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An Evaluation of Student Outcomes in Interdisciplinary STEM Activities: An Example of Using STEM Rubrics

Disiplinlerarası STEM Etkinliklerinde Öğrenci Çıktıları Üzerine Bir Değerlendirme: STEM Rubrik Kullanma Örneği

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Abstract
The aim of this research is to evaluate the achievements of sixth-grade students in interdisciplinary STEM education with STEM rubrics. A mixed research method was used in the research. A homogeneous sample was used in the study. The research was conducted with 6th grade students in a public school in the Eastern Anatolia Region in the 2018-2019 academic years. Seventy-seven students who participated in the STEM activity in accordance with the voluntary principle participated in the study. Qualitative data were collected with a structured interview form. The table-graphic drawing form was used in collecting quantitative data. In the analysis of the data, descriptive analysis, frequency, and percentage values were used. The findings showed that the majority of participants participating in interdisciplinary STEM education defined the constant velocity movement as the unchanged form along the way. In addition, it was determined that a small number of students were under the misconception of perceiving events such as zero resultant force acting on an object, stopping or accelerating a car as constant velocity motion. It was determined that the participants mostly focused on the car example while defining the constant velocity movement. It has been determined that the participants' ability to create graphics using table data is at a good level. It indicates that the use of rubrics in assessment practices in STEM education is an application that can be used in the assessment of student outcomes.

Keywords: STEM education, STEM assessment, constant velocity motion, table-graph drawing, analysis.

Öz
Bu araştırmanın amacı disiplinler arası STEM eğitiminde altıncı sınıf öğrencilerinin kazanımlarının STEM rubrikleri ile değerlendirilmesidir. Araştırmada karma araştırma yöntemi kullanılmıştır. Araştırmada benzeşik (homojen) örneklem kullanılmıştır. Araştırma 2018-2019 eğitim öğretim yılında Doğu Anadolu Bölgesindeki bir devlet okulunda 6. sınıf öğrencileri ile yürütülmüştür. Araştırmaya gönüllülük ilkesine bağlı olarak STEM etkinliğine katılan 77 öğrenci katılmıştır. Nitel veriler tam yapılandırılmış görüşme formu ile toplanmıştır. Nicel verilerin toplanmasında tablo-grafik çizim formu kullanılmıştır. Verilerin analizinde betimsel analiz ile frekans ve yüzde değerleri kullanılmıştır. Bulgulara disiplinler arası STEM eğitimine katılan katılımcıların, büyük bir çoğunluğunun sabit süratli hareketin yol boyunca suretin değişmemesi olarak tanımladıklarını göstermiştir. Ayrıca az sayıda öğrencinin bir cisme etki eden bileşke kuvvetin sıfır olması, bir arabanın durması veya hızlanması gibi olayların da sabit süratli hareket olarak algıladıkları yanılgısında oldukları belirlenmiştir. Katılımcıların sabit süratli hareketi tanımlarken çoğunlukla araba örneği üzerinde durdukları belirlenmiştir. Katılımcıların tablo verilerini kullanarak grafik oluşturma durumlarının iyi düzeyde olduğu tespit edilmiştir. STEM eğitiminde değerlendirme uygulamalarında rubriklerin kullanımının öğrenci kazanımlarının değerlendirilmesinde kullanılabilecek bir uygulama olduğunu göstermektedir.

Anahtar Kelimeler: STEM eğitimi, STEM değerlendirme, sabit süratli hareket, tablo-grafik çizimi, analiz.

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1. Introduction

Science uses scientific principles when trying to understand the working laws of the universe. In doing so, it uses different disciplines such as mathematics. Problems encountered in daily life are among the science subjects in problems that can be solved by the common use of many disciplines. The aim here is to enable the individual to learn many subjects, concepts, and problem-solving with the discipline of science. Nowadays, one of the most popular approaches that defend the strong learning of science subjects is the STEM education approach. One of the most important goals of the science, technology, engineering, and mathematics (STEM) approach is to solve daily life problems with the integration of different disciplines (Zhbanova, 2019).

STEM is an educational approach created by using the first letters of science, technology, engineering, and mathematics disciplines (LaForce, Zuo, Ferris, & Noble, 2019). It expects the individual to solve the problem using different disciplines with activities such as trips, observations, and applications inside and outs of the school. In addition, it includes many goals such as introducing the individual to STEM education, explaining the basic concepts of STEM education, introducing 21st-century skills, developing skills such as the engineering cycle and design processes (Awad, Salman & Barak, 2019; Baek et al.2019; Idin & Aydogdu, 2016; Kelley & Knowles, 2016). STEM education has emerged with the aim of supporting the economic development of individuals in the 21st century, improving their career preferences and daily skills. The most important of daily skills is to be able to solve the problems faced by the individual and to use different disciplines in this process (Lecocke et al. 2019).

