Osmangazi Journal of Educational Research **Volume 9(2), Fall 2022**

RESEARCH Open Access

Suggested Citation: Savaş, G., & Ünveren- Bilgiç, E. N. (2022). Evaluation of Primary School Mathematics Teacher Candidates' Activity Design Processes in the Context of Activity Design Principles. *Osmangazi Journal of Educational Research, 9*(2), 139-164.

Submitted: 20/10/2022 **Revised:** 22/12/2022 **Accepted:** 22/12/2022

Evaluation of Primary School Mathematics Teacher Candidates' Activity Design Processes in the Context of Activity Design Principles

***Gülşade Savaş, ** Emine Nur Ünveren Bilgiç**

Abstract. Activity design is an integral part of mathematics education. This study aims to examine the pre-service primary level mathematics teachers' consideration of the principles of activity design in the process of designing activities. For this purpose, a multiple case study as a qualitative research method was used in the study. The participants of the study consisted of 54 undergraduate students studying in the 3rd year of Primary Level Mathematics Teacher Education programme of a state university in the spring semester of the 2020-2021 academic year. The data of the study were collected by examining the activity designs in the lesson plans prepared by the students. In the analysis of the data obtained, descriptive analysis was carried out in line with the theoretical framework put forward by Yeşildere-İmre (2020). Based on the research findings, it was determined that none of the pre-service teachers included the student perspective in the purpose statement in the activities they designed and all pre-service teachers expressed the purpose of the activity from the perspective of the instructor. In addition, it was found that none of the pre-service teachers designed an activity which considered assessment. In addition, it was observed that none of the pre-service teachers used an expression for informing the students within the scope of the assessment of the activity.

Keywords. Activity design, mathematics education, teacher education.

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Note: A special presentation titled "Evaluation of Primary School Mathematics Teacher Candidates' Activity Design Processes in the Context of Activity Design Principles" was made during the 5th International Symposium of Turkish Computer and Mathematics Education (TURCOMAT-5) held on 28-30 October 2021 in Antalya.

Partnership for 21 century [P21] (2009) have defined 21st century skills as communication, critical thinking, creativity and innovation, problem solving, perseverance, collaboration, information literacy, technology skills and digital literacy, and have suggested that these are becoming more and more significant. The century we currently live forces individuals to closely follow many innovations and advancements that the century brings. So much so that the reflection of this situation in education can be seen in revisions in the curricula. In order for students to construct their learning individually, the role of teachers has now begun to be characterised as facilitating students' research and discovery (Cobb, 1994, p. 4) and eliminating the obstacles and challenges that arise while guiding students' learning processes (Öztürk & Kurtuluş, 2017, p. 774). This has brought about a change in the teaching strategies, methods and techniques used in the delivery of lessons. With the organisation of the classroom environments in which teaching is carried out in accordance with the constructivist approach, the concept of activity has come to the fore and has increasingly become an important keystone.

There are many studies in which many definitions are given according to different perspectives on the concept of activity, the basic features that an activity should have been outlined, and information on how to design and integrate activities into the teaching process is presented (Doyle, 1983; MacDonald, 2008; Uğurel & Bukova-Güzel, 2010; Burkhardt, & Swan, 2013; Gustafsson, & Ryve, 2021; Geiger et al. 2014; Geiger et al., 2022; Komatsu, & Jones, 2019). Burkhardt & Swan (2013) defined activity as "applications that students are asked to do in which mathematics has an important place". Geiger et al. (2014) also define activities as "an integral part of many aspects of mathematics learning, including mathematical content, processes, and modes of study, which teachers integrate into teaching in a pedagogical manner so that students can construct mathematics". It is interesting to note that the common point emphasised in these definitions is that students should take an active role in the process of constructing mathematics in an activity. It can be said that activities allow students to construct knowledge individually and to adapt and use the constructed knowledge in any new situation they encounter. Activities are designs that provide students with the best responses to questions of what knowledge is, why and how something is, and provide a transition from process knowledge to conceptual knowledge through processes such as abstraction, proof, discovery, etc. In addition, activities make mathematics, which is an action that goes far beyond having conceptual knowledge, more accessible for students. One of the most important roles of activities is to provide students with the opportunity to acquire the experiences of a mathematician by doing and experiencing through taking responsibility for their own learning by utilising more than one sense organ and encouraging them to participate actively. In mathematics education, it is seen that activity focuses on the concepts of activity (educational activity) and tasks (Burkhardt, & Swan, 2013; Uğurel & Bukova-Güzel, 2010, p. 335; Dede et al., 2020). Although activity (educational activity) and tasks seem to have the same meanings when translated into Turkish, it should be stated that these two concepts do not exactly overlap in meaning. Activity (educational activity), as discussed by MacDonald (2008), is the actions that support the learning processes of learners by laying a foundation for their learning and aiming to increase their learning at the end of this process. On the other hand, task is considered by Doyle (1983) as the ability of learners to produce a product as a result of the learning process by using certain processes and solution ways in line with a predetermined purpose. Depending on the manner in which activity (educational activity) and task are undertaken, the relationship between the two can be expressed as activity (educational activity) being the product of the pedagogical approach of the teacher who is the implementer of a task (Dede et al., 2020). In other words, activity (educational activity) can include the task (task).

