

## Preservice Teachers' Material Preparation Knowledge and Points to be considered While Developing the Material

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### Article history

**Received:**  
13.03.2021

**Received in revised form:**  
27.06.2021

**Accepted:**  
05.07.2021

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### Key words:

Mathematics,  
Mathematics lesson,  
Materials for mathematics  
lesson,  
Material design,  
Preservice mathematics  
teacher.

This study aimed to analyze knowledge of preservice teachers on material preparation process for mathematics lesson and their opinions about the points to be considered while developing material. In this context, in addition, it was intended to determine the preservice teachers' differences to use their knowledge on material preparation while developing materials in the course. To that end, 39 preservice teachers in total who studied in Elementary and Secondary School Mathematics Teaching Program at a state university in Southern Anatolia Region in the Fall semester of 2019-2020 academic year and who received "Instructional Technologies" and "Material Design in Mathematics Teaching lessons" were addressed two different open-ended questions in writing. Data obtained as a result of the applications performed were analyzed through content analysis. At this stage, the number of answers given by the students to the open-ended questions was determined and thus qualitative data were quantified. Then, frequency analysis and categorical analysis methods were noted in quantified data. At the end of the study, preservice mathematics teachers' both knowledge on material preparation process and points to be considered while developing material were gathered under three different sub-themes which are material use, content/design, and student. However, it was observed that preservice teachers focused mostly on *content/design* of the material among these sub-themes. It was found that priority order for the sub-themes *material use* and *student* varied when looked both at knowledge on material preparation process and points that should be taken into account during material developing. It is seen that there are some differences in the priorities of the use of pre-service mathematics teachers' knowledge on material preparation while developing materials.

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### Introduction

It is a fact that the need for environments where teachers can present the knowledge to their students in a more effective manner is on the rise due to easy access to information thanks to developing technology. Technology affects the teaching of mathematics and the enrichment of students' learning (NCTM, 2000). Preservice mathematics teachers' technology use is important subject in teacher education programs today (Waits & Demana, 2000). Place and

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importance of teaching materials for an effective learning and teaching environment must not be ignored. One of the fundamental factors that promote effective mathematics teaching is teaching supported with materials which, on one hand, facilitates learning and perception by materializing and contributes to permanent learning, on the other (Cameron & Bennett, 2010; Tezer, 2008). According to Shulman (1986), it is important for qualified teachers to be able to create and apply the most effective learning techniques in order to ensure that the concepts are understood by students. So, today's teachers need to use educational technology to reach students in classrooms. Using technology effectively in the classroom, on the one hand, creates productive individuals who are active in the lessons, on the other hand, it only provides the opportunity to improve the learning environment of the students (Burkhart, 2011). Molenda, Russell and Smaldino (2002) emphasize that materials prepared with the help of technological tools will provide a more enjoyable education and training environment. Instructional technology is utilized for developing correct, up-to-date and effective materials. Teachers and school systems have the task of helping students how to use the technology in real life problems (Heddens & Speer, 2006). Learning materials are the most important tools needed in teaching and learning activities in schools and increase student success (Nesari & Heidari, 2014). The fact that materials used in instruction concretize concepts allows understanding abstract concepts more easily. Teaching materials together with the technology, tools and equipment used in education, contribute to the learning and teaching process by attracting students' attention, concretizing abstract concepts, and providing permanent learning (Heinich et. al., 2002). Hence, the fact that they concretize abstract concepts can be put forth as a contribution and indeed as another advantage of material use for eliminating rote learning. Use of materials by preservice teachers in the lessons contribute to a more permanent learning and meaningful learning of them by allowing them to understand the subject better (Yalın, 2003). In addition, use of materials improves efficiency in the lessons by making them enjoyable and help teaching new subjects without boring students (Kazu & Yeşilyurt, 2008). Considering all these positive effects and benefits, the question of 'what are teaching materials' comes to mind. Teaching materials are defined as presentations of lessons prepared using tools in order to fulfil objectives (Yanpar, 2005). It is necessary to take the needs requirements of teaching program in developing teaching materials into consideration. Considering such needs leads us to three different circumstances which are selection and use of ready materials in material preparation process, use of existing materials by making them more suitable and if the foregoing is not possible, development of materials by the teacher (Kaya, 2005). Lesson materials to be prepared by teachers are usually expected to be simply designed but authentic materials (Demirel, 2007). Therefore, production of more economical lesson materials by teachers within the limits of their facilities and conditions and in particularly developing sit by themselves are of importance. Making of materials, even if they are simple, by teachers or preservice teachers is also important as it features their creativity. When the studies in the literature was examined, teaching materials have been found that aim the development of different skills such as creative thinking skills, mathematical understanding skills, critical thinking and mathematical problem solving skills and student self-efficacy (Çenberci & Yavuz, 2018; Rosita, Nopriana, & Dewi, 2017; Imswatama & Lukman, 2018; Ulandari, Amry & Saragih, 2019). In addition to these, Rosita, Nopriana and Dewi, (2019), aimed to design circle learning materials to improve mathematical communication skills and learning trajectories. Material development may have different and positive influences both on teachers and students (Demirel, Seferoğlu & Yağcı, 2004). This requires presence of teachers who are well aware of the importance of instructional technologies and capable of using them in an efficient manner. Powers and Blubaugh, (2005) was emphasized that preservice mathematics teachers i.e., future mathematics teachers need to be the creation of technology. In order to get these positive effects in education and training environment, teachers and preservice teachers need to be acquainted with and understand the

