Implementation process

The study was conducted in the first semester of 2015/2016 school year. In the 7-week-long study, a work on teaching algorithm with FC and LEGO applications to high school students was done. There was interaction with the students except for the first week that was spent with creating the study groups. For the students in EGA to be able to work according to FC, a private group (FCG) was created on Facebook (see Figure 2).

Figure 2. FCG

FCG included all the helpful educational content as videos in teaching algorithm and flow charts, as well as LEGO Mindstorms EV3 set that students would be using as class content and EV3 programming. These videos were not uploaded on FCG all at once; rather, they were uploaded one by one. 22 videos between 4-20 minutes were uploaded on FCG. On the study day, all the time that was saved was spent with applications. With EGB, all work was done in the classroom face-to-face with the students. Schematic presentation of the pre-lesson, in-lesson and post-lesson processes with the study groups are given in (see Figure 3).

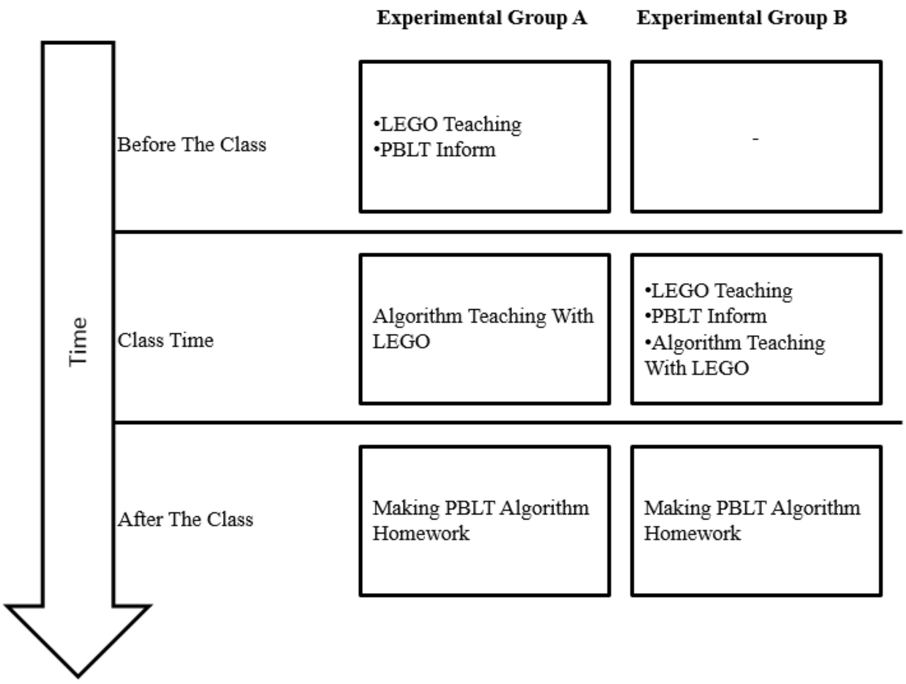

Figure 3. Process of teaching

Students were asked to design a robot and program those robots, and then PBL themes (PBLT) were created by the researcher for the students to use LEGO applications in teaching algorithm. The main subject of the PBLTs was “Let’s Create Solutions for the Aging Population” (see Figure 4).