Another important concept that emerges (after the concept of activity) is the concept of activity design. Activity design can be defined as the framework that designs the steps to be taken at various stages of the learning process of an activity (Yeşildere-İmre, 2020). A review of studies conducted on activity design shows that different researchers present different activity design principles. For example, a study by Ainley et al. (2006, p. 23) pays attention to developing activities they prepared in accordance with the principles of purpose and utility and concluded that the impact of these principles was quite high. Stylianides and Stylianides (2008, p. 861) drew attention to the context principle by preparing cognitively challenging, in other words, high-level activities under the leadership of the daily life context principle. Özmantar and Bingölbali (2009, p. 322) listed the common principles in the studies on activity design as purpose, classroom management, multiple starting points, tools that can be used, teacher and student roles, students' prior knowledge, student challenges and misconceptions, and testing and assessment. Kieran et al. (2015, p. 76) stated that the common feature of the principles of activity design in the different cases they presented is that they all involve principles that will lead to the design of activities that will create opportunities to develop students' existing understanding. Yeşildere-İmre (2020), on the other hand, developed activity design principles by discussing a total of six headings: the analysis of the outcome targeted by the activity, the purpose of designing the activity, the assessment of student knowledge, the selection of examples to be undertaken in the activity and the writing of instructions, assessment, and the design of the activity implementation process.

Significance of the Research

A review of the literature showed that the speed of the change in mathematics teaching approaches led to problems in the implementation of the activities prepared by teachers or in the interpretation of their purposes by pre-service teachers and, in addition, it was largely observed that the activities designed were more so has the features of 'tasks' rather than an 'activity' (Lithneri 2017; Leung, & Baccaglini-Frank, 2017; Çenberci & Özgen, 2021). As pre-service teachers will be future teachers, it can be said that it is very important to determine to what extent they can use the principles of activity design. Accordingly, the aim of this study is to examine the pre-service primary education level mathematics teachers' consideration of the principles of activity design in the process of designing activities.

In this context, this study makes an in-depth review of the instructional designs of the 3rd year pre-service primary level mathematics teachers within the scope of the course of Association in Mathematics Teaching in accordance with the Activity Design Principles developed by Yeşildere-İmre (2020). The aim of the research is to seek answers the question "Which activity design principles do pre-service teachers consider in the activities they design?".

Method

Based on the aim of the research, the study was carried out in a multiple case study design, in which the activities designed by pre-service teachers were viewed in a qualitative perspective. The data were obtained by collecting the activities designed by students in the form of a written document. These documents were reviewed by means of descriptive analysis in order to provide another perspective for a richer analysis or an improved representation of the context of interest (Özkan, 2021). In the descriptive analysis, the stages followed were: (1) creating a framework for descriptive analysis, (2) processing the data according to the thematic framework, (3) defining the findings, and (4) interpreting the findings (Yıldırım & Şimşek, 2011). The theoretical framework used in the descriptive analysis process is based on Yeşildere-İmre's (2020) theoretical framework which is based on the studies conducted for the design of an activity. In this scope, the below headings were determined to constitute the themes:

i. Analysing the targeted attainment of the activity,

ii. The purpose for which the activity is designed,

iii. Assessment of student knowledge,

iv. Selection of examples to be analysed in the activity and writing the instructions,

v. Assessment, and

vi. Design of the activity implementation process

The sub-themes and codes in the theoretical framework were shaped by Yeşildere-İmre's (2020) explanations of the relevant headings in the literature. The reason for the inclusion of the stages outlined by Yeşildere-İmre in the research is that they have an up-to-date structure that is referred to throughout the literature.

The themes addressed in this context are: *analysis of the targeted attainment of the activity*, analysis of the association of the activity with the attainments, its scope and limitations; the purpose of designing the activity, *the purpose of the activity* from the perspective of the student and the teacher; *assessment of student knowledge*, the sufficiency of the prior knowledge of the students' difficulties; *selection of the examples to be examined in the activity and the writing of the instructions*, the writing of the questions that will enable the student to realise the relationship between the examples to be included in the activity and the associations the student is expected to discover; *assessment*, the criteria by which students display success in the activity process; and *the design of the activity implementation process*, the design of what is expected from the student, the role of the student, the role of the teacher in the implementation process and the design of the classroom organisation.

Qualitative research is criticised for having a high level of subjectivity and low validity and reliability (Arastaman et al., 2018). In this context, the research process was shared in detail to ensure validity and reliability. Accordingly, the research process started with the researcher conducting the "Activity Design" course to seek a theoretical framework to analyse a data set in this context based on the question, "Do pre-service teachers pay attention to the principles of activity design in lesson plans and application of good design examples in other courses/lessons?". After the theoretical framework for descriptive analysis was identified, the characteristics of the sample group to be studied were determined by the researchers. The activity designs in the lesson plans designed by the pre-service teachers were subject to descriptive analysis according to the theoretical framework put forward by the document analysis approach.

Research Process

The motivation for the research was derived from curiosity of researchers as to whether there was a systematic in "activity design-activity development" practices, which are frequently mentioned in Teacher Training Programmes as a result of sharing the "Activity Design Principles" with students in the context of a "Making Connections in Teaching Mathematics" course. During the 14-week teaching period, the researcher conducting the course within the scope of the Making Connections in Teaching Mathematics course; *Theoretical and Philosophical Foundations of the Concept of Mathematical Activity, Activities in Mathematics Education and It's Historical Development, Interdisciplinary and STEM Activities in Mathematics Education, Principles of Designing Mathematical Activity, Applications of Classroom Activity in Mathematics Education and Student Thinking, Examples of Argumentation-Based Classroom Activity, Examples of In-Class Activity Based on Mathematical Modeling, The Role of Mathematical Activities in Supporting Reasoning, Using Technology in Mathematical Activities, Proof Activities in Mathematics Education, Culturally Responsive Mathematics Activities, Mathematical Activity Applications in Special Education, Activity Applications for Gifted Students,* followed a course syllabus. In this light, the researchers focussed on examining whether the students, who were previously exposed to "Activity Design Principles" in the course process, paid attention to these principles in the activities they designed in the context of another course.

