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Determination of the effect of STEM-integrated argumentation based science learning approach in solving daily life problems

Salih Gulen*, University of Mus Alparslan, Mus, Turkey.

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Abstract

The purpose of the study is to determine the effect of the science-technology-engineering and mathematics integrated argumentation based science learning approach on the resolution of daily life problems and the change of high-level thinking skills. Mixed method was used in the research. Quantitative data were collected with a single group pre-test–post-test experimental design. Qualitative data were gathered with document review and daily life problem determination form. The data presented with descriptive and content analysis, frequency, percentage and Wilcoxon signed rank test techniques. A homogeneous sample was used in the study and was carried out with a randomly chosen class in a mountain village secondary school. From the analysis of the daily life problems before and after the implementation, it was observed a positive change in the participants thinking on the identification and solution of daily life problems. Also, the unresolved problem factor determined for the land factor in hazelnut transportation is removed after the application.

Keywords: STEM-integrated ABSL approach, STEM education, argumentation, daily life problems, reflective thinking.

* ADDRESS FOR CORRESPONDENCE: **Salih Gulen*,** University of Mus Alparslan, Mus, Turkey.
E-mail address: sgnova@windowslive.com / Tel.: + (0436) 249 49 49

1. Introduction

Science-technology-engineering and mathematics (STEM) education, which was born out of the need of the twenty-first-century skills, aims at successfully completing the problem-solving process by using multiple disciplines (Corlu, Capraro & Capraro, 2014; Gulen, 2016; Yildirim, 2018b). STEM education; is a product of increasing technological developments and global competition. The aim of this educational approach is every individual who constitutes the society in the face of global developments solves all kinds of problems and to increase interest in STEM disciplines (Carnevale, Smith & Melton, 2011). In line with this aim, efforts are being made to overcome the inadequacies of solving daily life problems in society with the integration of STEM education into school curricula (Agile, 2018; DeChenne, Koziol, Needham & Enochs, 2015). Although there are different approaches and studies on the integration of STEM education into school curricula, it is not right to adhere to a certain approach in the integration of the common opinion (Altun & Yildirim, 2015; Gulen, 2016; Honey, Pearson & Schweingruber, 2014; Ring-Whalen, Dare, Roehrig, Titu & Crotty, 2018).

There is intense interest in worldwide on STEM education. A similar interest took place in the science curriculum that was changed by the Ministry of National Education (2018). Another noteworthy element in these changes of the Ministry is the regulation of 'students make argument' and ensuring their participation in the argumentation process (MNE, 2018, p. 11). Argumentation, which is a writing-by-doing science learning approach, is more commonly known as the argumentation based science learning (ABSL) approach (Gulen & Yaman, 2018; Hasancebi, 2014). This approach aims to solve the individual's daily life curiosity by using the basic elements (speaking, listening, reading and writing) of the language (Roth & Worthington, 2011). For this aim, ABSL is defined and it is necessary for the students to conduct research in the face of any subject or problem that is being wondered, designs, as the process of persuading the other party by using the evidence of the specified solution or claim (Aydin, 2013; Diller, Haret, Linsbichler, Rummele & Woltran, 2018; Gozum, 2015; van Bruggen, Kirschner & Jochems, 2002).

Daily life problems that are both targets of STEM education and the ABSL approach; are expressed as problems that are encountered at the everyday level and are related to life. Even our known lives or context-based problems (Cepni & Ozmen, 2011; Yrek & Dolu, 2018). In Gulen's (2016) study, STEM-integrated ABSL approach, prepared by integrating STEM education with ABSL approach; followed the participant's process of creating arguments using different disciplines in the face of daily life problems and presenting them in the context of evidence. The model of the approach that Gulen (2016) has prepared from the model of Toulmin (1958) is given below:

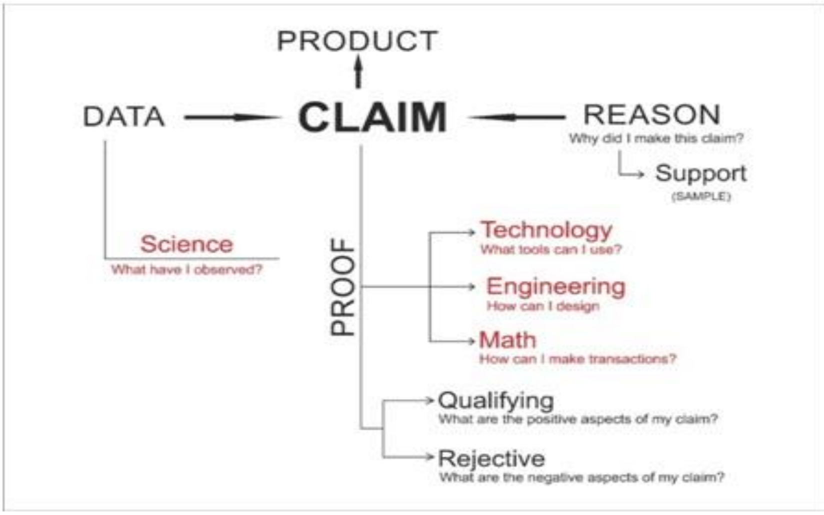


Figure 1. STEM-integrated ABSL approach model

In this model (Figure 1); the created claim (with STEM disciplines, reason, support, qualification and rejection) for solving of the determined daily life problem to be presented and transformed into a product.

The STEM-integrated ABSL approach: Claim, opinions or explanations for the solution of the problem. Data, events or observations used to support the claim. Rationale, the reasons why the data support the claim. Support, examples are given daily. Qualifier, conditions are valid. Rejection, conditions are invalid. Technology, it is the equipment used in the product to be built. Engineering, design of the product to be built and planning. Mathematics, processes to solve the problem. Product, it is the concrete model that students use engineering and mathematics with technology. Science, container concept covering every step described above (Ceylan, 2012; Gulen, 2016; Gunel, Kingir & Geban, 2012; Kabatas Memis, 2011).