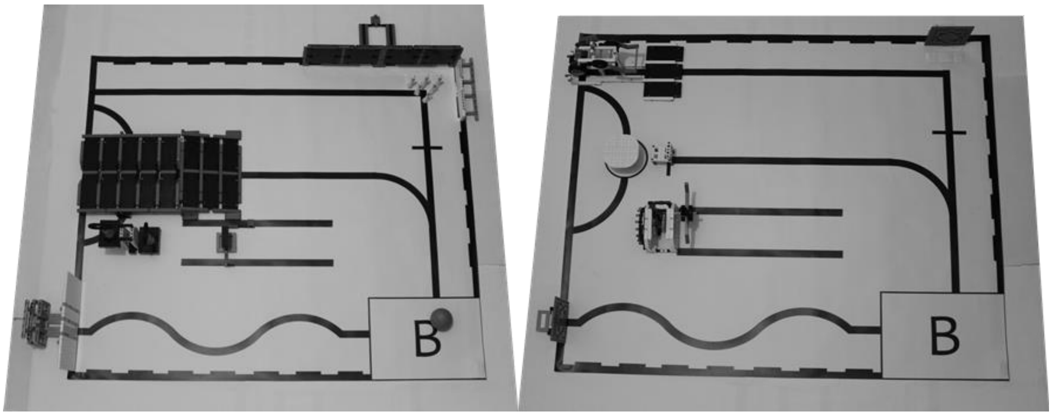

Figure 4. PBLT images

With PBLT, some of the problems that the elderly may come across were pointed out in the themes. Students were asked to create solutions to these problems by improving and programming their robots. There were four different problems on each PBLT area. With the PBLT document and narration which was given to EGA on FCG and EGB in the classroom, the situation and rules that they had to follow to solve the problem were explained to the students. Before starting to solve the problems with the robots, students were asked to prepare the algorithm and flow chart of the solution. At this point, it was explained that the students could prepare the algorithms and flow charts in cooperation with a part of their friends or all of them as well as individually.

At the beginning of the study, the teacher of the class was briefed about the study. Then considering the timetable, research groups were chosen with the teacher. Taking account of the sizes of the classes, each research group was divided into two team among themselves with a random nickname (EGA=AG1+AG2, EGB=BG1+BG2). Each team was provided with a EV3 set (see Figure 5).

Figure 5. EV3 set

During the 1st, 2nd, 3rd, 4th weeks, students were instructed on the EV3 set (see Figure *6*). In these weeks, only EV3 use, robot design and programming are taught.

EGA EGB

Figure 6. 1-4 Weeks of works

Students designed their robots and learned how to program them. In the 5th, 6th, 7th weeks, students worked on PBLT area. In this context, students prepared algorithm and flow chart at the stage of solving the problem on PBLT area and programmed their robots. After the implementation process, the teacher carried out lessons in the first half of the students' normal class hour. In the other half of the lesson, LEGO applications were performed. In the week that algorithm and flow chart were taught, students programmed their robots and completed the work by solving the problems on PBLT (see *Figure 7*).