Research Sample Group

The sample group of the study were 3rd year students enrolled in the Primary Level Mathematics Teacher Education Programme. The reason behind the preference to include these students was the assumption that they are more competent in terms of activity design, material integration, testing-assessment and teaching methods compared to 1st and 2nd year students, since they have taken lessons in these fields and they would be able to spare more time (as they their exam preparation process is not as intensive) compared to 4th year students. Thus, purposive sampling was used to determine the sample group of the study. Purposive sampling allows in-depth study of situations that the sample group are thought to have rich information (Patton, 1987).

Data Collection

The data of the study was collected within the scope of the "Making Connections in Teaching Mathematics" course. The pre-service teachers selected the attainments of the designs they would develop, themselves. The pre-service teachers were asked to associate the attainments they undertook in the activities, create associations between concepts, associations between different representations, and also make associations with real life and with different disciplines. Participants of the sample group came together with the researcher, who was the instructor of the course, once a week and received feedback on their designs. During the feedback process, the researcher provided feedback only on scientific accuracy, appropriateness of mathematical language and associations. The pre-service teachers did not receive feedback on the contexts that should be included in the activity designs. At the end of the semester, the pre-service teachers shared their designs with the whole class and carried out self-assessment and peer assessment. Similarly, there was no feedback given on the activity design in these evaluations.

Data Analysis

The researchers first determined the themes to be descriptively analysed in line with the theoretical framework put forward by Yeşildere-İmre (2020). Then, sub-themes and codes were determined as a result of the review in the relevant literature. Then, both researchers individually coded 54 designs that were evaluated to be included within the scope of the research. Finally, the researchers interpreted the codes they obtained together and developed a common understanding to reveal the findings.

Both researchers undertook a descriptive analysis of the activity designs in the lesson plans of pre-service teachers in the scope of the theoretical framework put forward at different times. The percentage of agreement between the themes, sub-themes and codes undertaken by the researchers was calculated as 0.93 according to the formula (Reliability = [Agreement / (Agreement + Disagreement)] x 100) (Miles & Huberman, 1994).

Results

The activity designs in the lesson plans of pre-service teachers were examined and the findings obtained as a result of the descriptive analysis carried out in the context of the theoretical framework are presented as follows.

Table 1.

Frequency of the Analysis of the Attainment Targeted with the Activity

Activity Design Principles	Association		Frequency
Analysis of attainment targeted in the activity	• Remarks		
		Emphasised	33
		No emphasis	21
	• Scope of attainment		
		All	41
		Partial	12

When the "*Remarks*" sub-theme under the theme of "*Analysis of attainment targeted by the activity*" is examined in Table 1, it can be seen that in 33 of the designs, the pre-service teachers preferred to emphasise the (recommended) elements included in the attainments. In 21 of the designs, it was observed that the pre-service teachers did not take this into account. For example, in activity designed by S8[1], "M.8.2.2.2. Recognises the coordinate system with its properties and shows ordered pairs". This activity does not make an emphasis on the specific attainment of "*providing association to real life situations with determining the location on the coordinate system*"; and the association with real life situations is *not emphasised in the remarks*. Attention was paid to focusing on *all of the attainments* related to the "*Scope of the attainment*" sub-theme under this theme in 42 of the designs. However, in 12 of the designs, although the complete attainment was shared as a statement in the design of the activity, it was observed that the design was certain *part of the attainment* and not focusing on the whole attainment.

Table 2.

Frequency Regarding Purpose of the Design of Activity

Activity Design Principles	Association	Frequency
Purpose the design of activity	• Statement of aim	
	Student perspective	
	Teacher perspective	54

[1] "S*x*" denotes the 3rd year student included in the sample group of the study.

	• Type of Activity	
	Activities aimed at teaching the concept	23
	Activities aimed at reinforcing the concept	22
	Activities aimed at assessment	
	Focus on problem solving (authentic)	21
	Focus of problem solving	29
	Mathematical deduction and proof based	12
	Focused on mathematical communication and exchange	19
	Focused on association between mathem concepts	24
	Focused on using different notations	23
	• Supported with manipulatives	
	Concrete	37
	Virtual	12
	None	14

In considering the sub-theme of the *purpose statement* under the "*Purpose of design of activity*", which is one of the themes addressed within the scope of the research, it was determined that all of the pre-service teachers wrote the purpose statement in the activities they designed from the *perspective of the teacher* and did not write any information from the *perspective of the student*, outlining the outcome to be attained upon completion of the activity. While writing the purpose sentence, the pre-service teacher S1 (like all the other pre-service teachers), included a statement such as "*Shows and interprets the data obtained in daily life in a pie chart*", which is thought to provide direction to the teacher.

It was seen that some of the pre-service teachers structured their activities on problem solving in an authentic context. The design by S52 (as shown in Figure 1) was a problem solving experience in an authentic context such as "Would you like to contribute to a school that does not have a library, so that they can have a library like yours?". In this scope, the activity focuses on students helping to establish a library in another school in line with the need, deducing the relationship of directly proportional multiplicities with different concepts allowing an affective learning process to be experienced.

1.ADIM

Öğretmen ve öğrenciler birlikte tartışarak bu kampanya için 500 TL para yardımı yapmaya karar verirler. Aynı zamanda öğretmenin ilk gün 50 TL katkı sağlayacağı ve geriye kalan 450 TL nin de her bir öğrencinin kumbaraya her gün 1 TL atması ile tamamlanacağı kararına varılmıştır.

2.ADIM

Öğretmen öğrencilerden kumbarada biriken paranın günlere göre artışının tablo şeklinde gösterilmesini ister ve daha sonra bir öğrenci tahtaya tabloyu çizer.

Geçen Zaman (Gün)	Başlangıç	1.Gün	2.Gün	3.Gün	…	n.Gün
Biriken Para Miktarı (TL)	50 TL	50TL+1x25TL	50 TL+2x25TL	50TL+3x25TL	…	50TL+nx25TL

Figure 1. Steps of the Activity Designed by S52 in the Authentic Context.