It has been determined that both the STEM education and the ABSL approach improve high-level thinking skills in the problem-solving process and in solving daily life problems (Jimenez-Aleixandre & Erduran, 2007; Marulcu, 2010; Scheuer, Loll, Pinkwart & Mclaren, 2010). In addition, Gulen (2016) has identified the importance of high-level thinking skills in solving daily life problems with the STEM-integrated ABSL approach. High-level thinking skills are the types of thinking that the individual creates by challenging the cognitive structure, such as critical, reflective and synthesis. In the research, reflective thinking skills that the individual uses to solve daily life problems are discussed. Reflective thinking; it is the process of thinking about the individual to reveal the positive or negative aspects of the applied method or the solution of the daily life problems (Ersozlu & Kazu, 2011; Gulen & Yaman, 2018).

1.1. Why STEM-integrated ABSL approach?

The integration of STEM education is a major issue. Studies have indicated that teachers are challenged in STEM integration (Ring-Whalen et al., 2018). There need to be some examples of integration. For STEM education to be implemented in the classroom, it is determined that there is few class and material are needed (Yildirim, 2018b). Also, it has been discovered that STEM education and integration can be used from earlier ages (Ong et al., 2016). Material inadequacy in classrooms and meeting STEM applications from early ages are the reasons for the study. Because materials made from the natural environment and work with secondary school students will be an example. Additionally, Christensen and Knezek (2017) found that secondary school students had a high tendency to pursue careers in STEM disciplines. It is important for students to guide the positive development of STEM disciplines in their willingness to pursue a career and to work towards winning the twenty-first-century skills. If sufficient knowledge is provided to the students, they will be engaged in developing the important twenty-first-century capabilities, such as problem solving, communication and collaboration (Krajcik & Delen, 2017). Except for all these reasons, Capraro et al. (2018) found that students collaborate in collaboration and obtain products using STEM disciplines. It is important that STEM disciplines are used in cooperation in this study. Because ABSL is integrated with STEM, it is a collaborative approach.

ABSL is a dynamic process used to address scientific issues (Diller et al., 2018; Evren Yapicioglu & Captain, 2018). It has been determined that the processing of scientific issues in the argumentation framework has had positive results (Craig-Hare, Ault & Rowland, 2017). In this approach, the aim is to discuss, especially scientific issues in the context of scientific evidence (Gulen & Yaman, 2018). Students participate actively in the lesson and develop scientific thinking skills (Apaydin & Kandemir, 2018). Therefore, this approach is preferred. Except those, Ozcan, Aktamis and Higde (2018) found that teachers did not have enough knowledge about the argumentation. This approach has been used in terms of being both informative and exemplary. And most importantly, it is aimed to strengthen the learning process by integrating STEM with ABSL which has a different meaning in this study. As a result, it is aimed that students should make arguments while obtaining scientific data and presents these arguments with different disciplinary evidence. It is necessary to use the ABSL approach which is the basic elements of the language and creating and interacting with the STEM which contains different disciplines and an example of integration (Gulen & Yaman, 2018). It will also set an example for topics such as material use and daily life problems. This integration is aimed to be presented in evidence of the claim in conjunction with the STEM disciplines in ABSL (Putri & Rusdiana, 2017).

People use a variety of ways to get ahead of their daily life problems. In all of these ways, the aim is to solve the problem. Because of the necessities that emerged in the twenty-first century, the individual is thought to be more likely to succeed in solving the problem by using multiple disciplines (such as Science, Technology, Engineering and Mathematics) in daily life. It is also a widespread idea that the ability of literacy and speech, which distinguishes humanity from other forms of life, will help solve problems. Therefore, it is considered that the STEM-integrated ABSL approach, which is prepared through the integration of the STEM education with the greatest education approaches in curriculum cold ABSL approach, is more active in a solution of daily life problems. It is also important to make a positive contribution to the development of high-level thinking skills with this approach.

In this study, the solution of daily life problems and the change of high-level thinking skills (reflective thinking) which participated after the solution were investigated by the STEM-integrated ABSL approach.

1.2. Purpose of the research

The purpose of the study is to determine the effect of the STEM-integrated ABSL approach on the resolution of daily life problems and the change of high-level thinking skills. The research problems prepared for this purpose are mentioned below:

1. Is there an effect of the STEM-integrated ABSL approach in solving daily life problems?
    a) What are the daily life problems of the participants?
    b) Is there a change in daily life problems in terms of pre- and post-work with the STEM-integrated ABSL approach?
    c) How did they solve the problem of daily life prepared according to the approach?
2. What is the effect of the STEM-integrated ABSL approach on reflective thinking in terms of pre- and post-work?

1.3. Limitations of research

Research is limited to a village school class of 13 students. The study was limited to the hazelnut problem and its solution to the student’s daily life problems in the mountainous area. The study uncovers only student views, reflective thinking and identification of daily life problems.

2. Method

Mixed method was used in the research. This method was used to close off the missing aspects of both qualitative and quantitative data (Yildirim & Simsek, 2013). The nested pattern is preferred because of the majority of qualitative data and to increase the objectivity of the study with quantitative data. The nested pattern is used in studies where the qualitative data are very large and quantitative data are supported (Glesne, 2013; Merriam, 2013). Quantitative data were collected with a single group pre-test–post-test experimental design. A weak experimental design used to compare single group data before and after study (Cepni, 2010). Qualitative data were gathered with document review (STEM-integrated ABSL texts) and daily life problem determination form. Measurement tools such as daily life problem determination form, reflective test, STEM-integrated ABSL texts and debate recording are presented with descriptive and content analysis, frequency, percentage and Wilcoxon signed rank test techniques (This test was used because the data show nonparametric value). The daily life problem determination form and STEM-integrated ABSL texts were developed by the researcher in consultation with field experts. Reflective test is prepared by Kizilkaya and Askar (2009).