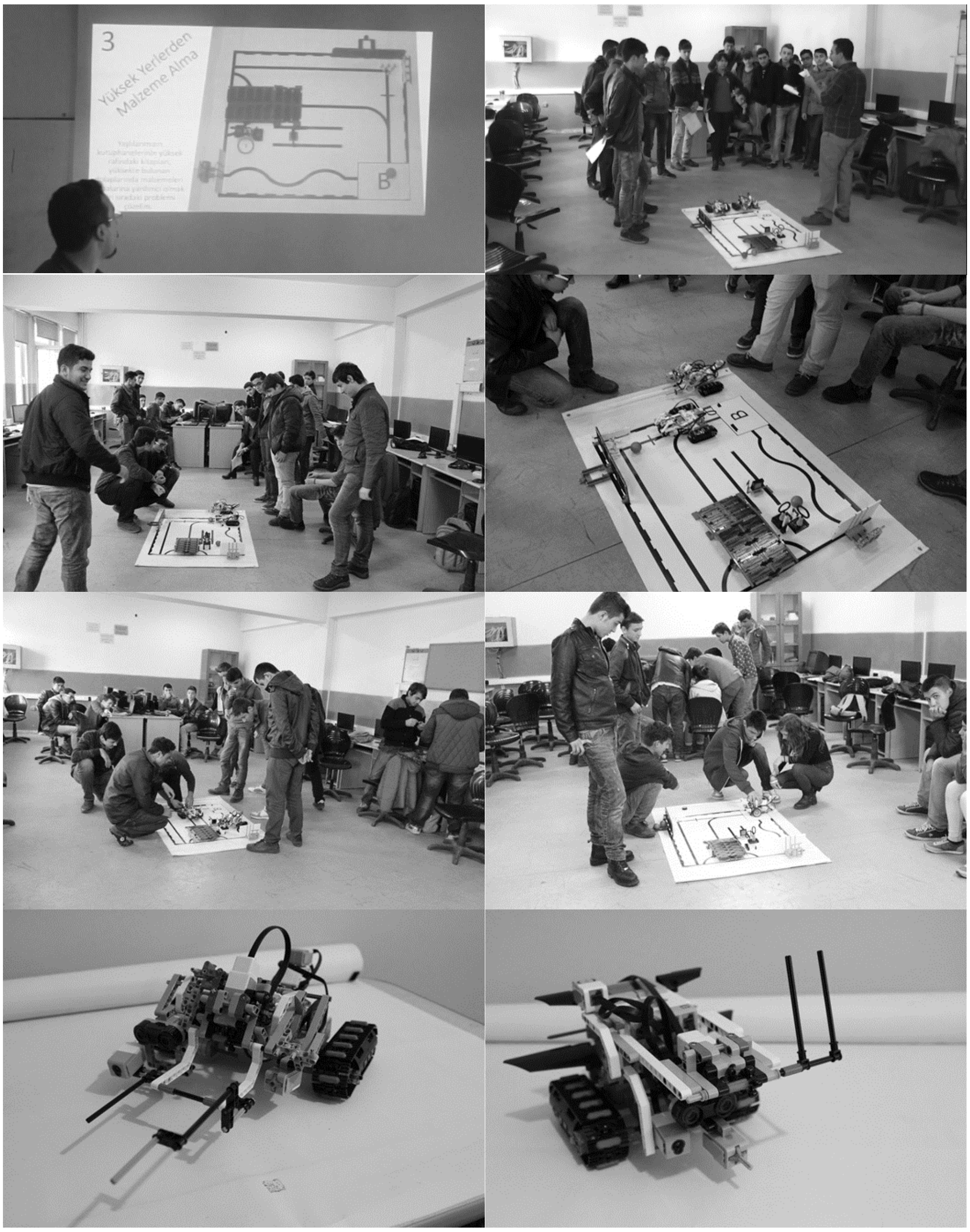

Figure 7. 5-7 Weeks of works

At the end of the study, a focus group interview was done with the groups.

Data collection

Separate focus group interviews were done with the groups in EGA and EGB. During the whole process of the study, all the work was done and the students were observed by the researcher. At the same time, the work was recorded on camera. After each week, notes were taken on the works by the researcher. The points that went unobserved and all work in general were examined on the camera record.

Validity and reliability of the study

The researcher interacted with the students in person in times of the work and on the Internet with EGA outside the work time. Students answered data collection tools more sincerely and easily. Also, the data was collected through observation and interview to be able to examine the students' emotions, thoughts and behaviors towards the study. After the process of data collection, the findings and results that were gathered in the process of data analysis will be compared with each other and the relationship between them will be revealed. In the study, criterion sampling from purposeful sampling methods was used. During the focus groups interviews, the questions were asked in the same order to each participant. While analyzing the date, no comment was added by the researcher. Besides, consistency of the analysis results was compared by making two experts analyze the data. In this context, the reliability of the study was determined by using reconciliation percentage formula by Miles and Huberman (1994).

$$Compromise\ Percentage\ (P) = \frac{512}{512 + 42} \times 100 = 92{,}42$$

Data analysis

NVivo8 was used to analyze the data gathered from the study. Focus group data were examined through content analysis. In the analysis process, the data were divided into three groups of pre, while and post implementation. The views on FC were divided into a different group. Besides the researcher, the data were analyzed by two academicians and the results were compared. Then the focus group interviews were transferred into electronic media. After that, it was analyzed through NVivo8. In this context, the data were coded and assigned to lists and then put into themes. At the end of the focus group interview analysis, the data were supported with observation results and meaningful results were attempted to create.

Findings

This section mentions the results that were reached at the end of data analysis. The statements of participants were given beside the findings. In the thematic displays that were shown in the findings section are frequency of values and first value is shown as EGA, second value as EGB (EGA-EGB).

Findings on the students' views on LEGO applications

Findings on pre-implementation

The thematic display of students' views on pre-implementation process is given below (see Figure 8).