importance of instructional technologies and know about developing and using teaching materials. At this point teacher education programs are of great importance.

In 1998, "Instructional Technologies and Material Design (ITMD)" was incorporated into all teacher training programs as a compulsory lesson by the Council of Higher Education (YÖK, 1998). This lesson is intended to enable preservice teachers to become aware of the place of tools and equipment in teaching and design, develop materials and use technology (Gündüz & Odabaşı, 2004). While in previous years Instructional Technologies Material Design (ITMD)-(2-2) lesson given in the fourth-grade curriculum of Teacher training Undergraduate Program was brought to the forefront by CoHE, as of 2018, "Instructional Technologies (2-0)" given as a compulsory lesson in the second grade curriculum of new Teacher training Undergraduate Program and elective "Material Design in Mathematics Teaching (2-0)" lesson has been brought to the fore (CoHE, 2018). As can be seen, ITMD lesson is divided into two different lessons in the new undergraduate program and both its name and credits are changed to "2 hours - theoretical" and also grade level is brought from the fourth grade to the second grade in the undergraduate program. In the final position, these lessons maintain their place as core lessons of teacher training programs. The reasons mentioned above sets forth the importance attached to these lessons which were first offered in teacher training programs in 2007 and are still given place in new undergraduate teacher training programs.

We come across some national and international studies in the literature which examined development and usage process of teaching materials among (Koparan & Özbey, 2018; Özer & Tunca, 2014; Rosita, 2016; Kuloğlu, 2019; Calık-Uzun, Kul & Celik, 2019). Koparan and Özbey (2018) analyzed opinions of preservice mathematics teachers about concrete material development and use process. As a result, they found that most of the preservice teachers had positive viewpoints about development and use of concrete materials. Özer and Tunca (2014) examined the points which were considered by preservice teachers when preparing and using materials and concluded that they mostly took into consideration "noticeability, simplicity and understandability" of materials. The researchers also determined that most preservice teachers were thinking of using, when they become teachers, teaching materials which they designed as such materials facilitated learning. Rosita (2016), was aimed to describe the development of Number Theory materials that help students to improve their mathematical representation and argumentation skills in this study. At the end of the study, they said that teachers should provide and develop materials appropriate to the characteristics and social environment of the student. Kuloğlu (2019) aimed to determine opinions of preservice Turkish language teachers about "Instructional Technologies and Material Design" lesson and situations they faced during the lessons. According to the results of the study, a vast majority of preservice teachers primarily stated that materials to be designed should draw the attention of students and be durable and supplies to be used for preparing materials should be affordable. Calık-Uzun et al., (2019) wanted to evaluate the effects of Instructional Technologies and Material Design (ITMD) course on preservice mathematics teachers' attitudes and their opinions about to the material preparation process.