First Step:

The teacher and the students discuss together and decide to contribute 500TL for this campaign. It was decided that the teacher would contribute 50TL on the first day and the remaining 450TL would be completed by each student contributing 1TL into the money box each day.

Second Step:

The teacher asks the students to show the increase of the accumulated money in the money box according to days in the form of a table and then one student draws the table on the board.

This table contains the amount of money accumulated in TL according to the time elapsed in days.

Time (Days)	Start	Day 1	Day 2	Day 3	…	Day n
Accummulated Amount of Money (TL)	50 TL	50TL+1x25TL	50TL+2x25TL	50TL+3x25TL	…	50TL+nx25TL

Figure 2. Explanation of the Activity Designed by S52 in the Authentic Context.

The activity design of S4 was a problem solving activity in a context independent from daily life by associating linear equations with "electrical circuits", as shown in Figure 3. While performing this process, S4 made an association between the mathematics discipline and the science discipline. It can be considered that this situation can allow students to see the applications of mathematics.

OHM YASASI VE DİRENÇ

Elektrik akımına karşı oluşan etkiye **direnç** denir. Birimi **Ohm**'dur. Sembolü **Ω** (büyük omega)'dır. Denklemlerde **R** harfi ile ifade edilir.

Ohm yasası, bir devre elemanının geriliminin **(V)**, üzerinden geçen **akım (I)** ve **direnci (R)** ile doğru orantılı olacağını söyler:

V = I x R

Gerilim (V)	Akım (I)
1,75	1
3,50	2
5,25	3
7,00	4
8,75	5

Figure 3. The Activity of S4, which is Independent of the Association to Real Life.

OHM'S LAW and RESISTANCE

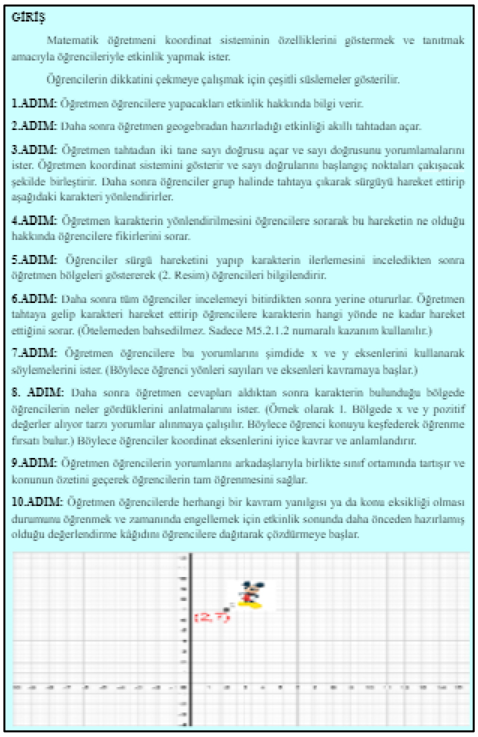
The effect against electric current is called **resistance**. The unit is **Ohm**. Symbol is **Ω** (big omega). It is expressed by the letter **R** in equations.

V = I x R

Gerilim (V)	Akım (I)
1,75	1
3,50	2
5,25	3
7,00	4
8,75	5

Figure 4. Explanation for the Activity of S4, which is Independent of the Association to Real Life.

It can be said that the sample group participants placed a focus on communication by including group work, brainstorming, discussions, and the station technique in their designs. While providing mathematical communication, it was observed that the participants took into account the connection between mathematical concepts, which is one of the four main components of the mathematical association process, in the activity design process. Accordingly, one of the participants (S48) created a design as shown in Figure 5 by associating the coordinate plane with the number line and numbers.



GİRİŞ

Matematik öğretmeni koordinat sisteminin özelliklerini göstermek ve tanıtmak amacıyla öğrencileriyle etkinlik yapmak ister.

Öğrencilerin dikkatini çekmeye çalışmak için çeşitli süslemeler gösterilir.

1.ADIM: Öğretmen öğrencilere yapacakları etkinlik hakkında bilgi verir.

2.ADIM: Daha sonra öğretmen geogebradan hazırladığı etkinliği akıllı tahtadan açar.

3.ADIM: Öğretmen tahtadan iki tane sayı doğrusu açar ve sayı doğrusunu yorumlamalarını ister. Öğretmen koordinat sistemini gösterir ve sayı doğrularını başlangıç noktaları çakışacak şekilde birleştirir. Daha sonra öğrenciler grup halinde tahtaya çıkarak sürgüyü hareket ettirip aşağıdaki karakteri yönlendirirler.

4.ADIM: Öğretmen karakterin yönlendirilmesini öğrencilere sorarak bu hareketin ne olduğu hakkında öğrencilere fikirlerini sorar.

5.ADIM: Öğrenciler sürgü hareketini yapıp karakterin ilerlemesini inceledikten sonra öğretmen bölgeleri göstererek (2. Resim) öğrencileri bilgilendirir.

6.ADIM: Daha sonra tüm öğrenciler incelemeyi bitirdikten sonra yerine otururlar. Öğretmen tahtaya gelip karakteri hareket ettirip öğrencilere karakterin hangi yönde ne kadar hareket ettiğini sorar. (Ötelemeden bahsedilmez. Sadece M5.2.1.2 numaralı kazanım kullanılır.)

7.ADIM: Öğretmen öğrencilere bu yorumlarını şimdide x ve y eksenlerini kullanarak söylemelerini ister. (Böylece öğrenci yönleri sayıları ve eksenleri kavramaya başlar.)