Qualitative data were prepared by two different field experts. Analysis was made with the joint decision of two experts. A pre-established test of quantitative data reliability and validity study was used. But internal reliability is calculated. The validity of the study is maintained; direct citation in descriptive and content analyses is provided for the correctness of the research results. For the reliability of the research, the situation of the sample group is detailed, the existing roles are explained, the conceptual framework and data collection and analysis are presented. In addition, these data are supported by the quantitative data. It has contributed to the reliability and validity of the study using pre-made test data. The Cronbach's Alpha value of the reflectance test was calculated as 0.9. In addition, the teacher is the same person as the researcher.

Research was based on STEM-integrated ABSL approach planning and presentation activities developed by Gulen (2016). According to this;

Start: General information was given about what to do throughout the application. Preliminary applications of daily life problem determination form and reflective test were done. According to the findings obtained from the daily life problem determination form, STEM-integrated ABSL approach texts were prepared, including a participatory research questionnaire (two lessons).

Introduction: Texts prepared according to the STEM-integrated ABSL approach are presented in attendance. The group has answered the questions in the texts in cooperation (two lessons).

Practice: From the answers they gave in the texts, they used the tools and obtained the product (four lessons).

Presentation: Participants presented their products and provided evidence to convince the group against the arguments they made about their products. This process was recorded and the question–answer relationship between the participants was written down (two lessons).

Evaluation: The daily life problem determination form and the final application of the reflective test were carried out. In addition, the texts (STEM-integrated ABSL approach tests) of the groups were collected for analysis (two lessons).

The application lasted 12 hours in total. That is, it lasted 3 weeks (4 hours a week science lessons).

2.1. Sampling

A homogeneous sampling was used effectively to collect qualitative data in the study. The aim of this sampling is to determine a state of a subset of small and similar features (Yildirim & Simsek, 2013). The study was carried out with a randomly chosen class in a mountain village, rugged and transportation centre of village secondary school in the Karadeniz Region in the academic year of 2016–2017. Class presence has been 13 persons. Depending on the principle of volunteering, the whole class participated in the research. It was desired to have two groups randomly from the participants in the aim of the research. The participants' socioeconomic status was found to be similar.

3. Findings and comments

Findings obtained in the study are given below according to the order of the research questions (Starting with the code of the research problems). Participants' code names were used in the cited excerpts (F: Female and M: Male).

3.1. Findings and comments of part one of the first research questions

The situations in which participants in the survey expressed their daily life problems before implementation are shown in Table 1.

Table 1. Statistical significance of daily life problems before implementation

Daily life problem determination form (*N*: 13)	**Frequency (*f*)**
1. Do you write about situations that you might encounter as a problem in your daily life?	*N*: 5
a) Problems caused by winter cold	3
b) Not having Internet	1
c) Failure to understand the lessons	1
2. Do you write problem cases that your family have consistently encountered and cannot solve?	*N*: 4
a) Problems due to winter cold	2
b) Drying of hazelnuts	1
c) The stall is remote	1
3. How do you solve a problem in your daily life?	*N*: 11
a) Thinking research	6
b) Get help	4
c) Solving with intelligence	1
4. Could you explain the reasons why you cannot solve daily life problem?	*N*: 10
a) Due to wrong thinking or behaviour	6
b) Land factor in hazelnut transportation	3
c) Non-supply of needs	1

Note: Although the number of participants was 13, there were different numbers of participants in each question

As seen in Table 1, pre-implementation daily life problems were screened and the data obtained were indicated. It is noteworthy that questions were answered by a different number of participants. In general, it is seen that the participants both express their own problems and the problems their families face as a result of the coldness of winter months. Interestingly, when you look at the answers to the questions of 'how do you solve a problem in your daily life' and 'could you explain the reasons why you cannot solve daily life problem?' How do you solve a problem in your daily life? The most striking answer to the question was found to be 'thinker research'. Below are the quotations for this answer.

If I cannot find the solution to the thinker first, do a research (F1).

I think in my head first. Then I can do the research if I cannot solve the solution by itself. (F3).

First I think then I will investigate how I will solve and then apply (M5).

As evidenced by the quotations, the participants expressed that they would 'thinker' the problem first, then 'investigate' the solutions and then 'apply' it with the appropriate solution. The fact that some participants have problem-solving skills before the implementation also means that the number of participants is low. Could you explain the reasons why you cannot solve daily life problem? Some of the answers given in the question are as follows:

Carrying hazelnut in the field, farming down the house and not moving up (M7).

Transporting hazelnut in the field, the field is up and carrying it up (M6).

As understood by the participants' conclusions, it is understood that the hazelnut is seen as a problem that cannot be solved due to reasons such as hazelnuts being 'below' the house and 'moving up'. It is a big step in terms of the aim of investigating this problem identified here. In the framework of this problem, the researcher made the necessary preliminary studies, prepared texts about the daily life problem related to the subject area and aimed to guide the problem to the participants to solve the problem in the perspective of the STEM-integrated ABSL approach. For this purpose, the texts prepared by the researchers with the opinions of the experts of the STEM were used.

3.2. Findings and comments of part two of the first research questions

The data of daily life problems re-applied at the end of the study are shown in Table 2.