STEM education requires the combined use of knowledge and skills from different disciplines (Wang, 2012). The use of science and mathematics is known to have the most used topics in STEM education (Gülen and Yaman, 2019; Thibaut, Knipprath, Dehaene, & Depaepe, 2018). One of the most avoided and difficult disciplines of STEM education in mathematics. This discipline draws attention to its intellectual dimension as well as calculations. The connections of mathematics discipline with many disciplines are known. However, its connection with natural sciences cannot be ignored. Science problems can be solved through mathematics. Similarly, mathematical operations may include science topics (Hacıömeroğlu, 2018). In addition to all these, it cannot be denied that science and mathematics are used together in many fields in daily life. Because of its importance for human life and its contribution to the development of scientific life, learning mathematics has always been an important discipline in the teaching process (Altun, 2016). Doing mathematics is not limited to knowing only mathematical concepts; it includes the skills of using concepts and the relationship between these concepts in daily life and other disciplines (Ministry of National Education [MoNE], 2013). It is known to be called competence. Mathematical competence, developing and applying mathematical thinking style to solve a series of problems encountered in daily life. Emphasis is placed on processes, activities, and knowledge built on a solid arithmetic skill (Demirkuş & Bilgin, 2018). Mathematical competence includes the ability and willingness to use logical-spatial thinking and presenting (formulas, models, constructions, graphs, and tables) at different levels (Otuz, Kayabaşı, & Ekici, 2018).

Science mainly deals with many different subjects, especially those related to natural phenomena. Biological issues, chemical issues, environmental issues, technological issues, and physical issues are among the basic subjects of science. One of the most important issues to be noted here is physical issues. Among the physical subjects, movement with constant velocity and graphics related to this subject is of particular importance (Demirkuş, 1999; Dönmez, Gürbüz and Kocabıyık, 2019). The individual is expected to understand the data by using his / her mathematical competence on this subject and to chart it. Here, the ability of the individual to transform the table into a graphic or to read it is important. It is known that the visual literacy of the individual has an effect on this. Graphic literacy is one of the types of visual literacy. Being able to interpret tables and graphs or literacy is extremely important in science. The graphics, which are adequately included in the science curriculum, ensure the concretization of the data (MoNE, 2018). It plays a major role in transferring the data to paper. In addition, these tables and graphs help the individual to develop scientific process skills. Visual transfers are provided thanks to the table and graphic literacy that support the mental development of the individual (Talaslıoğlu & Şahin, 2018).

It is possible to come across many current studies on STEM education in the literature review (Gülen, 2016; Şahin & Kabasakal, 2018). It is possible to see studies on the integration of science and mathematics disciplines (Czerniak, Weber, Sandmann, & Ahern, 2010; Rogers & Abell, 2007). Shanahan, Shanahan, and Misischia (2011) determined in their study that individuals' ability to identify numerical errors in texts more quickly developed thanks to the discipline of mathematics. This finding shows that numerical data in daily problems of science will be determined more easily by the participants. Wittmann (1995) stated in his study that mathematics is a design. Accordingly, participants can design graphs based on the tables. In addition, Bialek and Botstein (2004) found that mathematics unites quantitative thinking. Apart from these, Chamblee and Slough (2002) stated in their study that mathematics and science are keeping the communities in a reform right now - and perhaps continuously. Accordingly, it is understood that mathematics and science are disciplines that raise the individual for the future with a common teaching purpose. Vasquez, Sneider, and Comer, (2013) express the use of two different disciplines, such as science and mathematics, together as an interdisciplinary STEM. In this study, students' use of science and mathematics disciplines together after interdisciplinary STEM applications at the level of knowledge and practice was not examined.

Although STEM has been an important movement in the last decade (Martín-Páez, Aguilera, Perales-Palacios, and Vílchez-González, 2019), research focuses more on teacher practices, student attainment, and STEM education design. Evaluation approaches and their development are almost overlooked (Sondergeld, Koskey, Stone, & Peters-Burton, 2015). It is stated that more STEM assessment research is needed to investigate how and to what extent STEM learning can improve students' inquiry abilities, higher-order thinking skills or creativity (Fang & Hsu, 2019). Odabaşı (2018) lists the assessment and evaluation tools that can be used in STEM education as diary, observation, poster, concept map, V diagram, checklist, rating scales, rubrics, group assessment, peer assessment, and self-assessment. National Research Council [NRC] (2014) emphasizes that the tasks that students are expected to do in STEM education, criteria for how to evaluate these tasks and rubrics to be used for scoring purposes should be prepared. Zengin, Kaya, and Pektaş (2020) state that the use of rubrics is less preferred in the STEM assessment dimension. In this study, after interdisciplinary STEM activities, the use of rubrics, one of the STEM assessment tools developed to determine students' attainment in knowledge and practice levels, was emphasized.