8. ADIM: Daha sonra öğretmen cevapları aldıktan sonra karakterin bulunduğu bölgede öğrencilerin neler gördüklerini anlatmalarını ister. (Örnek olarak 1. Bölgede x ve y pozitif değerler alıyor tarzı yorumlar alınmaya çalışılır. Böylece öğrenci konuyu keşfederek öğrenme fırsatı bulur.) Böylece öğrenciler koordinat eksenlerini iyice kavrar ve anlamlandırır.

9.ADIM: Öğretmen öğrencilerin yorumlarını arkadaşlarıyla birlikte sınıf ortamında tartışır ve konunun özetini geçerek öğrencilerin tam öğrenmesini sağlar.

10.ADIM: Öğretmen öğrencilerde herhangi bir kavram yanılgısı ya da konu eksikliği olması durumunu öğrenmek ve zamanında engellemek için etkinlik sonunda daha önceden hazırlamış olduğu değerlendirme kâğıdını öğrencilere dağıtarak çözdürmeye başlar.

Figure 5. Steps of the Activity Designed by S4.

INTRODUCTION
The maths teacher wants to conduct an activity with the students to show and introduce the features of the coordinate system.
The teacher shows various decorations to try to attract the students' attention.
First step: The teacher informs the students about the activity to be done.
Second step: Then the teacher opens the activity prepared from Geogebra on the smart board.
Third step: The teacher opens two number lines from the board and asks them to interpret the number line. The teacher shows the coordinate system and connects the number lines so that their starting points coincide. Then, the students go to the blackboard as a group, move the slider and direct the character below.
Fourth step: The teacher asks the students about the direction of the character and asks the students for their opinions about what this movement is.
Fifth step: After the students make the slider movement and examine the progress of the character, the teacher informs the students by showing the regions (picture 2).
Sixth step: Then, after all students have finished the examination, they sit down. The teacher comes to the board and moves the character and asks the students how much the character moves in which direction. (The shift is not mentioned. Only the attainment numbered M5.2.1.2 (Ministry of National Education [MoNE], 2018) is used.)
Seventh step: The teacher asks the students to say these comments now using the x and y axes. (Thus, the student begins to grasp directions, numbers, and axes.)
Eighth step: Then, after the teacher receives the answers, he asks the students to describe what they see in the area where the character is located. (For example, in the 1st region, comments such as x and y take positive values are tried to be taken. Thus, the student has the opportunity to learn by exploring the subject.) Thus, the students understand and make sense of the coordinate axes.
Ninth step: The teacher discusses the students' comments with their friends in the classroom environment and provides the students to learn fully by passing the summary of the subject.
Tenth step: In order to learn about any misconceptions or lack of subject in the students and to prevent them in time, the teacher distributes the evaluation paper that teacher has prepared before at the end of the activity to the students and starts to solve them.

Figure 6. Explanation for the Activity Designed by S4.

The use of different representations in the mathematics teaching process and the sound transition between these representations make the connections between concepts visible. With this as a starting point, S34 focused on the transition between table, line graph, bar chart and pie charts in the representation of the votes used in the election of the class president in the activity design.

The activity design of S52, in which orienteering was used as the manipulative to reach a target point with the help of a map, is given in Figure 7.

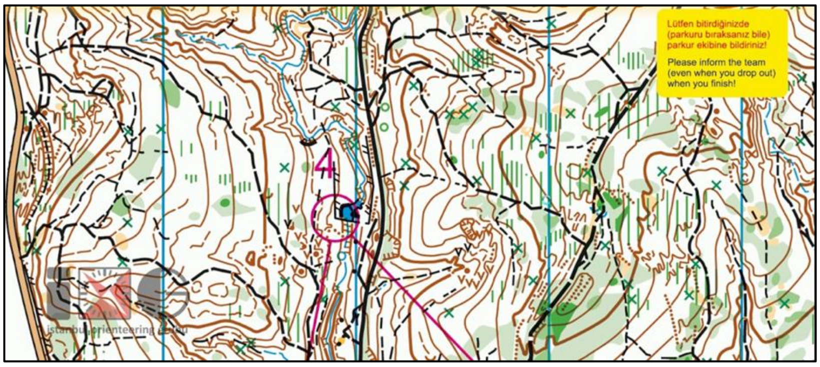


Figure 7. Activity Design of S52, which Includes Virtual Manipulatives.

The designs included Excel and Geogebra applications, videos and games as virtual manipulatives. Accordingly, K48 utilised Geogebra software in their design to reveal the area relationships of polygons with perimeter lengths, as shown in Figure 8.

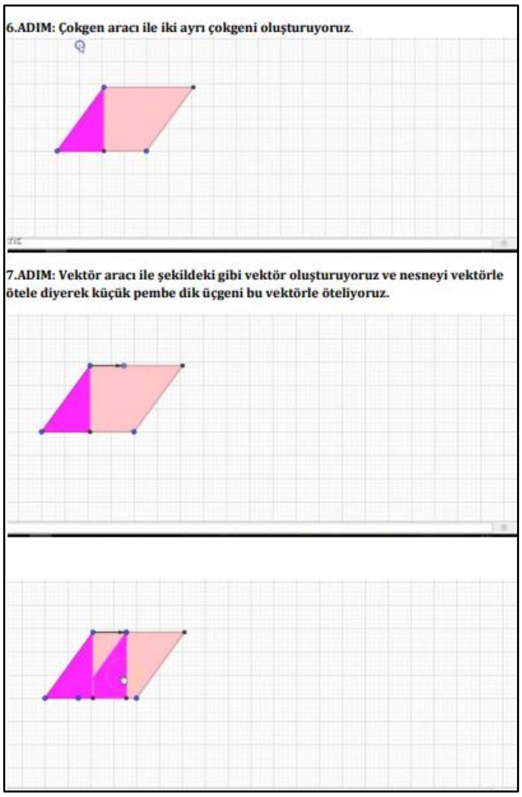


Figure 8. Activity Steps Designed by S48, Including Geogebra.