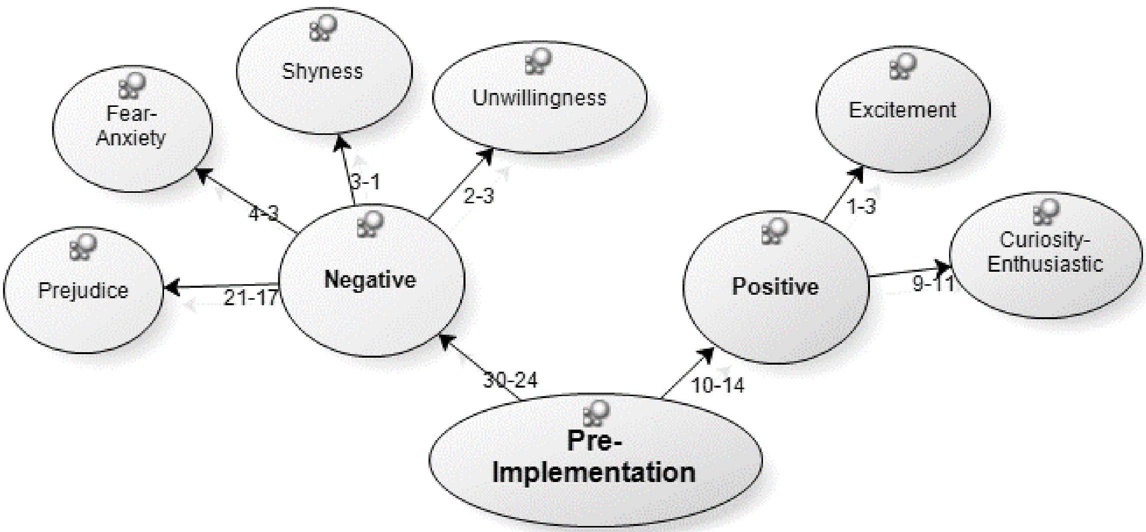

Figure 8. Thematic display of pre-implementation results

When Figure 8 is examined, it can be seen the students were mostly prejudiced against the study. The thought of giving up the work, unwillingness, getting bored were some examples of students' statements. Besides these, they used statements that included fear, anxiety and unwillingness. The statements quoted from students are as follows:

"At first I thought I was going to fail at such a class, with the robot application. I mean I would be negatively affected. As I continued to do it, I had fun" (AGS15).
"When you first came here and we watched, I thought we could not do it. I thought 'Are we really going to create a robot?' I thought I would have so much difficulty at first" (BGS14).

It is seen besides the statements of, there are also ones that include curiosity, willingness and excitement. In this context, students stated they were interested in the study, curious about it and thought it would be exciting. The positive statements quoted from the students are as follows:

"At first I was intimidated when I saw the pieces. We did not want to come to the class. Then we put the pieces together and something good came out" (AGS14).
"Honestly I was really excited when I first saw the robot" (BGS16).

It is seen that the students were shy in pre-implementation process. This may be due to the fact that the researcher and students met for the first time, newly starting the lesson and did not know each other.

Findings on while-implementations

The thematic display of students' views on while-implementation is given below (see Figure 9).