1.1. Purpose of the research

The aim of this research is to evaluate the achievements of sixth-grade students in interdisciplinary STEM applications through STEM rubrics. In this context, following interdisciplinary STEM applications, the answers to the following questions were sought:

- What is the knowledge level “constant velocity movement” of the participants by using STEM rubrics?
- What are the table-graphic application levels fixed velocity chart data of the participants by using STEM rubrics?

2. Method

A mixed-method was used in the study. In the mixed method, it is aimed to cover the deficiencies in the solution of research problems with both qualitative and quantitative data (Büyüköztürk, 2009; Çepni, 2010; Yıldırım & Şimşek, 2013). Creswell and Plano Clark (2015) define mixed methods research as collecting, analyzing, and correlating both quantitative and qualitative data for a single study or series of studies. It was emphasized that the basic assumption in using both quantitative and qualitative approaches together and relating them with each other is to understand the research problem better (Altan, Üçoğlu, & Zileli, 2019). Converging a parallel pattern was used as the pattern of the research (Creswell & Plano Clark, 2015). The convergent parallel pattern is formed by the simultaneous application of qualitative and quantitative research processes. This pattern gives equal priority to methods, keeps these stages separate from each other during analysis, and then combines the results while making general interpretation (Creswell & Plano Clark, 2015).

2.1. Participants

A homogeneous sample was used in the study. The purpose of the homogeneous sample is to determine the status of groups with similar characteristics in a subject in order to collect data effectively (Creswell, 2013). The research was conducted with 6th-grade students in a public school in the Eastern Anatolia Region during the 2018-2019 academic years. A total of 77 students participated in the study on a voluntary basis. It is assumed that the participants learned constant-velocity movement, the use of table data, and graphic drawings in the classroom under the guidance of their teachers in the first semester of the academic year. The general characteristics of the participants are given in Table 1.

Table 1. General Characteristics of the Participants

Male (f)	Female (f)	Socioeconomic Statue
40	37	Middle

According to Table 1, 40 male and 37 female students with moderate socio-economic level participated in the research. Participants lives in Eastern Anatolia Region in Turkey.

2.2. STEM Activity Process

In the research, interdisciplinary STEM activity was carried out by the school's science teacher. The teacher has the necessary knowledge and skills in STEM education. Teacher participated in in-service training about STEM education and stated that (s)he carried out STEM activities in different subjects in science class. The teacher applied the same interdisciplinary STEM activities in three different classes with sixth grade students. Vasquez et al. (2013) defined interdisciplinary (Inter) STEM applications as including concepts and skills from two or more disciplines in order to deepen students' knowledge and skills. For example, groups work together to create a mathematical model or solve a scientific problem. At this stage, students worked on general subjects without separating it from mathematics or science. The teacher divided the participants into groups on the Constant Speed movement and then applied the STEM activity. Interdisciplinary STEM applications took 4 lesson hours for each class. The teacher created a problem situation by giving a toy car to the groups. Teacher followed the steps of speed, speed calculation, constant velocity motion, and drawing graphics. Findings obtained in this study cover two questions asked to students after interdisciplinary STEM applications.

2.3. Data collection tools

Collecting Qualitative Data

Qualitative data were collected with a fully structured interview form. In this form, students' answers to the question were analyzed and questioned. The following question was used in the fully structured interview form.

1. What is constant velocity motion? Can you explain by giving examples from daily life?

Collection of Quantitative Data

The Table-Graphic drawing form was used in collecting quantitative data. The purpose of using this form is to determine the level of students' ability to visualize the knowledge and concepts they have learned and to perform their mathematical operations with the relationships between them. Students were asked to draw tables and graphics within the framework of the following question.

2. First calculate the speed using the road-time table given below and fill in the speed-time table. Then use the path-time and velocity-time tables to draw the path-time and velocity-time graphs.

Change of Position (m)	5	10	15	20	25	Velocity (m/s)	…	…	…	…	…
Time (s)	1	2	3	4	5	Time (s)	1	2	3	4	5

2.4. Analysis of data

Analysis of Qualitative Data

Descriptive analysis was used to analyze qualitative data. In analyzing the data, the researchers stated the responses of the participants one by one, and then the themes were formed by taking expert opinions. The answers are given by the students after the themes were scored with the rubric prepared by the researchers. Structured interview form data aimed to determine the level of students' indicating constant trot movement.