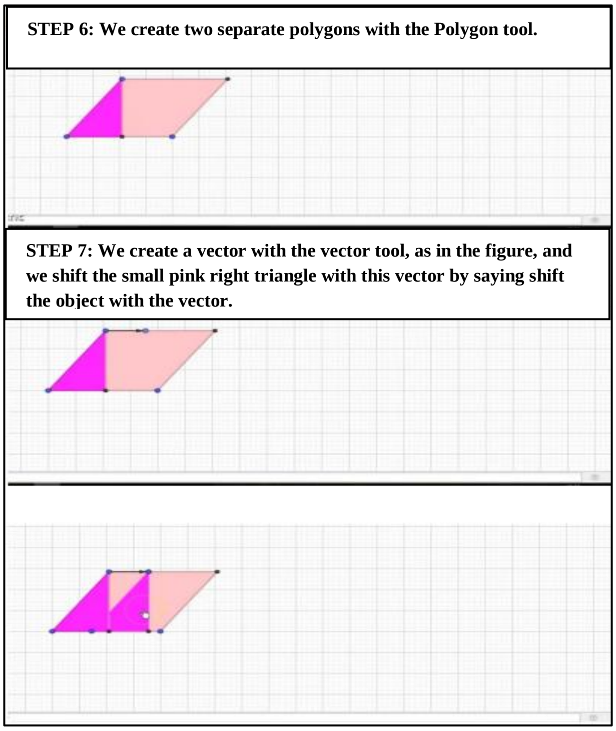


Figure 9. Explanation of the Activity Designed by S48.

Table 3.

Frequency of Assessment of Student Knowledge

Activity Design Principles	Association	Frequency
Assessment of student knowledge	• Student difficulties	
	Supported by hypotheses	3
	None	48
	• Preliminary information	
	Provided	31
	None/Insufficient	35

It was observed that attempts under the theme of assessment of student knowledge, which are aimed at determining the difficulties that students may experience in line with the attainment to be addressed within the scope of the activity, were very few and insufficient in the designs. Preliminary information was included in 31 of the designs, in this regard. In this context, it can be said that pre-service teachers have some inadequacies in including preliminary information and misconceptions that may be related to the learning outcome.

Table 4.

Frequency of Selection of Examples to be Evaluated and Writing of Instructions for the Activity

Activity Design Principles	Association	Frequency
Selection of examples to be evaluated and writing of instructions for the activity	• Intelligibility	
	Use of numbers/examples for ease	30
	Steps of activity short and clear	37
	Insufficient	18
	• Instructions	
	Adequate	42
	Inadequate	12

In line with the themes analysed under the theme of the selection of the examples to be undertaken in the activity and the writing of the instructions, it was seen that 36 of the designs of the pre-service teachers provided intelligibility and 42 of them were adequate in the writing of the instructions. On this point, it is seen that the designs of pre-service teachers have a higher rate than the other themes.

Table 5.

Frequency Related to Assessment

Activity Design Principles	**Association**		**Frequency**
Assessment	• Assessment		
		Process	35
		Multiple Choice	20
		True-False	6
		Open Ended	44
		Fill-in-the-Blanks	23
		Project Task	1
		None/Insufficient	2
	• Informing Students		
		Yes	
		No/Insufficient	54

When the results of the assessment theme were analysed, it was found that 52 participants considered the form of assessment and only 2 participants did not include a component related to assessment in their designs. Although numerically low, considering that the sample group participants are 3rd year undergraduate students, this reveals that these participants had not internalised that assessment is an integral part of learning-teaching environments. Based on the sub-theme of assessment type, it was observed that the participants paid attention to the effective use of student-teacher feedback mechanisms by ensuring that the teacher and the student remained in interaction in the assessment of the process in the activity designs. However, it is seen that the assessment carried out as a product under the sub-theme of assessment type consists only of open-ended, multiple choice, fill-in-the-blank and true-false questions. Only S33 preferred to include the project assignment as product-oriented in their activity design, as shown in Figure 10. S33 provided students the opportunity for readiness for the learning process by including the project assignment before the activity. This situation reveals that pre-service teachers think that learning outside the classroom can only take place in activities of solving questions and identifying the situation. The participants overlooked that learning can be extended and deepened with project homework.

ÖN BİLGİLER

Bilgilendirme: Kan grubu belirlenirken kan içindeki 3 antijene bakılır. Bunlar A, B ve Rh antijenleridir. A ya da B antijenlerinden hangisi varsa yazılarak gösterilir. Bu antijenlerden hiçbiri yoksa 0(sıfır) yazılır. Rh antijeni varsa (+) yoksa (-) yazılır.

ÖĞRETME- ÖĞRENME SÜRECİ

ÖN HAZIRLIK

- Dersten bir önceki hafta öğrencilerden eve gidince ailelerinin veya akrabalarından 5 kişinin kan grubunu not defterlerine yazıp derse gelirken bu notlarını da yanlarında getirmeleri istenir
- Öğretmen daha önceki konularda işlenen verileri toplama ve yorumlama konularını öğrencilere hatırlatır.
- Hatırlatılan ön bilgilerden sonra öğretmen etkinlik kâğıdını öğrencilere tanıtır.

UYGULAMA

Öğretmen sınıfı 6 şar kişilik 4 gruba ayırır. Etkinlikteki kan grupları ve Antijen konularına giriş yapmak için öğretmen aşağıdaki soruları öğrencilere yöneltir;

- Kan grubunuzu biliyor musunuz?
- Antijen nedir? Kan grubu nedir? Kan grupları nasıl oluşur?
- Kan grubu nasıl ölçülür? Anneniz veya babanızla kan grubunuz aynı mı?
- Kaç çeşit kan grubu vardır?