Table 2. Statistical significance of daily life problems after implementation

Daily Life Problem Determination Form (*N*: 13)	**Frequency (*f*)**
1. Do you write about situations that you might encounter as a problem in your daily life?	*N*: 13
a) Carrying wood	5
b) Problems due to winter cold	4
c) Animal grazing	3
2. Do you write problem cases that your family have consistently encountered and cannot solve?	*N*: 13
a) Carrying wood	3
b) Lots of village affairs	3
c) Hazelnuts collection	2
3. How do you solve a problem in your daily life?	*N*: 13
a) Identify the problem, write, think and calculate the needs	10
b) Consultation with the friends or family	3
4. Could you explain the reasons why you cannot solve daily life problem?	*N*: 13
a) Not investigating and thinking as competently	8
b) The thought that it is difficult	3
c) Too many hazelnuts and woods	2

As shown in Table 2, post-administration daily life problems were re-scanned and the data obtained were indicated. It is noteworthy that all participants responded to the questions. In general, it is seen that both the participants and their families often express problems due to the cold winter of the winter months, the transfer of wood and the work done in the village. Interesting results arise when examining the answers to the questions '*how do you solve a problem in your daily life*' and 'could *you explain the reasons why you cannot solve daily life problem?*' How do you solve a problem in your daily life? The answers to the questions given below are cited below:

A process, research studies, experiences, thinking positive and negative aspects, is it costly? Is not it? This is my calculations (F3).

I try to solve things by thinking about things like transaction, research, proof, reason, support, design, costs, costs of equipment, etc. (F4).

First, I will examine the problem and determine what I need and make an account. According to the probing, I think thoroughly and calculate what I need and solve it (M5).

First, we have to do something to solve the problem, then we look at how much the cost of this problem is and what is needed (M8).

As can be understood from the citation, participants understand that the problem will first be determined by '*examining*', '*needs*', '*tools*' and '*solving*' by determining all '*costs*' before the problem is encountered. It is also noted that some participants used new concepts such as '*support*' and '*design*' in their '*positive and negative*' aspects of the '*claim*'. This data demonstrates that with the impact of the STEM-integrated ABSL approach, participants learn the problem-solving process with great participation. Could you explain the reasons why you cannot solve daily life problem? Some of the answers given in the question are as follows:

Because there is a lot of hazelnuts (M6).

I cannot solve it difficult (M4).

Process, research, draft, cost, etc. whether we think about things (F4).

I cannot think of it, think absurdity, do not do it, think goof (F3).

We did not try to do what we did not do (M2).

Participants stated that the problems of daily life about hazelnuts cannot be solved because of the reasons such as giving up '*trying*', '*not*' thinking '*to be*' and '*difficult*' to solve. It is also understood that this is the effect of the probing in its inability to think in detail such as '*transaction*', '*research*', '*draft*' and '*costs*'. As can be understood from the citation, the STEM-integrated ABSL approach activities seem to be a significant change in participants' pre- and post-implementation considerations. Firstly, it was determined that the participants expressed reasons for not being able to try, not to do and to not pay attention to the problem-solving elements. This implies that the participant learned new things after the application and it is perceived as questioning why he cannot think or not until now. Indeed, the increase in the number of respondents supports this. It is considered that the participants have gained general self-confidence with the activities. Moreover, it is most important that the thoughts on the difficulty of hazelnut transport are removed but it is noteworthy that participants were concerned about the number of hazelnuts.

3.3. Findings and comments of part three of the first research questions

Participants in the solution of the texts of the STEM-integrated ABSL approach were two groups among themselves. Groups; they were able to demonstrate the nature of the problem, to identify the problem, to collect data, to make claims (reinforcing the claim with technology-mathematics and engineering disciplines), to explain the reasoning, support, qualification and rejection aspects of the claim. The theme-category and coding of the content analysis in STEM-integrated ABSL approach texts are given below:

Theme 1. My data about probing

In the text of the STEM-integrated ABSL approach, the following question was asked and the solution made in group was analysed in detail.

Transported hazelnuts; Ali has packed 50 bags of hazelnuts he collected from a 10-acre hazelnut garden 5 km away. How can Ali bear the house in this garden which is mountainous and not having a road with the lowest cost and as soon as possible?

Category 1: Collection of data; the data obtained by the groups from the problem are presented below:

Ali has packed 50 bags of hazelnuts collected from a 10-acre hazelnut garden 5 km away and wants to bring them to the house with minimal expense and cost (first group).

Garden 5 km away, garden 10 acres, 50 bags nuts, garden mountainous and no way (second group).

Participants indicated the transport 'distance', the number of 'acres', the amount of 'hazelnut' and the 'garden' terrain conditions. Participants noted the data belonging to the probing as understood by the citations of both groups. Participants have an idea for solving the problem by way of this data.

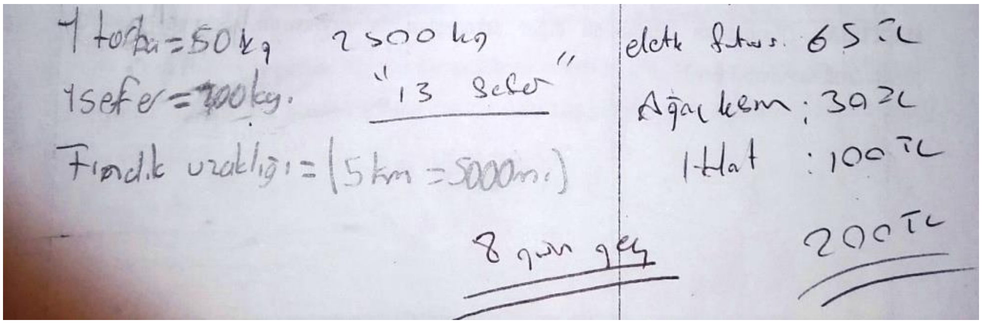
Category 2: Assertion for resolution; participants stated their work on the basis of disciplines of technology-engineering and mathematics for resolution prior to making a claim as follows ('TL' used in Turkish currency):

Cardboard, mast, rope, adhesive, box (Technology)

I started dancing four of the pylons and sewing them when I finished. Then, box (placement) (Engineering)