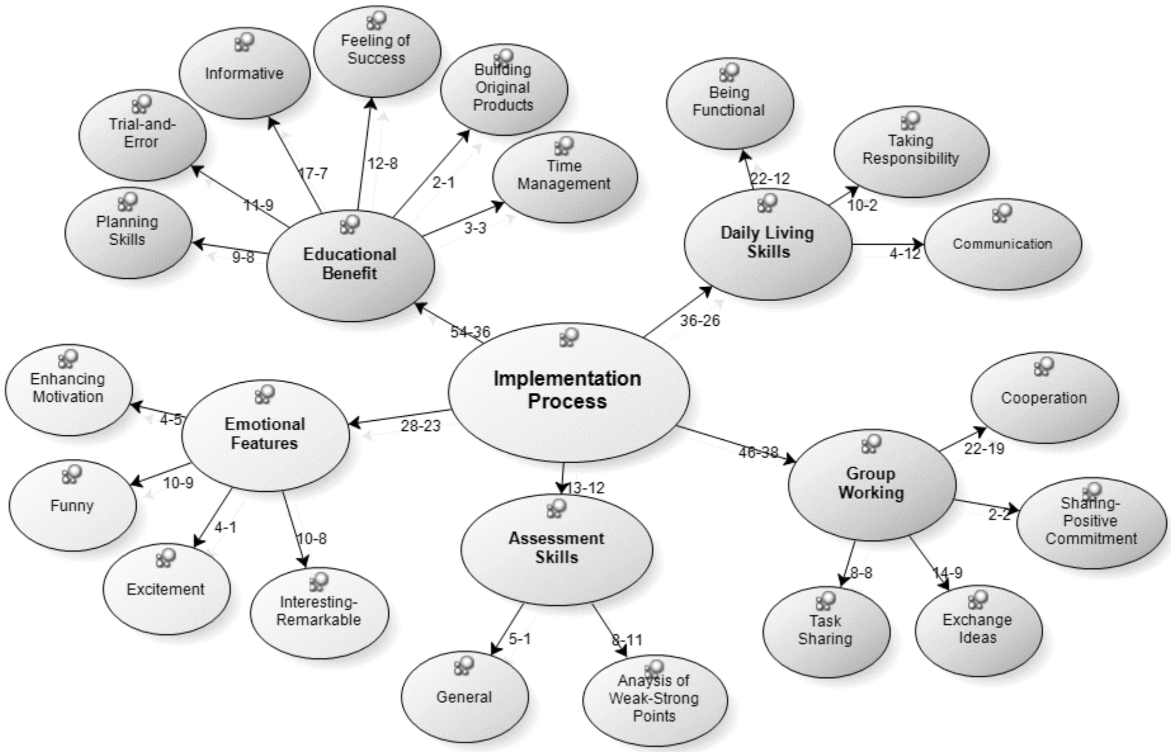

Figure 9. Thematic display of while-implementation

When Figure 9 is examined, the views such as that the process was informative, students learned by trial-and-error methods and that they had a feeling of success when they solved problems on LEGO applications were stated. Besides this, the students stated that their abilities to make plans and manage the time were improved at the end of the study. The statements quoted by students on educational benefits are as follows:

"We got the best of it. We learned how to plan and solve problems. So it was good" (AGS13).

"We did not know much about algorithm and flow chart. Then we did things like these and it was good with robots. We test and learn better" (BGS4).

Students stated that when they work in teams, they worked cooperatively with their teammates. Helped each other and exchanged ideas between teams. About task-sharing, students' statements are as follows:

"Working in groups means producing different ideas in a short amount of time. When one of us could not do something, the other helped him do it" (AG15).
"If we tried to do it alone, we would not be able to continue. When we do it in groups, everyone produces an idea. So group work is more advantageous" (BGS17).

On the work done, the students said that taking responsibility was important and that everyone worked according to it. They also stated that LEGO applications were functional and they could be used not only to solve problems on the area but also to solve other possible problems in daily life. Besides, students said that with the study, they got to know their classmates better and interacted with them. About the daily life theme, students' statements are as follows:

"We got to know our classmates. We understood what we can accomplish with them" (AGS11).
"There are disabled people. If robots are made with the purpose of helping people, they can help disabled people or women, in the kitchen" (BGS3).

Students stated that implementation process was fun and increased their interest in the lesson. The studies drew their attention and the study in general boosted their motivation. They also stated that they worked with excitement. About the affective features theme, students' quoted statements are as follows:

"…Then it became more fun when we started to create the robot" (AGS8).
"If you did not start this with this class, it would not be fun at all. I did not attend the classes. We did not use to have fun. It just passed like that" (BGS5).

Students said that they could revise their works, self-assess, gauge the weak/strong points of themselves and their robots. About assessment skills, statements of students quoted as follows:

"When we first did it, the robot was very long. Then we made another plan and this time it was shorter and with stronger pieces" (AGS15).
"It was simple in appearance. The functions are good. But I think the appearance was simple" (BGS6).