Soruları sorularak verilen cevaplar sınıf tarafından seçilen temsilci öğrenci tarafından tahtaya yazılır.

2. Adım: Öğrencilere kan grubu ile ilgili aşağıdaki adresteki video izletilerek konunun hatırlatılması ve pekiştirilmesi sağlanır.

https://youtu.be/vcv02bUbBNs (Khan Academy-Kan grupları)

3. Adım: Video izletildikten sonra oluşturulan gruplara Etkinlik kâğıdı dağıtılarak Öğrencilere geçen hafta evde not etmiş oldukları kan gruplarını etkinlik kağıdındaki verilen tabloya yerleştirmeleri ve verilen soruları tartışıp cevaplamaları istenir. Öğrenciler grup arkadaşlarıyla fikir alışverişi yaparak verilen süre içerisinde soruları cevaplandırır.

4. Adım: Her gruptan aralarından bir sözcü seçmeleri istenir ve cevaplanan etkinlik kâğıtları grup sözcüleri tarından tüm sınıfa anlatılır ve her grubun etkinlik kağıdı sınıf panosuna asılır.

DEĞERLENDİRME

Öğretmen etkinlik tamamlandıktan sonra öğrencileri bireysel çalışma pozisyonuna alarak değerlendirme kağıdını her öğrenciye dağıtarak ikinci kısmını çözmeleri için 10 dakika ve değerlendirmenin test kısmını çözmeleri için ise 20dk vererek dersin son 10 dakikasında öğrencilerin çözümleri tartışılır.

Figure 10. Steps of the Activity Designed by S33, Focusing on a Product.

PRELIMINARY INFORMATION
To inform: When determining the blood group, 3 antigens in the blood are checked. These are the A, B and Rh antigens. It is indicated by writing whichever of the A or B antigens is present. If none of these antigens are present, 0 (zero) is written. If Rh antigen is present, (+) or otherwise (-) is written.
TEACHING-LEARNING PROCESS
PRELIMINARY

- The week before the class, when students go home, they are asked to write the blood group of 5 people from their families or relatives in their notebooks and bring these notes with them when they come to class.
- The teacher reminds the students about collecting and interpreting the data covered in previous topics.
- After the reminded preliminary information, the teacher introduces the activity sheet to the students.

IMPLEMENTATION
The teacher divides the class into 4 groups of 6 each. In order to introduce the blood groups and antigen topics in the activity, the teacher poses the following questions to the student;

- Do you know your blood group?
- What is antigen? What is blood group? How are blood groups formed?
- How is blood group measured? Do you have the same blood type as your mother or father?
- How many types of blood types are there?

The answers given by asking questions are written on the board by the representative student selected by the class.
Second step: The students are reminded and reinforced by watching the video about the container group at the address below.
http://youtu.be/vev02bUbBNs (Khan Academy-Blood groups)
Third step: After watching the video, activity sheets are distributed to the groups created, and students are asked to place the blood groups they noted at home last week on the table given in the activity sheet, and to discuss and answer the given questions. Students exchange ideas with their groupmates and answer the questions within the given time.
Fourth step: Each group is asked to choose a spokesperson among them, and the answered activity papers are explained to the whole class by the group spokespersons and the activity sheet of each group is hung on the class board.
EVALUATION
After the activity is completed, the students' solutions are discussed in the last 10 minutes of the lesson, giving the students 10 minutes to solve the second part and 20 minutes to solve the test part of the assessment, by placing the students in an individual study position and distributing the evaluation paper to each student.

Figure 11. Explanation of the Product-Focused Activity Designed by S33.

It was found that none of the participants informed the students about the assessment process in their designs. At the end of the activity designs, there is no information about in which medium and how long the assessment (other than the project) will be carried out or how their performances will be assessed.

Table 6.

Frequency of Design of Activity Implementation Process

Activity Design Principles	Association	Frequency
Design of activity implement ɛss	• Duration of implementation	
	Adequate	39
	Inadequate	20
	• Expectation from student	
	Informed/Provided	38
	None/Insufficient	33
	• Roles	
	Student	11
	Teacher	43

	• Classroom organisation	
	Effort made to reach outcome	7
	No effort to reach outcome/insufficient	47

Of the total, 36 of the designed activities were found to be sufficient for the sub-theme of implementation process under the design of the activity implementation process. However, there are no statements in any of the designs that the assessment will be carried out during the implementation process of the activity.

Among the participants, 38 pre-service teachers expressed the expectations from the students under the theme and 16 participants had not been able express this expectation sufficiently in their designs. For example, S33 expressed what students should do before and during the lesson in the design. When the designs were analysed holistically, it was seen that 43 of the participants put forward teacher-oriented studies in the roles sub-theme under this theme. Although the language is more student-focused on the implementation process of the activity, it was seen that there is a teacher-focus within the activity design.

In scope of the sub-theme of classroom organisation under this theme, 7 designs showed an effort to reach a conclusion based on the points where the meaning of the activity put forward during the design process was associated with mathematics or real life. However, this number is quite low. It was seen that the participants did not tend to express a general judgement after expressing the last step/stage in their designs.

Discussion and Conclusion

In solving the problems in today's world, individuals need to develop a multiple perspective by bringing together more than one discipline (Roehrig et al., 2012). Thus, it is significant for individuals to observe not only what mathematical knowledge is, but also why, how, and what the effects of the results of this knowledge are. With this in mind, there is a transformation in mathematics teaching approaches in order to be able to provide students with this multiple perspective. This situation has necessitated the correct integration of activities into mathematics teaching. As a result of the research conducted in this context, it was found that pre-service teachers had inadequacies in determining the scope, writing a purpose statement, assessment, using materials/manipulatives and clearly outlining the final outcome of the activity in the activity design process.