Since the approaches which promote activeness of learners in education programs have gained importance, the use of instructional materials by preservice teachers has come into further prominence. Teachers are expected to set up effective learning environments, have material development skills and use appropriate materials during the lesson (Kolburan-Geçer, 2010). When considering evolving teaching circumstances and due to the importance of material design and application processes which will help preservice teachers create effective teaching environment and thereby teachers will make them by self-better equipped and will make a great

contribution to their professional development.

Although a lot is known about the importance and necessity of the use of material, very little is known about the preparation and development of materials. The importance of equipping preservice teachers with necessary information and skills for material design must not be ignored. Thence, this study focused on the development of the preservice mathematics teachers and the details of the material design and development process. This increases the importance of the study. The use of content analysis in the study and the detailed analysis of preservice teacher's ideas on this issue increase the importance of the study. In this respect, it is thought that it will make an important contribution to the literature. From this point of views, it was aimed to measure the knowledge level of the preservice teachers who take "Instructional Technologies" and "Material Design in Mathematics Teaching" lessons in the material preparation process and to determine what they pay attention while developing the material within the scope of the course. In line with this purpose, answers to following research questions were sought:

- (1) How is the knowledge of preservice mathematics teachers about material preparation process for mathematics lessons?
- (2) What are the points to be considered by preservice mathematics teachers while developing the material for mathematics lessons?

## **Method**

### ***Research Model***

This is a qualitative research and particular case study aiming at revealing knowledge of preservice mathematics teacher on material preparation process for mathematics lessons and the points to be considered while developing the material. This research is a case study and in case studies, an event or situation is examined in the context of real life (Yin, 2009; Platt, 1992).

### ***Research Sample***

This research was conducted with all preservice mathematics teachers from among those who studied in Elementary and Secondary School Mathematics Teaching programs in the fall semester of academic year 2019-2020 at a state university in the Southeastern Anatolia Region and took 'Instructional Technologies' and 'Material Design in Mathematics Teaching' lessons. A total of 39 (26 female and 13 male) voluntary preservice mathematics teachers at the same grade level participated in the study. The age range of the preservice mathematics teachers was 18-24. These preservice mathematics teachers were selected in accordance with easily accessible situation sampling method which is one of purposive sampling methods used in qualitative research. This sampling method was preferred because it provides a convenient and accessible facility for the researcher (McMillan & Schumacher, 2010). 25 of the said preservice teachers constituting the research sample are preservice teachers who were studying in Elementary School Mathematics Teaching Program while 14 of them were studying in Secondary School Mathematics Teaching Program.

### ***Data Collection***

Preservice mathematics teachers who participated in the study at the end of the fall semester of academic year 2019-2020, took 'Instructional Technologies' and 'Material Design



in Mathematics Teaching' lessons and after prepared materials, were addressed the following open-ended questions in writing:

- (1) Please explain material preparation process for mathematics lessons in detail by stages.
- (2) What should be taken into consideration when preparing materials for mathematics lessons?

The first question was asked in order to see the lack of knowledge of the students in the material preparation process and was evaluated in this respect. The second question was asked with a view to determining which points preservice teachers brought to the fore while they were doing their materials in the course. In drafting these research questions, question types which are given place in qualitative studies conducted in different fields and serve the purpose with respect to material design were utilized. At the finalization stage of prepared questions, a researcher specialized in mathematics teaching applications and lessons on material design was consulted for expert opinion. At the beginning, three questions were prepared, and after the interviews, considering that there were close statements, it was decided to stay in two questions together with the expert's opinion.

Applications took around 20 minutes and preservice teachers answered freely these two different open-ended questions addressed to them. In the applications performed within the scope of this study, all preservice mathematics teachers who participated in the study were asked not to write their names on the working papers given to them in order to allow them to reflect their true feelings and thoughts. It was assumed that all participating preservice teachers answered the questions truly and frankly and they wrote their real thoughts on the working papers.