1 bag = 50 kg, 2,500 kg, 1 time = 200 kg, 13 times, Hazel distance: 5 km = 5,000 m

Electric bill: 65 TL, Tree cut: 30 TL, Rope: 100 TL = 200 TL (Mathematics)



Picture 1. The first group of participants' calculations for mathematics discipline

The above quotations belong to the first group. Picture 1 shows the calculations made by students in the scope of mathematics discipline. Above, these calculations are given in English. The members of the group indicated the equipment to be used in the prototype of the technology, such as 'cardboard', 'pole', 'rope', 'glue' and 'box'. The design of the 'pole' stitch and 'box' placement was written in the engineering footprint of the claim. Lastly, in the mathematics of the indictment, elements such as 'expense' and 'number of days' in the works and transactions to be made are mentioned. As it is understood from the data, members of the first group will pay 200 TL and move 13 times and 8 days (unspecified how many times a day) nuts will be transported by a cable car-like transportation route.

Water, soil, small branch (Technology).

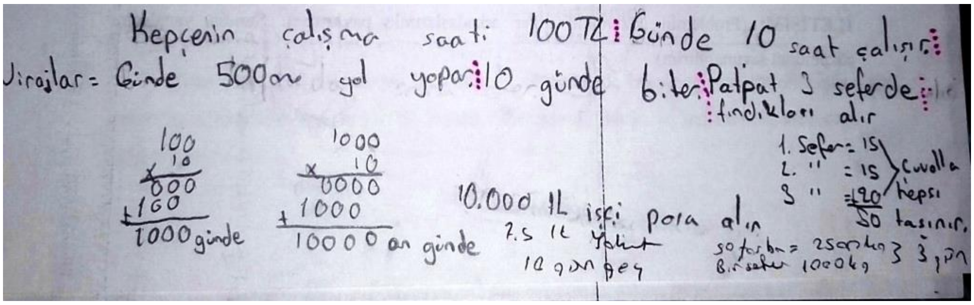
The width of the pass is 3 m and to return in the bends to be in danger 4 m (Engineering)

The operating time of the bucket is 100 TL. It works 10 hours a day. Curves = 500 m a day. It ends in 10 days. Patpat 3 takes the nuts at once.

1st step = 15, 2nd step = 15, 3rd step = 20, all 50 sacks are carried. 50 bags are transported at a rate of 2,500 kg 1,000 kg = 3 days.

100 × 10 = 1,000 (TL) day, 1,000 × 10 = 10,000 (TL) 10 days

10,000 TL working money, 7.5 l fuel (Mathematics)



Picture 2. Calculations of the second group of participants for mathematics discipline

Picture 2 shows the calculations made by students using mathematics discipline. Above, these calculations are given in English. When the data of the second group is examined; group members indicated tools, such as 'water', 'soil', 'small branch', which they would use in the technology footprint of the prototype for their claim. The design of the 'road' width and 'cornering' calculations to be made is written in the engineer's footstep. Lastly, in the mathematics of the claim, elements such as 'expense' and 'number of days' in the works and transactions to be made are mentioned. As it is understood from the data, members of the second group will be transported by means of transport called pat pat on the sloping mountain road to be made by hazelnuts in 13 days with a cost of 10,007.5 TL. In both groups, after gathering the evidence based on technology-engineering and mathematics disciplines for their claims, they created their claims a follows:

My claim; the cable car may be costly but we can easily carry the nuts without getting tired

Reason; you can easily bring the nuts home

Support; going cold in winter because our parents need to weed the animals but it is far away.

Qualified; anyone away from the hazelnut garden can take hazelnuts to home easily; thanks to this cable car.

Rejection; the ropes of the cable can be broken, the poles can be broken more than weights.

The first group claims that the participants not 'tire' and the nuts can be transported by establishing a 'cable car' system. The reason of claim that the nuts are taken home in an 'easy' way, they support the fact that they can also be used for transporting 'weeds' to animals in winter. Moreover, those who are away from hazelnuts garden can carry hazelnut 'thanks to the cable car' that is qualified of the claim. They point out that there is a possibility of 'breaks' or 'possibility of breaking the pillars' from 'too much weight' that is a rejection of the claim.

My claim; make a way

Reason; less costly than others, safer

Support; father and grandfather made way

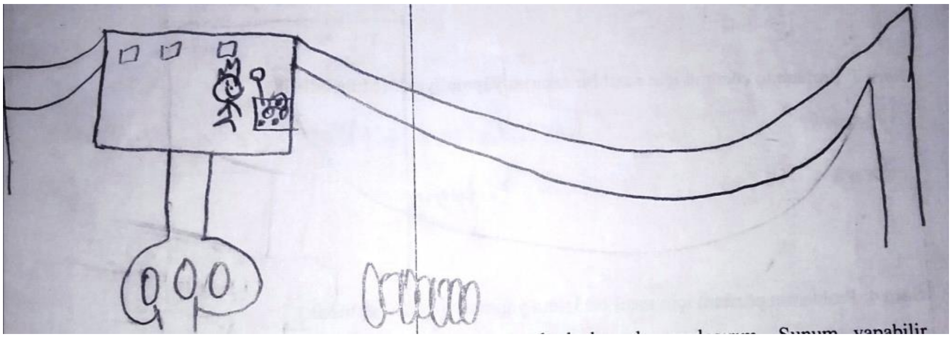
Qualified; It's safer, we can bring it the same every year.

Rejection; It takes a little longer.

The second group of participants made a brief statement; claiming that hazelnuts can be carried by making a 'way'. The reason of claim that the hazelnuts are transported in a less 'costly' and 'safe', 'father and grandfather' in the old 'way' is shown as support. In addition, they also stated that they can carry hazelnut 'more safely' with 'the same way' that is qualified of claim and normally can be 'long' that is a rejection of the claim.