Table 2. Scoring Criteria for Qualitative Data

	Scoring criteria of qualitative data		
	Criteria	**Value**	**Total**
SCIENCE	Definition and Example of the Concept	5	60
	Definition of the Concept and No Examples	4	48
	Sample Only	3	36
	Misconception or wrong answer	1	12
	No data	0	0

In Table 2, the value has been expanded by 12 to correspond to a 100-point system. In collecting qualitative data, the value of defining the concept and giving examples was determined as five, and a total of 60 points can be obtained. If the participant has defined the concept and did not give an example, its value is four and it can get 48 points in total. If the participant only gives an example without defining the concept, its value is three and it can get 36 points. If the participant has misconceptions or gave an incorrect answer, the value is one and the score is 12. If the participant has not answered, he will get 0 value and 0 points.

Analysis of Quantitative Data

The table-graphic form was scored according to the criteria given in Table 2. Later, these notes were converted into a hundred grade system.

Table 3. Scoring criteria for table-graphics

	Scoring Criteria for Quantitative Data		
	Part	Criteria	**Value**
		Correct data (40 points)	
MATHEMATICS	Table	Use of data	5
		Filling the gaps	5
	Graph	Naming the arms	5
		Entering values	5
		Matching values	5
		Expressing units	5
		Drawing the path-time graph	5
		Drawing velocity-time graph	5
		Total	**40**
		Missing or incorrect data	
	Other	No data entered	0
		Incorrect data entered	1
		Having misconceptions	2
		Missing data entry	3
		Total	**6**

There are eight dimensions regarding the use of tables and graphics in scoring quantitative data. A total of 40 points can be obtained from these dimensions. The participant can get 0 points when participant does not enter any data under the other dimension, one point when incorrect data is entered, two points when there is a misconception, and three points when there is missing data. Therefore, since it is 60 points from qualitative data and 40 from quantitative data, it makes 100 points in total. The scores obtained from the structured form and Table-graphic forms were interpreted according to the value range specified in Tables 2 and 3.

Table 4. Interpretation value range of the scores

Rank	Value	Value Range
1	Very bad	00.01 - 20
2	Bad	20.01 - 40
3	Middle	40.01 - 60
4	Good	60.01 - 80
5	Very good	80.01 - 100

As seen in Table 4, a range of values has been determined in order to interpret the scores obtained from the table-graphic form. In order to give a more precise interpretation, 100 points are divided into five equal parts. Accordingly, there are values such as very bad (00.01-20), bad (20.01-40), medium (40.01-60), good (60.01-80), very good (80.01-100). It can be used to calculate both qualitative and quantitative data, then the arithmetic mean of the qualitative data and the score values obtained from the quantitative data will be taken.

2.5. Reliability and Validity

Within the scope of the reliability studies in the research, the status of the sample group was detailed, the existing roles were explained, and the conceptual framework and data collection and analysis were presented. In addition, these data were supported by descriptive analysis (Glesne, 2013). The structured interview form prepared by taking expert opinion. The reliability calculation was made using the formula of Miles and Huberman (1994) for coding and scoring. According to this calculation, 90% reliable coding was used throughout the study. As a matter of fact, 80% and above is considered reliable according to Miles and Huberman (1994). In the descriptive analysis made to ensure the validity of the research, the accuracy of the research results was shown by including direct quotations (Merriam, 2013). Participants' names are presented as K. In addition, in the preparation of the table-graphic form, subject gains were taken into account in terms of content validity. Validity values such as structure and appearance were obtained by obtaining expert opinion (Yıldırım & Şimşek, 2013). Two experts (academicians with a doctorate degree) in science education analyzed the data.

3. Results

The data collected with both qualitative and quantitative measurement tools in the study are presented below. In the presentation of the data, the priority of the research problems was paid attention to.

“What is the knowledge level “constant velocity movement” of the participants by using STEM rubrics?” Sub-Problem Results

The data obtained as a result of the fully structured interview form analysis used in the study are presented below. As a result of the descriptive analysis, the most used expressions are shown in Table 5.

Table 5. Answers given by the participants

Expressions	Participants (P)	Frequency (f)	Percentage (%)
Both A Definition and An Example	20, 24, 29, 35, 38, 39, 42, 45, 46, 47, 48, 49, 51, 53, 54, 60, 61, 64, 66, 68, 70, 71, 73, 74, 75, 76, 77	27	35
Only Description Available No Sample	18, 22, 37, 55, 57, 58	6	7.8
Only Sample Available No Description	4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 21, 23, 25, 26, 27, 28, 30, 32, 33, 34, 41, 56, 59, 62, 63, 65, 67, 69	31	40.2
Misconception or false statements	1, 2, 3, 8, 17, 31, 36, 40, 43, 44, 50, 52, 72	13	16.8
No Answer	-	-	-
Total		**77**	**100**

As seen in Table 5, the answers given by the participants to the structured form were evaluated in four categories. It is seen that 35% of the participants use correct expressions by giving both a description and an example with constant speed movement. It was seen that 6% of the participants only wrote a description. 40.2% of the participants only gave examples, but it is seen that they do not define a fixed speed. It is observed that the participants (16.8%) also have false or misconceptions.