When the observation data on implementation process was examined;

- At the stage of deciding what kind of robot they would make, it was seen that every student expressed an idea, discussed and exchanged ideas. It was seen that every student made research and analysis at this stage.
- It was seen that on the robot designs PBL applications, all the students contributed and helped each other.
- It was seen the students had fun during the implementation and that they did not leave even on the breaks. So it can be interpreted as the high motivation and interest towards lesson.
- While testing the robots, it was observed other teams also watched it, exchanged ideas and revised their own robots.
- When EGA and EGB were compared, although the algorithms and flow charts the students prepared prior to PBLT did not clearly reflect the solution, it was seen that it helped them follow a path on the solution through observation and on student feedback it was seen that after solving the problem with robot programming, the algorithm and flow charts reflect the complete solution of the problem.

Findings on post-implementation

Thematic display of the students' views on post-implementation is given below (see Figure 10).

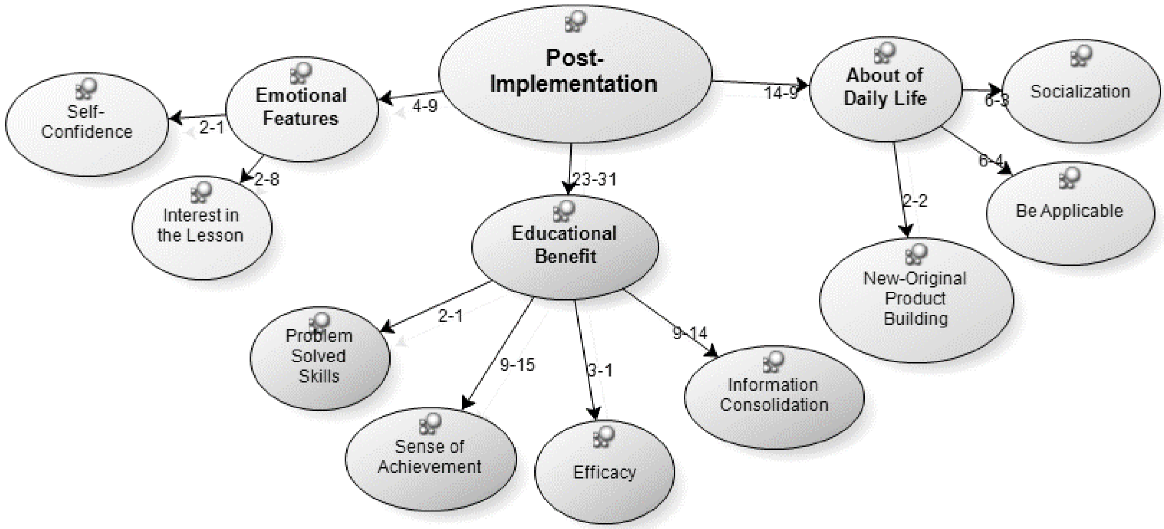

Figure 10. Thematic display of results on post-implementation

When Figure 10 is examined, students stated they mostly learned algorithm and flow charts subject and supported it with repetitions. Besides, students stated they felt successful when they solved problems with LEGO applications. The students' quotes on educational benefit are as follows:

"They said programming classes were difficult. This year we understood it better with robot." (AGS4).
"The most beneficial part for me is that I did not use to know how to do algorithm before you came. It seemed complicated to me. When you came, it got better with the robot" (BGS11).

Students stated that they socialized with their classmates during the study. So, this situation can be interpreted to have improved the students' communication between themselves as a team. Besides, the students stated their opinions on future works. The students' statements quoted on daily life theme are as follows:

"Not that robots we built but in the future, bigger ones might help in carrying cargos or in a company"(AGS15).
"I think we benefitted too. Besides, it was a good memory for us. So it was not just a class, but at the same time something that I discussed with my friends" (BGS6)

Lastly, the students stated that the study increased their self-confidence and interest in the lesson. On affective features theme, the students' statements were quoted below:

"We applied algorithm not by directly listening to the teacher, but by having fun and making it" (AGS15).
"It was fun. Before the robot it was boring" (BGS8).

Findings on the students' views on FC applications

Thematic display of students' views on FC applications is given below (see Figure 11).