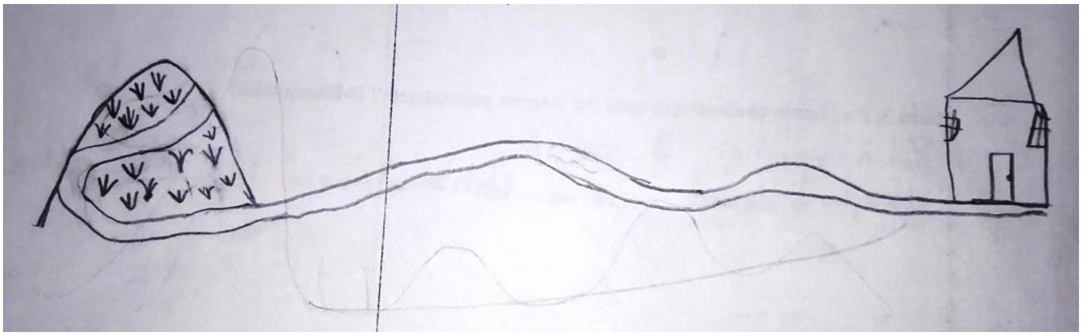
Theme 2. My product data

Category 1: Product design and prototype; the participants of both groups made their claims with all their dimensions, then made the designs of the product and made drawings like the Pictures 3 and 4. Then, as shown in Pictures 5 and 6, the prototype or model of the product is made.



Picture 3. The design of the first group claim

As shown in Picture 3, the first group of participants made their drawings for building a cable car system with the help of rope and box.



Picture 4. The design of the second group claim

Picture 4 shows the drawings for the design of the road to be made between the house and the rugged hazelnut garden.

Picture 5. The prototype of the product of the first group claim

Picture 5 shows the prototype of the cable car system claimed by the first group participants.

Picture 6. Modelling of the product of the second group

Picture 6 shows the model of the transport way claimed by the second group of participants.

Category 2: Product presentation; in the presentation of the products, three personality representatives from both groups made product-oriented presentations, respectively. In their presentations, the problem situation, claims, solution proposals and calculations are explained. The presentation of the first and second group is given below (this recorded data was later written down):

We think that Mister Ali, who has 50 bags of hazelnuts 5 km away from his home, can carry hazelnuts with the safest and fastest cable car system. Because the region is mountainous and rugged, it provides the means to move vehicles. Besides, there are durable and quite long trees in the area. We can transport with the help of these trees and ropes. The distance between the house and the hazelnut is 5,000 m. When we plant a mast at every 1,000 m, we need 5,000 m rope with six solid trees together with the head and the end. The cutting and transporting of the six trees in the region are 40 TL and the rope is 100 TL. The system will be transported from above and below with the aid of the weight and electricity. Approximately 60 kW of electricity will be used during transportation, which will be reflected in the bill to approximately 70 TL. Since the cable car will take 200 kg at a time, 13 flights will be made. In addition, tree cutting, material preparation, bonding and testing will take 8 days in total. A total of 210 TL will be charged (first group).

The presentation of the first group passed as above. The presentation of the second group is as follows:

We think that Mister Ali, who has 50 bags of hazelnuts 5 km away from his home, can carry hazelnuts in the safest and earliest way with the help of roads. As the mountainous and rugged formations make the movement of the vehicles difficult, the pavement work machine and the road from the house to the hazelnut field will be done with a width of 3 m. The turning spots and curves will be 4 m wide. This will be paid 100 TL per day for the bucket. A total of 10,000 TL will be paid for the workmanship to work for 10 hours a day. (We have determined that we can make 500 m a day in our research, so these will last 10 days). We will carry 50 bags (estimated 2,500 kg) three times and the fuel amount will be 7.5 TL, totaling 10,007.5 TL and this process will take 10 days (second group).

In the citation for the presentations of the groups, the first group seems to have increased the cost by '10 TL'. Summarising; the first group will be carrying hazelnuts with a cable car system at 210 TL for 8 days and the second group will carry hazelnuts for 10 days at 10,007.5 TL cost. Below the questions and answers are given to the participants during the presentation.

How will the scoop make its way because it is mountainous and rough? (First group)

The scoop will be palette and will be bored because it will start down the mountain (second group).

Will the storm and lightning in rainy weather damage the cable car system? (second group)

The cable car system is not affected by lightning because it is a wood blocker, and it will not be a storm in the months to be used in summer, but will not work in windy weather (First group).

What do you do after the road will be damaged in rainy weather? (First group)

The proportion of the stone in the area is high. The road will be made from more stone so that it is not affected by the rain (second group).

Will you do it again every year? Your timber will decay in the rain or winter months. Will not it be too costly? (second group)

Yes, we will repeat it every year if necessary (First group).

Citation of the first group of participants, they asked how the 'scoop' would work on 'mountainous' and 'rough' grounds. Participants in the second group were informed that the scoop would be 'palette' and that there would not be any 'boredom'. Participants in the second group asked whether nature elements such as 'storm' and 'lightning' would 'damage' the cable car system. Participants in the first group expressed that they would not be used in the 'windy' weather but that they would not be affected by 'lightning' and would not be affected by the 'storm' in summer. Also, Again, the first group of participants stated the road will be destroyed in the 'rainy' weather, the second group participants *stated that the way would be 'stone' and it would not be affected by the 'rain'. Finally, the second group of participants thought that the timber would 'decay' because of the 'rain' or 'winter' months, so that the windmills would be made 'every year' again. It was determined that the first group participants expressed 'yes' and 'every year' again. The presentation was ended with mutual questions and answers of the groups.*

3.4. Findings and comments of second research questions

The mean scores of Kandemir (2015) were used to interpret the data obtained from the reflective thinking test.