Category 1: Both A Definition and an Example

The answers given by the participants under the theme “both a definition and an example” within the definitions of the constant speed movement are as follows;

> *Constant velocity motion is the movement of an object at the same speed. Sample; a car with balanced speed, hour and minute hands (P20).*
>
> *It is the path that a being takes in a fixed way. Sample; The car moving at a constant speed or the cheetah rushing to its prey without changing its speed (P39).*

It is the movement made by objects that take equal paths in equal time intervals, that is, the speed of which does not change during their movement. For example, a car traveling at the same speed is the minute hand of a wall-hung clock (P53).

> *Car driving at the same speed along the road, Chetan moving at a constant speed along the road (P68).*
>
> *It is said that something always goes at the same speed. For example, a car always traveling at 20 km (P77).*

As it is understood from the expressions of the participants, “constant velocity motion” is defined as “vehicle, substance” or “being” at “same speed” along the “path”. It was determined that the participants mostly used the "car" example. It is also understood that “cheetah” and “hour hand” or “minute hand” of the clock are among the examples. In general, it can be said that the majority of the participants defined the constant velocity movement as the unchanging form along the way. It is seen that the definitions used by the participants respond around the definition written in the book. When the examples are examined, there are examples of the cheetah and the hour or minute hand of the clock hanging on the wall, which are given examples in the textbook or in the lesson of the use of correct expression. Participants who answered in this category were given five points.

Category 2: Only Definition Available No Sample

The citations in this category are as follows:

> *It is when a moving object or person takes a certain path in a certain time interval (P18).*
>
> *It is the movement of a mobile with the same speed along the way (P22)*
>
> *Constant velocity is the movement of an object with the same speed (P37).*
>
> *It is the movement made by objects that take equal paths in equal time intervals, that is, the speed of which does not change during their movement (P55).*
>
> *It is the taking of a mobile in a certain time interval along the way (P58).*

As understood from the expressions of the participants, it is seen that they perceive the question on the definition. It is seen that they only give a definition to the question but do not give an example. It has been determined that the participants mostly use "path" and "time". Participants who answered in this category were given five points. Participants who answered in this category were given four points.

Category 3: Only Sample Available No Description

The citations in this category are as follows:

For example, it is the movement of the minute hand of the hour (P4).

It is a car with balanced speed, or the movement of the hour and minute hands (P16).

It is the cheetah running for its prey without changing its speed (P28).

The cheetah progresses at a constant speed (P41).

It is a car traveling from A to B at a speed of 80 km (P68).

As understood from the statements of the participants, it is seen that they perceived the question as an example. It was observed that the answers they gave were not wrong, but they only commented on the sample. It was determined that the participants mostly used the "car" example. It is also understood that the "cheetah" and the "minute hand" of the clock are among the examples. Participants who answered in this category were given three points.

Category 4: Misconception or false statements

Under this category, the errors of the participants about movement with constant velocity were cited:

The car moving rapidly on the road has a constant speed (P1).

The car goes too fast and stays stable (P8).

It is when the stationary car continues to stop (P17).

A car travels 20 km at zero speed (P40).

Ali draws 8N from the east and Arda 8N from the west (applying). The table is an example of constant velocity motion (P52), since the two (strength) are the same.

Motion with constant velocity is the movement in which the resultant force is 0 (zero) (P72).

Participants in this category are understood to think that "fast" progressing or "stopping" of a car is a constant velocity movement. In addition, the participants describe the events that affect an object but where the "resultant force" is "zero", as "constant velocity motion". In general, it can be said that the participants are mistaken that they perceive events such as zero resultant force acting on an object, stopping or accelerating a car as constant velocity motion. Participants who answered in this category were given one point.

Table 6. Scoring the answers given by the participants

Scale	**Grade average**	**Percent (%)**	**Comment**
Qualitative Data Average	3.44	68.8	Good

Table 6 shows the general average of the grades that the participants got on an individual basis over 60, their hundred values and their interpretation. Accordingly, it is seen that the participants got "good" grades in defining the constant speed movement at the knowledge level. This finding shows that the participants' knowledge of the definition and giving examples is high.

" What are the table-graphic application levels fixed velocity chart data of the participants by using STEM rubrics?" Findings Regarding the Sub-Problem

Quantitative data obtained other than qualitative data are given below. Table 7 was created as a result of the scoring of the information obtained from the table-graphic form.