### **Data Analysis**

Answers given by preservice mathematics teachers who participated in the research to two open-ended questions addressed to them were analyzed using content analysis method of qualitative analysis methods. Qualitative Content Analysis method is one of many different research methods used to analyze and Qualitative content analysis is defined as “*a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns*” (Hsieh & Shannon, 2005). Qualitative content analysis aims to be intensively examine the language and to further level, aim to be classified by taking into account similar meanings (Weber, 1990).

In content analysis method, collected data are first conceptualized, then organized logically according to these concepts and subsequently themes are determined making use of them (Yıldırım & Şimşek, 2005). Data analysis of this study was conducted in the following stages: coding data, determining themes, organizing, and defining the data according to codes and themes and interpreting findings. At the stage of coding data, answers given by preservice teachers to two open-ended questions addressed to them were handled by reading them over and over, wordings and sentences used in the answers of students were examined with an effort to reveal significant and applicable dimensions for the research. Subsequently, data obtained were divided into meaningful parts, trying to find their conceptual meanings. At the stage of determining themes, it was tried to find the themes that can be gathered under categories codes of which were specified previously. In this way, themes in the most general level and sub-themes under these themes were determined. In this study, for these two themes obtained from research data viz. *Knowledge of preservice mathematics teachers in material preparation process for mathematics lessons* and *Points that are taken into consideration by preservice*

mathematics teachers in developing materials for mathematics lessons were analyzed. Three sub-themes, being *material use*, *content/design* and *student*, were determined. Under these sub-themes were the codes defined and organized. Subsequently, findings formed by such codes and themes were interpreted. Research data were analyzed through categorical analysis and frequency analysis. The data was analyzed by the researcher twice at different times. Also, attention was paid to reasonability, conformity with experiences of individuals, persuasiveness, significance and readability of research data in writing reports on research findings.

### Validity and Reliability of Research

Persuasiveness and consistency were ensured by means of an expert review for this study. Through expert reviews, obtained data were evaluated together with a neutral researcher. In this context, it was endeavored to group the data obtained in written form under specified themes and which codes and sub-themes should be under which themes was determined. Three sub-themes, being *material use*, *content/design* and *student*, were determined. It was thought that this code could be under the *content/design* sub-theme of *material use*, however, considering statements of students, this code was placed under the *material use* sub-theme. In this way, it was tried to enhance the quality of the research. Transferability was ensured by sampling method used in determining the students included in the research was explained in detail by. In this study, verifiability was ensured by making citations from the data obtained as far as possible and at a reasonably sufficient amount.

### Findings

In this study by which knowledge of 39 preservice mathematics teachers, who participated in the research, on material preparation process and points to be considered in material developing process is investigated, it was decided to gather statements of students under two general themes in relation to the first and second research questions. Percentage and frequency values attained as a result of collecting the answers, given by participating preservice teachers to the research questions, under these two different themes are given in Table 1.

**Table 1.** Distribution of statements of students by themes

Themes	Frequency(f)	Percentage(%)
Knowledge of preservice mathematics teachers in material preparation process for mathematics lessons	168	51.21
Points that are taken into consideration by preservice mathematics teachers in developing materials for mathematics lessons	160	48.79
Total	328	100,00

It was understood from Table 1 that, preservice teachers explained their knowledge of material preparation process and their opinions about the points which should be taken into account in material developing process with an approximately equal number of statements.

### ***Knowledge of Preservice Mathematics Teachers on Material Preparation Process For Mathematics Lessons***

As a result of the analysis made for the first research question which is "How is the knowledge of preservice mathematics teachers about material preparation process for mathematics lessons?", it was found that students participating in the research explained their opinions about this research question in detail.

To put it another way, these preservice teachers used 168 statements in total for their knowledge of material preparation process for mathematics lessons. This showed that a majority of the participating preservice teachers explained their knowledge of material preparation process for mathematics lessons in considerable detail. It was decided to evaluate and collect the answers given by preservice mathematics teachers to this research question under three sub-themes. Percentage and frequency values for these sub-themes are given in Table 2.