Table 3. Kandemir's (2015) reflective thinking tendency criteria

Score range	Reflective thinking disposition level
1.00–1.80	Very low
1.81–2.60	Low
2.61–3.40	Middle-level
3.41–4.20	High
4.21–5.00	Very high

Using the criteria in Table 3, the data in Table 4 were analysed by sub-factors, taking into account pre-test and post-test scores.

Table 4. Descriptive statistical values of reflective thinking skills of participants in pre-test–post-test

Factors	Item		$\overline{X}$			Sx	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Questioning	1	3.2	3.4	3.36	3.56	1.09	0.77
	3	3.5	3.5			1.13	0.97
	7	3	3.5			1.41	1.2
	9	3.6	3.7			0.96	1.18
	13	3.5	3.7			1.13	0.85
Evaluation	2	3.3	2.7	3.28	3.32	1.15	1.11
	4	2.8	3.2			0.99	1.07
	6	3.5	3.6			0.93	1.26
	10	3.2	3.8			1.21	1.01
	14	3.6	3.3			1.19	1.25
Reasoning	5	3.6	3.6	3.33	3.48	1.26	1.12
	8	3.2	3.5			1.14	0.78
	11	2.8	3.2			1.09	0.9
	12	3.7	3.6			0.95	1.39
General average				3.32	3.46	1.12	1.06

Table 5. Reflective thinking skills Wilcoxon signed rank test values

Posttest-pretest	*N*	Mean ranks	Sub of ranks	*Z**	*p*
Negative ranks	3	6.67	20	1.5	0.14
Positive ranks	9	6.44	58		
Ties	2				

*Based on negative orders

When the data in Table 5 are examined, it is seen that the value of '*p*' (0.14) is greater than 0.05. These data indicate that there is no significant difference between participants' reflective thinking levels before and after implementation.

4. Discussion

In this section, discussion was given following the research questions.

4.1. Is there an effect of the STEM-integrated ABSL approach in solving daily life problems?

4.1.1. What are the daily life problems of the participants?

According to the findings of determining the daily life problems made before the application; most of the participants did not respond to the questions. The most common problem among respondents is the difficulties that arise from winter conditions. 'How do you solve a problem in your daily life?' is the important aspect of the research's purpose. It was seen that answers such as 'think-through research' or 'get help' were given. And 'could you explain the reasons why you cannot solve daily life problem?' it was determined that the answers such as 'wrong behaviour', 'misconception' and 'land factor in hazelnut landing' were given. The text prepared for the purpose of the research and the subject to be put into practice was selected from the answers given to this question by the common decision of the researchers and expert teachers. According to this; it was decided to prepare a text based on the research question and STEM-integrated ABSL approach for the solution of hazelnut transport which could not be done because of the land factor. Similarly, Tasdemir and Demirbas (2010) have taken the data from the participants with daily life questions. However, Karatas and Guven (2010) and Hidiroglu and Ozkan Hidiroglu (2017) have prepared by taking into consideration the level of participatory readiness, in consultation with the experts who take daily life problems in their work.

4.1.2. Is there a change in daily life problems in terms of pre- and post-work with the STEM-integrated ABSL approach?

According to the finding from daily life problems form which was reused at the end of the application, it has been determined that all of the participants responded to the questions. Participants were seen as both themselves and their families expressing more of the problems they faced during the cold months of winter, such as transport wood and working in the village. When looked at the answers to the question of 'how do you solve a problem in your daily life?' stated that they would examine, need, choose tools, specifying all costs and solve the problem. Some of the participants point out that they use as new concepts such as support, design positive and negative aspects of the claim. This data demonstrates that participants learn the problem-solving process with a great deal of involvement, by the impact of the STEM-integrated ABSL approach. The question of 'could you explain the reasons why you cannot solve daily life problem?' was given; participants stated that the problems of daily life about hazelnuts cannot be solved because of the reasons such as 'giving up trying', 'not thinking to be' and 'difficult to solve'. It is also understood that this is the effect of the probing in its inability to think in detail such as transaction, research, draft and costs. As understood from the pre- and post-implementation analysis of daily life problems, the STEM-integrated ABSL approach activities seems to be a significant change in participants' thinking. Firstly, it was determined that the participants expressed their reasons for not being able to try, being unable to do things and not paying attention to problem-solving elements. This situation is perceived as questioning whether the participant provides the necessary learning with the activities and why cannot think or not until now. Indeed, the increase in the number of responding respondents supports this. It is considered that the participants have gained general self-confidence with the activities. Most importantly, it is noteworthy that the thoughts on the difficulty of hazelnut transport are removed. Similarly, Akkus (2008) determined that positive developments in participants' post application competence in associating problems with daily life.

As a result of the activities of the STEM-integrated ABSL approach, it has been found that the participants have realised that there are some factors that can arise from their daily life problems that can be solved. As a matter of fact, Gulhan and Sahin (2016) came to the conclusion that STEM activities developed the perceptions and attitudes of participants in these areas. In addition, Gulen and Yaman (2018) found that STEM-integrated ABSL approach activity affected the views of students positively. Yildirim (2018a) found that STEM practices related to daily life positively affected participants' sensitivity and behaviour towards the issue of research. This finding is similar to the result of STEM-integrated ABSL approach finding, which is applied. It was also found that the positive developments in the solution of problems based on daily life or in the learning of participants' interest and knowledge levels (Acar & Yaman, 2011), motivations (Kutu & Sozbilir, 2011) and understanding of daily life methods (Demir & Akarsu, 2013). Findings are similar to findings of the study. In addition to these studies, Urek and Dolu (2018) have not found a significant difference between problems based on daily life and traditional problems data obtained from pre- and post-implementation studies in the study. Kutu and Sozbilir (2011) were not able to detect a statistically significant effect on participants' attitudes toward life-based learning. In addition, Karatas and Guven (2010) found that participants failed to solve their daily life problems. In other words, these findings are not similar to the findings of the study.