Table 7. Table-graphic form scoring result

Rank	Criteria (N: 77)	Average	Percent (%)	Comment
1	Use of data	4.94	98.80	Very good
2	Filling the gaps	3.96	79.20	Good
3	Naming the arms	3.03	60.60	Good
4	Entering values	4.60	92.00	Very good
5	Matching values	4.56	91.20	Very good
6	Expressing units	2.29	45.80	Middle
7	Drawing the path-time graph	4.44	88.80	Very good
8	Drawing velocity-time graph	3.49	69.80	Good
9	Overall (size) average	3.91	78.28	Good

Table 7 shows the grade average and percentage value of each step as a result of the scoring of the table-graphic form. In addition, comments that can be made to these steps have been added. Accordingly, in the table and graphic drawings of the participants; it is understood that they are “very good” in steps such as being able to use data, enter values and match them, and draw the path-time graph. It is seen that they fill the gaps in the tables, the naming of the graphic arms and the drawing of the velocity-time graph. Finally, it is understood that the participants' use of units during the operations performed in table and graphic form is at a "medium" level. In general, it is seen that the table-graphic usage of the participants is at a "good" level. The grade average, percentage value and interpretation is taken from the table-graphic form are shown in Table 8.

Table 8. Table-graphic point values

Scale	Average	Percent (%)	Comment
Table-graphic	31.30	78.25	Good

Table 8 shows the general average of the grades, the percentage value and the interpretation of the individual grades of the participants out of 40. Accordingly, it is seen that the participants got "good" grades in the table-graphic form. This finding is at a good level of the participants; It shows that they can use the data in the tables, fill in the gaps, enter and match values, express units, name the graphic arms, draw the path-time and speed-time graphs. Some of the activities of the participants using tables and drawing graphics are given below.

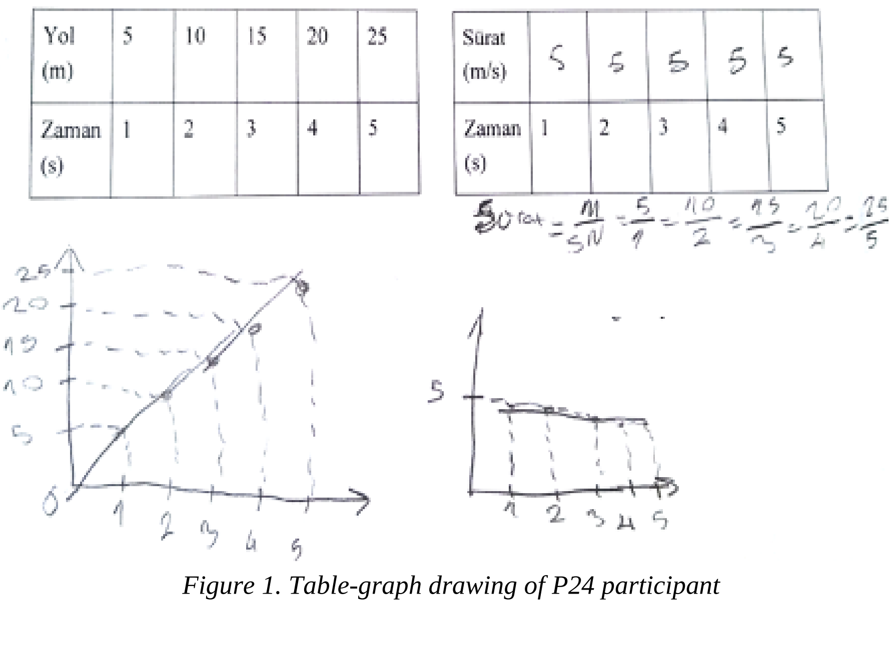
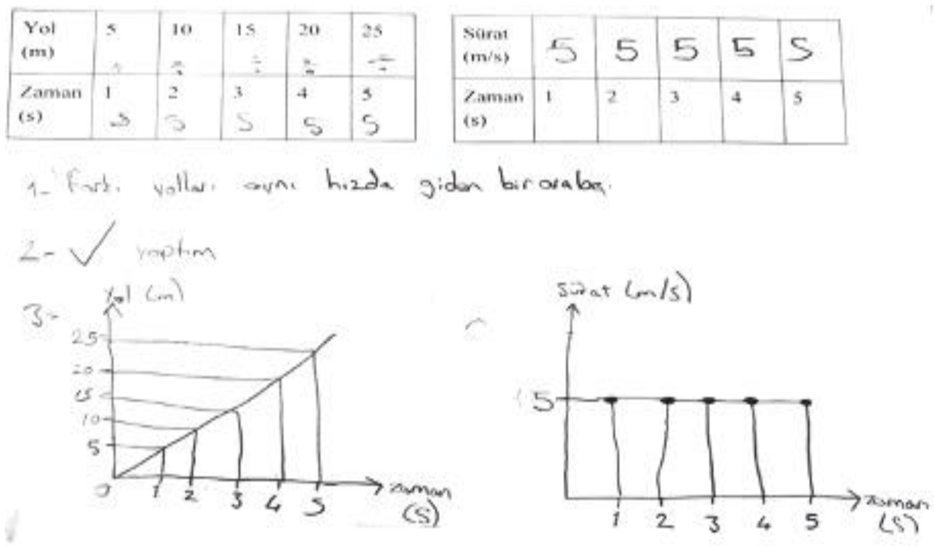