**Table 2.** Distribution by sub-themes of statements in which preservice mathematics teachers explained their knowledge of material preparation process

Sub-Themes	Frequency (f)	Percentage (%)
Content / Design	98	58.33
Material use	34	20.24
Student	36	21.43
Total	168	100,00

The fewness of statements under the *material use* sub-theme may be attributed to the fact that when it comes to material preparation process, primarily the *content/design* sub-theme is focused on.

Codes determined under the sub-themes with respect to knowledge of preservice mathematics teachers who participated in the study, in material design process are explained in detail in the tables given below. Frequency and percentage values for the interpretations made by preservice teachers with regard to *content/design* sub-theme are presented in Table 3.

**Table 3.** Percentage and frequency values for preservice teachers regarding their knowledge under the content/design sub-theme

Content/Design	Frequency(f)	Percentage(%)
Support to realization of learning outcomes /suitability for learning outcomes	19	19.38
Suitability for the subject	17	17.34
Suitability for goal	15	15.30
Remarkable colours / Coloured materials	13	13.26
Suitability for learning and teaching principles	7	7.14
Visuality / Aesthetic	7	7.14
Support to learning	5	5.10

Supporting with congruent figures, pictures and graphs	6	6.12
Being relating to daily life / Reflecting Real Life	4	4.08
Eligibility for schedule	2	2.04
Correct scaling (Bigness-smallness/Having sizes in conformity with the reality)	2	2.04
Supporting correct and valid content of the lesson	1	1.02
Total	98	100,00

Statements of preservice mathematics teachers who participated in the study which included their knowledge of material preparation process were mostly related to *content/design* sub-theme. Under this sub-theme, *Suitability for the subject* had a percentage of (17.34 %) is important case with the statement of suitability for the subject is an important point as it is a very broad expression. When knowledge of preservice teachers on material preparation process is considered, it was observed that they focused on its Contribution to educational and instructional activities at the least.

The frequency and percentage values for the interpretations made by preservice teachers with regard to *student* sub-theme are given in Table 4.

**Table 4.** Percentage and frequency values for preservice teachers regarding their knowledge under the student sub-theme

Student	Frequency(f)	Percentage(%)
Suitability with features	10	27.77
Suitability for age	9	25
Suitability for availability level	6	16.66
Being interesting and motivating	4	11.11
Appealing to student	3	8.33
Suitability for the intelligence of the student (Comprehension Capacity)	2	5.55
Suitability to the knowledge level of the student	1	2.77
Conformity with the environment the student is brought up	1	2.77
Total	36	100,00

These findings indicate that preservice teachers focus on different features of students when preparing teaching materials under the *student* sub-theme. The average percentage of the expression *Being interesting and motivating* (11.11 %) is an important point for the *student* sub-theme.

The frequency and percentage values for the interpretations made by preservice teachers with regard to *material use* sub-theme are given in Table 5.

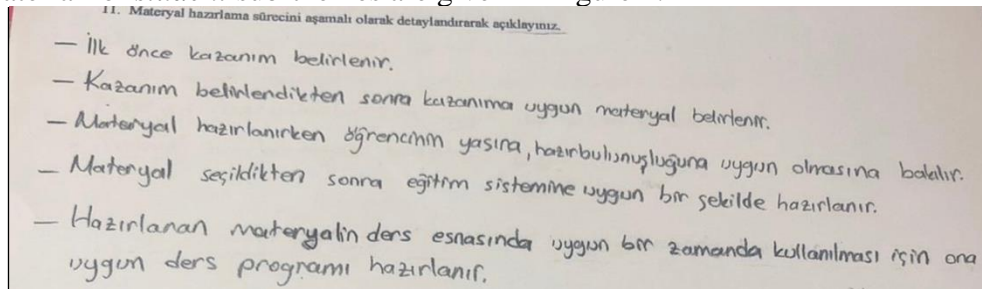


**Table 5.** Percentage and frequency values for preservice teachers regarding their knowledge under the material use sub-theme

Material Use	Frequency(f)	Percentage(%)
To be simple and straightforward	8	23.52
Durability	6	17.64
Safety / Not harming the student	6	17.64
Allowing student to take an active role	4	11.76
Applicability	2	5.88
Being concrete	2	5.88
Portable size	2	5.88
Suitability for studying in groups	1	2.94
Accessibility	1	2.94
Updateability/Repeatability	1	2.94
Usability by everyone	1	2.94
Total	34	100,00

Scarcity of statements regarding active being of students as a group drew attention in the sub-category of being active as a group, knowledge of preservice teachers on material preparation process.