4.1.3. How did they solve the problem of daily life prepared according to the approach?

In the analysis of the answers given to the research question in the text which was prepared for hazelnut transport; the first group of participants claimed that they would move the hazelnuts by a transport route similar to a cable car in 8 days with a cost of 210 TL and 13 flights based on the processes, calculations and drawings they created with the STEM disciplines. The second group participants claimed that they would move with a transportation vehicle called pat pat on the inclined mountain road to be made in 13 days with a cost of 10,007.5 TL. It was determined that the participants of both groups determined the reasons, support, qualification and rejection of their claims. It was seen that the groups made product designs and product prototypes or models. Later it was determined that the participants had presented their reciprocal products and asked each other questions. Participants were found to perform similar actions to solve the problem in the Bozkurt (2014) STEM education approach and Gulen (2016) STEM-integrated ABSL approach. As seen in Ong et al. (2016), STEM disciplines can be used from early ages. It also influences the career preferences of students (Christensen & Knezek, 2017).

4.2. What is the effect of the STEM-integrated ABSL approach on reflective thinking in terms of pre- and post-work?

Findings for reflective thinking skill differed in the study. The results of the analysis of the pre- and post-test findings have been found to rise from 'middle' to 'high' according to Kandemir's (2015) criteria. However, it was found that the participants' post-test scores were higher than the pre-test scores and did not show a significant correlation with the Wilcoxon signed rank test. Scardamalia, Bereiter and Steinbach (1984) reported that factors such as loud talk, feedback provided by feedback and the ability to question thoughts were positively affecting reflective thinking skills. Again, Farrell (2007) stated that the question of how the individual returns and learns what learned positively influences the reflective thinking skills. In addition, Kaf Hasirci and Sadik (2011) determined that reflective thinking is high with the scale used. These findings are similar to those of Kandemir's (2015) evaluation. It is thought that in-class activities based on STEM-integrated ABSL approach in the study affected this result. As a matter of fact, Kandemir (2015) determined that the participants' ability to blend old and new learning led to high reflective thinking skills. Similarly, Phan (2007) stated that using different methods and techniques in education positively affected participants' reflective thinking skills. Erbil and Kocabas (2015) determined that collaborative activities in the classroom environment and Demiralp and Kuzu (2012) influenced the reflective thinking skills positively in the classroom environments in which interaction is intense. Finally, it is understood that new and different activities in Ozden, Kabapinar and Onder (2015) study have a positive impact on reflective thinking. These findings support the reasons for the emergence of middle to high reflective thinking skills in the study. Apart from these studies, it has been determined that activities aimed at increasing reflective thinking skills are a positive relationship between other attitudes and reflections (Tok, 2008) and problem-solving abilities (Demirel, Derman & Karagedik, 2015). Based on these findings, it can be said that the reflective thinking skill influences the problem-solving process. As a matter of fact, Lee (2005) stated that communication of the individual and the ability to ask questions and setting context influence the development of reflective thinking skills. Finally, Gulen (2016) found that the STEM-integrated ABSL approach activities carried out in the classroom also had a positive impact on participants' reflective thinking skills. In spite of these results, although there is no meaningful relation due to the value of 'p', it is similar to the result of studying from the pre-test to the post-test.

5. Results and suggestions

As it is understood from daily life problems of students living in mountainous, rural and forested areas have been identified. It was determined that students were not able to solve these problems. It is understood all students living in similar areas have similar problems.

The analysis of daily life problems before and after the application, it is seen that the activities of STEM-integrated ABSL approach have a positive effect in the way of thinking about the problems of identifying and solving daily life problems of the participants. After the application, it was determined that the participants responded by taking into consideration factors such as the claims-reason-support-positive-negative aspects learned during the research and the use of the STEM disciplines. This finding has found that the activity, which was prepared according to the STEM-integrated ABSL approach, encourages participants to be more active in the problem-solving process and to have positive thoughts in this process. It is understood that the concerns of the students regarding the solution of daily life problems have been removed; thanks to the activities carried out. It has been determined that the students are working safely in this regard. STEM-integrated ABSL approach can be used with similar students.

It is seen that the unresolved problem factor determined for the land factor in hazelnut transportation is removed after the application. Participants were planning according to the STEM-integrated ABSL approach to hazelnut transport and they were all trying to convince the other group that they made up their claims with all aspects and using product presentation and evidence. It is seen that these students in middle school age solved their daily life problems by using STEM disciplines and ABSL approach. This approach can be used for other regional students with similar characteristics.

According to the reflective thinking skills before and after application; participants were found to have reflective thinking skills at the 'middle' level before the application and 'high' level after the application. It can be said that the applications made according to these findings affected the reflective thinking skills positively. In other words, it can be said that the participant's reflective thinking skills values are increased with the activities of STEM-integrated ABSL approach. The Wilcoxon signed rank test was applied to the question of whether the increase in the reflective thinking skills values was meaningful or not. When the value of 'p' of this test is greater than 0.05, it is determined that there is no meaningful difference between pre- and post-implementation reflective thinking levels. As a result; although the reflective thinking skill used before and after the practice was changed positively according to the criteria of Kandemir (2015), there was no significant difference in this change compared to Wilcoxon signed rank test. This approach can be used in the development of high-level thinking skills of students with similar characteristics and conditions.

It is suggested that the STEM-integrated ABSL approach can be used to solve daily life problems. It is possible to use the STEM-integrated ABSL approach in creating arguments and debating environments. It is proposed that the STEM-integrated ABSL approach can be used in the development of reflective thinking skills.

Compliance with Ethical Standards

6. Funding

This study was not funded.

7. Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

8. Informed consent

Informed consent was obtained from all individual participants included in the study.

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