Figure 1. Table-graph drawing of P24 participant



Picture 2. Table-graph drawing of P46 participant

As can be seen in Pictures 1 and 2, the tables and graphs made by the participants for constant velocity movement are seen. When these table-graphics are scored according to the criteria in Table 2, both of them; It was determined that they completed the criteria such as the use of data, filling the gaps, entering values, matching values, drawing the path-time graph and drawing the velocity-time graph. However, while there was no problem in Picture 2, it was determined that the graphic arms were not named in Picture 1, i.e. the drawing of the P24 participant, and the units were not sufficiently expressed and in the relevant places. Although the table-graphic in Picture 1 is given as an example of students' missing information, its accuracy is at an acceptable level. It is seen that the table-graphic in Picture 2 is prepared in accordance with all criteria. From these pictures, it is understood that the participants use the table for constant velocity movement and the graphical drawing situations.

4. Discussion

According to the descriptive analysis of the structured interview form after interdisciplinary STEM activities, it can be said that most of the students use correct and scientific expressions for constant speed movement. In STEM activities, hands-on activities were carried out by using group-based equipment. Similarly, Bülbül (2012) determined that tools should be used in learning the concept of movement. Also, with STEM education, student interest in physical activity issues increases (Lindstrom, Thompson, and Schmidt-Crawford, 2017). In addition, Aydin (2008), Trudel (2012), Seçer (2008) found that students had access to scientific data on concepts such as force and speed. In addition to these findings, it was determined that there were also misleading statements. Accordingly, it is understood that some students, though few in number, argue that the speed of the car, the stop or the resultant force being zero is also the constant velocity motion. According to the descriptive analysis of the fully structured interview form, it can be said that the vast majority of the students defined the movement with constant velocity as the unchanged form along the way. In addition, it can be said that a small number of students are mistaken that they perceive events such as zero resultant force acting on an object, stopping or accelerating a car as constant velocity motion. Similarly, Yildiz, Büyükkasap, Erkol, and Dikel (2007) showed in their studies that students do not fully understand the concept of speed and have different opinions about this concept. Also, according to Graham, Berry, and Rowlands (2013) study, misconceptions on this subject did not arise from previous learning. They determined that it mostly comes from the current interpretation mistakes. In addition, Balbağ (2018) found that pre-service teachers had non-scientific or superficial knowledge about the concept of speed. They also found that some pre-service teachers had misconceptions. Apart from all these, Ndiaye, Hérold, and Chatoney (2020) determined that students have difficulties with the concept of force.

In the table-graphic form drawings used in collecting quantitative data, it has been determined that students are very good at the steps such as using data, entering values and matching them, drawing the path-time graph. It has been determined that they are good at filling the gaps in the tables, naming the graphic arms and drawing the velocity-time graph. Finally, it is understood that the students' use of units during the operations in table and graphic form is moderate. In general, it has been determined that the use of tables and graphics by students is at a good level.