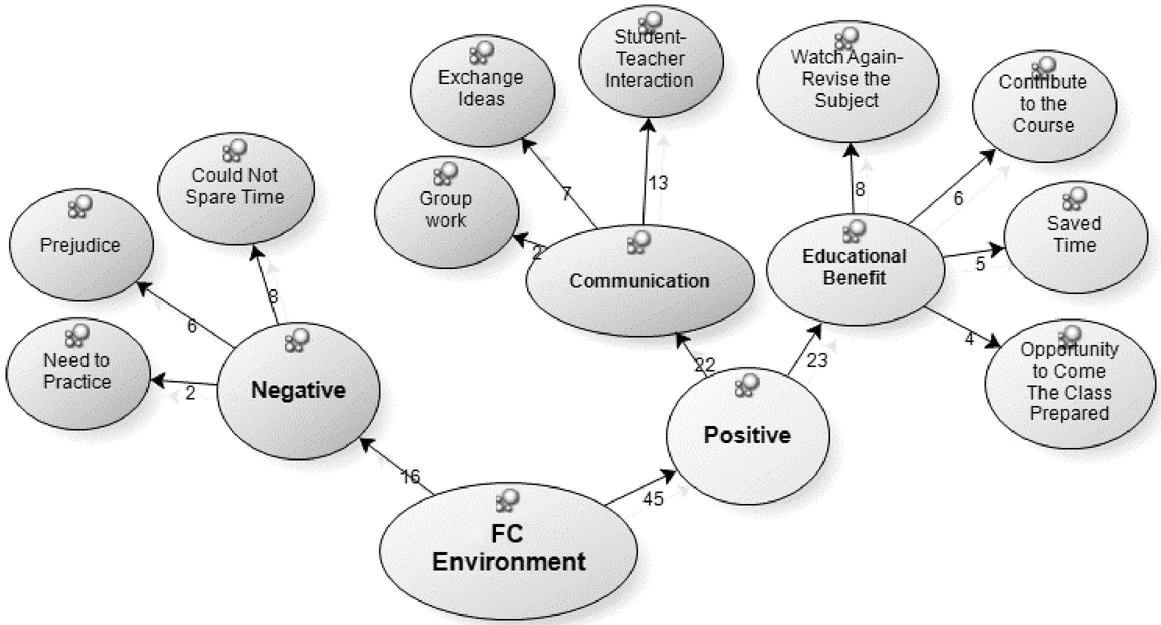

Figure 11. Thematic Display of Findings on FC

When Figure 11 is examined, students stated that they contacted their teacher via FC and asked questions about their works. Students said they could watch the videos repeatedly, revise the subjects and exchange ideas with their classmates. Also, the students said watching the videos before the class saved time and helped them come to class prepared. Quotes on EGA's positive opinions on FC environment are as follows:

"Without Facebook group you would have to teach it here. We would spend more time in vain" (AGS14).
"For example, we can prepare for the content by watching the videos. And there is always someone who cannot see while working so they can watch the video and see how it is done" (AGS15).

As negative views on FC, students in EGA stated they could not spare time to watch the videos due to their work/social lives. Besides, students said that they (on the first weeks of the study) had the prejudice of thinking that work in the classroom could be done without watching the videos and did not do necessary work on FC environment. Also, some students said it would be better to apply what was watched on FC environment immediately. On the theme of negative opinions on FC environment, the quotes of the students are as follows:

"There was a connection problem while watching the videos. I rewound and watched again" (AGS7).
"Class environment is more efficient. We work with our friends. On Facebook, some watch the videos and some do not" (AGS11).