An analysis of the activities designed by the sample group participants showed that most of the pre-service teachers had the tendency to produce activities for the entire attainment. It is noteworthy that the participants who addressed a certain and partial outcome of the activity wrote the entire attainment in their designs. This situation suggests that pre-service teachers focus on the attainment rather than seeing or focusing on a particular outcome when designing activities in the process of teaching attainments. When the related literature is reviewed with this context in mind, it is seen that Öztürk and Işık (2018) found similar results with this research, in which they stated that pre-service teachers had difficulties in designing an appropriate activity by considering the attainments in the activity design process.

Stein and Lane (1996) drew attention to the need to examine the relationship between mathematics teaching, learning and activities and proposed a conceptual framework to explore the relationship between these components. In this scope; in the process of activity design, the practitioner (pre-service teacher) needs to have an awareness and explanation of the purpose of the activity in the context of doing mathematics, concepts, the use of procedures related to meaning and/or understanding, retention and unsystematic and/or inefficient exploration. In addition, mathematical activities provide a context for exploring topics such as the nature of mathematics, assessment, constructivism, social constructivism, group work, etc. (Ball, 1996, 1988; Feiman-Nemser & Featherstone, 1992; Fosnot, 1989; Mosenthal & Ball, 1992). In this regard, it is imperative for students to know the boundaries of a task (Liljedahl et al., 2007). Thus, it was seen that the participants in the study did not exhibit a student-oriented approach to writing a purpose statement. However, by informing the student about the outcome to be reached by completing the activity is thought to affect motivation, interest and discovery of the associations to be established in the learning process. In addition, including a purpose statement where students are the focus will increase the meaning of the lesson in the learning-teaching process and make it clear why the activity is carried out. This situation suggests that pre-service teachers do not have an awareness of this issue or that they keep their selves in focus and do not consider a purpose statement necessary for students because they are place priority on carrying out the teaching process.

The assessment of student performance makes it possible to follow the extent to which students use appropriate solution strategies (Glaser, 1989), translate between different knowledge representations (Lesh et al., 1987) and the characteristics of student performance including communicating their thought and reasoning about mathematics (Romberg, 1992). In the context of the activity, it is possible to assess students' performance in dealing with a range of problems that include many criteria of non-routine and cognitively complex tasks. These are in parallel with the characteristics of the instructional activity, which assesses the extent to which students are given opportunities in the classroom to work on activities that can be solved using multiple solution strategies, multiple association representations, and require them to provide explanations for their work (Stein & Lane, 1996). In this context, it was observed that the participants had difficulties in providing a context for assessment in the activity design process. This suggests that there is insufficient knowledge about how assessment can be realised in an activity process or that the participants do not place priority on assessment as much as other codes. Similarly, it was observed that most of the participants ended their designs without concluding them; whereas, making sense of the outcome of a mathematical activity can be achieved by revealing the association of the actions performed in the process of mathematics with real life, other disciplines and the relationships within itself. In this context, it can be said that the pre-service teachers lacked in informing (supporting) the students about explaining the value of the actions they put forward, taking into account the purpose of designing the activity.

It was seen that pre-service teachers had the tendency to assess the activity design with open-ended questions, multiple choice questions, true-false questions and fill-in-the-blank questions. In addition, it was also seen that the process was also assessed in the steps of the designs. Furthermore, it was observed that the participants avoided giving project assignments in the design. There was also no finding about how much time the assessment is allocated when planning the duration of the activity. In such cases, it is thought that assessment may be neglected or not taken seriously.

In the process of teaching new knowledge, it is crucial to determine the level of prior knowledge, skills and competences required by this new knowledge (Turkish Qualifications Framework [TQF], 2022). This is significant for the discipline of mathematics, which is abstract, difficult and cumulative. Incorrect/incomplete knowledge learnt in the past or an unacquired concept can have a negative impact on the next stage of learning. Although 3rd year undergraduate students have taken many lessons on this subject, it was seen that they did not take into consideration learning difficulties in their designs; however, some had included this sub-theme in their designs in relation to prior knowledge.

It was seen that the participants' use of materials/manipulatives in their designs was very infrequent. Although it is stated in the literature that the use of materials in mathematics education has a very positive impact if it is delivered in a correct, effective and applicable manner (Van de Walle, 2007; Kamii et al., 2001; Stein & Bovalino, 2001), it is seen that the participants mostly used worksheets in their designs. In this context, care should be taken to ensure the use of materials/manipulatives are not perceived as a process separate from the activity. When the related literature is examined, it is seen that the results of the research coincide with the findings of Öztürk and Işık (2018), who revealed the insufficiencies of pre-service teachers in the use of real and daily life materials in the activity design process.

The language used by the participants in their designs was seen to be more guiding for the teacher. Although the statements in the activity steps are directed to the students, it was seen that steps such as purpose, objective and process at the beginning of the design are directed towards teachers. This supports the idea that the participants themselves need guidance, due to their lack of experience.

It is crucial that the information about why the activities in the syllabus are carried out, why they are delivered in a certain way and what the outcomes of the activity are should be put forward in a way to support 21st century skills and should be associated with the national learning outcomes in the curricula of the country. In this context, based on the findings of the study, it can be suggested that pre-service teachers should be provided with this awareness by addressing activity design in detail in teacher training programmes. In addition, it can be recommended that the "Activity Development in Mathematics Teaching" course is made compulsory in Teacher Training Programmes. In this way, the teachers of the future will have the opportunity to put forward their activity designs in a conscious structure by looking at the primary education programme holistically. It is thought that this process, which will start with activity design at the micro level, will contribute to the quality assurance system in the process of mathematics teaching at the macro level.

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Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

No funding was received.

Ethical Standards

Ethical and legal principles were followed in this research.

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