Apart from these findings, it was determined that the students could use the table-graphic data at a good level according to the average of their individual scores. This situation can be understood from his drawings. Similarly, Talaslıoğlu and Şahin (2018) found that graphic literacy activities positively affect decision-making skills and concept learning. In the study Cook, Teaff, and Cook (2015), it was determined that STEM education activities positively affect visual literacy. In addition, in the study of Akar (2018), it was determined that students did not have problems in graphic definition and drawing. Dönmez et al. (2019) showed that technology-focused STEM activities contribute to students' reading graphics in constant speed movement and eliminating misconceptions. Contrary to these studies, the study conducted by Bayazıt (2011) revealed that pre-service teachers had difficulties in understanding and interpreting graphics. It was also determined that the candidates failed to interpret the graphs without algebraic processing. Apart from these studies, Otuz, Kayabaşı, and Ekici (2018) determined that drawing tables and graphics show that it is mathematical competence. As can be understood from here, it is understood that the participants use their science knowledge by integrating their mathematical knowledge. As a matter of fact, in the studies of Baki and Celik (2018), it was determined that the participants preferred mathematical operations in subjects such as problem posing, determining strategies in problem solving and reaching results in problem solving. As can be understood from these studies, it can be said that the participants used their knowledge of science and mathematics well in interdisciplinary STEM ethics. It is possible for a car to travel at the same speed along the road with the use of both science and mathematics disciplines (Subotnik, Tai, Rickoff, and Almarode, 2009). As a matter of fact, based on the difference between the first second and the next, it can be said that the students reached this finding. It can be said that they use mathematical disciplines to calculate the resultant force acting on an object. It uses science and mathematics knowledge together in cases such as adding or removing multiple forces affecting the object (Tan, 2018). According to quantitative findings, mathematics discipline is used in all situations such as students' use of table data, filling in the gaps, drawing graphics and naming branches, expressing units, placing and matching given values on the graph. As a matter of fact, Wittmann (1995) stated that mathematics is to be able to design. While the student solves the problem based on scientific knowledge, he uses mathematical operations in the solution process. Examples of this are the division of road values into time values in the path-time table, placing and matching numerical data on the chart in the correct order, expressing units. Similarly, researchers such as Czerniak et al. (2010) and Sawada et al. (2010) determined that science and mathematics could be used in harmony with each other in their studies. In addition, Adams and Pegg (2012) and Halpern et al. (2007) determined that the teachers were able to integrate science and mathematics in their studies on gender. All the above findings show that it is possible to come across an example of interdisciplinary integration with STEM education. It was determined that the participants used science and mathematics disciplines of STEM in an integrated way. As a matter of fact, Şahin and Kabasakal (2018) stated that with STEM activities, science and mathematics concepts are concretized and learned more easily.

5. Conclusion and Recommendations

In STEM applications, most studies focus on attitude, motivation, and students' acquisitions, while it is seen that evaluation studies are not sufficiently included in STEM education. In this study, it was aimed to collect the achievements of students participating in STEM applications within the scope of science with qualitative and mathematical quantitative data. The findings show that rubrics can be used in interdisciplinary STEM applications. The results showed that the rubrics can be measured by scoring at the level of knowledge in the STEM evaluation stages, during the identification and exemplary stages. In this study, rubrics were evaluated without giving them beforehand. Orhan (2007) states that giving the rubrics to be used in the evaluation beforehand increases their success in terms of both process and product since they are aware of the criteria expected from them. In further research, STEM rubrics can be given in advance and examined in their effectiveness.

The results showed that at the stage of drawing tables and graphics in the STEM evaluation stages, rubrics at the application level can be measured by scoring. In general, it has been determined that students' ability to create graphics using table data is at a good level. It has been determined that students are very good at the steps such as using data, entering values and matching them, drawing the path-time graph. It has been determined that they are good at filling the gaps in the tables, naming the graphic arms and drawing the velocity-time graph. Finally, it was determined that the students' use of units during the operations in table and graphic form was at a medium level. It is recommended to focus on the weak points of students while creating tables and graphics. Because the STEM rubric prepared is an effective tool that can be used to see students' shortcomings. In creating graphics, it should be ensured that the graphic branches are named, the empty spaces are filled, and the velocity-time graph is drawn at a better level. It is also recommended to carry out activities regarding the importance and use of units during mathematical operations. Therefore, it shows that various rubrics should be designed to measure the achievements of students after

STEM activities. The rubrics prepared can be useful tools for researchers and teachers to make sense of assessment and evaluation practices.

Although the number of participants in this study was large, the STEM assessment application was carried out with a single experimental group. Experimental studies can be conducted to compare the effectiveness of different educational practices and STEM applications. Comparisons for STEM assessment applications can be made by using gender, socio-economic level, individual differences and various demographic characteristics.

It has been observed that the use of rubrics in the evaluation of interdisciplinary STEM applications is an easy and effective tool to determine students' misconceptions. In the study, it was determined that a small number of students mistakenly perceive events such as zero resultant force acting on an object, stopping or accelerating a car as constant velocity motion. Since this study is organized within the framework of an interdisciplinary STEM activity, it has been evaluated in line with science and mathematics disciplines. Following transdisciplinary (Trans) and Multi (Multi) STEM applications, research can be conducted to evaluate three and four disciplines. In this study, after STEM activities, STEM rubrics and outcome evaluation are emphasized. In future studies, a process evaluation will be emphasized, and students' acquisitions will be evaluated in a wide range.

6. Ethical Consent of Research

This research was approved by the decision number 7 taken in the Scientific Research and Publication Ethics Board of Muş Alparslan University dated 01.12.2020 and numbered 14.

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