Discussion

It was seen that LEGO applications had a positive effect on motivation and motivation level of students at the end of the study were higher than the beginning. The other studies concluded LEGO applications boosted students' motivation (Ortiz, 2015; Blikstein, 2013). Besides, it is thought FC applications done with EGA also had an effect on students' motivation. This result resembles the other studies in this field (Basal, 2015; Hsieh, Wu, & Marek, 2016). It was stated by the students that LEGO applications that were done in groups cooperatively improved the communication between the students and their teacher. At the beginning of the study, none of the students knew each other. So students had an opportunity to get to know each other with group works. Similarly, it was seen that students' communication process with the researcher whose role was the same with the students increased. When views of EGA and EGB were compared, it was seen that EGB stated more views on communication than EGA. However, when questions were asked to EGA about FC environment, most of them gave positive feedback on teacher-student relationship. This is thought to stem from the fact that EGA had the opportunity to communicate with the teacher outside the class via FC environment and ask questions without having to wait for the class like EGB. FC enables effective teaching and makes way for student-student, teacher-student interaction (Mehring, 2014). Students in EGA said that they could contact their teacher outside the classroom, work with their friends and exchange ideas. Similar to the studies in the field, it was seen that the fact that students could contact with their friends and teacher pleased them (Turan, 2015). Peterson (2016) stated in his study that the fact that teacher answers students' questions effectively in FC environment was among positive feedback. LEGO applications were carried out in groups cooperatively. LEGO applications generally help student work in groups and learn cooperative learning (Aufderheide et al., 2012). Besides it was stated that the fact that students worked cooperatively was among the benefits of FC (Gross, 2014). Strayer (2012) stated that with FC, students worked cooperatively and more easily.

There were negative views on FC. Though, these negative views disappeared over time. Similar studies showed that students had negative opinions when they first came across FC and then these views changed (Goru Dogan, 2015; Turan, 2015). It can be interpreted as students in Turkey not being familiar with FC and such environments. So, the process should be made easier for students (Chen et al., 2014). Besides, students should be made familiar with using FC by regarding cultural differences and learning styles (Goru Dogan, 2015). Within the scope of this study, students in EGA were told they would get extra performance grades if they came prepared and that week the majority of the students came prepared on FC. Kim, Kim, Khera, and Getman (2014) suggested students should be presented with encouraging factors to come prepared for the class. Similarly, Turan (2015) emphasized reinforcements should be used to encourage students. So in these studies, students may be told they are going to be graded or other kinds of encouragement may be given.

It was said to be positive by the students that they could watch the videos on FC repeatedly and whenever they wanted. The other studies reached similar results (Touchton, 2015). Students also stated that they could not find time to watch them because they were too long or took time. A similar result was found in another study (Turan, 2015). It is thought that FC technology plays an important role in fixing these problems. Because instead of Facebook that was used in this study as FC environment, another one that allows videos to be uploaded all at once or in one frame and allow students to choose could be used. The study suggests that an FC environment appropriate for allowing interaction and controlling the students should be used (Filiz & Kurt, 2015).

Conclusion

- It was seen that the students were generally prejudiced against the study. However these negative opinions gave place to positive ones.
- It was concluded that there was no negative feedback from students in the implication process. They pointed out the importance of the study on educational benefits, group work and improving daily life skills. Besides. With LEGO applications, it was seen that it helped students learn through trial-and-error, decide if they succeed and take responsibility in work. Also, the study reached the conclusion that the application boosted students' motivation, attracted them and was fun.
- At the end of the application, it was concluded that students thought they succeeded with LEGO applications, they learned better, socialized, and improved their problem-solving skills and their interest in the lesson increased.
- It was concluded that LEGO applications helped students in creating algorithm and flow chart.
- The conclusion was that FC enabled students to revise, watch videos repeatedly, and come prepared, save time no subjects that would be taught in class and work on the project instead and that this generally contributed to the lesson. Having said that, it was also seen that the students came home tired due to full-time school and having sports after school and could not do enough work on FC. However this problem disappeared when students were provided with enough reinforcements.

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Appendix 1

Interview questions example

EGA interview form

1- Explain your thoughts when you have learned designing robotic applications with LEGO products?
3- Tell about your experiences on the process in which you have started to learn LEGO applications?
5- What are your thoughts on Flipped Classroom?
7- What are your thoughts on the robot created as a group?
9- What do you think about the effect of robotic applications on learning algorithm and flow charts?

EGB interview form

2- How do your initial thoughts on LEGO applications change when you have examined the LEGO Mindstorms EV3 set for the first time?
4- What are your thoughts on preparing studies about robotic applications, algorithm and flow charts?
6- What did you get after the robot applications? What do you think about the contribution of the robotic applications on learning algorithm and flow charts?
8- What do you think about the contributions of these studies to you in the future?