Examples of the expressions of the preservice mathematics teacher participating in the study explaining their knowledge about the *material use*, *content/design*, *student*, and the process of preparing material for *student* sub-themes are given in Figure 1.



**Fig. 1.** Examples of Statements of Preservice Teachers Including Their Knowledge of Material Preparation Process with respect to Material Use, Content/Design and Student

Figure 1. Explain the material preparation process in detail.

- Firstly, the learning outcome is determined.
- After deciding on the learning outcome, related to this very learning outcome the material is detected.
- Whilst preparing materials, Suitability for age and availability level in relation to related student is controlled.
- To use the prepared material during the lesson at an appropriate time, a schedule-linked to the material is prepared.

### **The Points to be Considered by Preservice Mathematics Teachers during Developing Materials**

As a result of the analysis made for the second research question which is "What are the points to be considered by preservice mathematics teachers while developing the Material for mathematics lessons?", it was observed that again a considerable number of students who participated in the study explained their opinions about this research question. In other words, the said preservice teachers used in total 160 statements for the points they take into consideration in material develop process for mathematics lessons. Table 6 presents percentage and frequency values attained as a result of grouping the answers, given by preservice mathematics teachers to this research question, again under these three sub-themes.

**Table 6.** Distribution by sub-themes of the statements of preservice teachers who participated in the study about the points they consider in developing materials

Sub-Themes	Frequency (f)	Percentage (%)
Content/Design	68	42.50
Material use	55	34.38
Student	37	23.12
Total	160	100,00

Examinations revealed that–the fewness of statements under *student* sub-theme also drew attention and this situation indicating that preservice teachers focused primarily on *material use* and *content/design* sub-themes when developing material.

Codes determined under the sub-themes with respect to points considered by preservice teachers, while developing materials for mathematics lessons are explained in detail in the tables given below. Frequency and percentage values for the interpretations made by preservice teachers with regard to *content/design* sub-theme are presented in Table 7.

**Table 7.** Percentage and frequency values for points considered by preservice teachers in material developing with respect to content/design sub-theme

Content/Design	Frequency (f)	Percentage(%)
Remarkable colours / Coloured materials	11	16.18
Support to realization of learning outcomes/Suitability for learning outcomes	10	14.71
Suitability for goal	9	13.24
Correct scaling (Bigness-smallness/Having sizes in conformity with the reality)	9	13.24
Being relating to daily life / Reflecting Real Life	6	8.82
Visuality / Aesthetic	5	7.35
Supporting correct and valid content of the lesson	4	5.88
Suitability for the subject	6	8.82
Supporting with congruent figures, pictures, and	3	4.41

graphs		
Eligibility for schedule	2	2.94
Support to learning	2	2.94
Compliance with learning and teaching principles	1	1.47
Total	68	100,00

As noted earlier, statements of preservice mathematics teachers who participated in the study about the points they take into account in material developing were mostly about the *content/design* sub-theme. While the statement *Compliance with learning and teaching principles* was the least rated ones with an equal ratio of (1.47%). It is understood from the examinations that the preservice teachers, when developing materials, apart from *Suitability for learning outcomes of material*, they focus on the visual properties of material. Then they considered less *contribution of the material to education-training activities* which meant that they ignored it.

Frequency and percentage values for the interpretations made by preservice teachers with regard to *material use* sub-theme are given in Table 8.

**Table 8.** Percentage and frequency values for points considered by preservice teachers in material design with respect to material use sub-theme

Material Use	Frequency(f)	Percentage(%)
To be simple and straightforward	13	23.63
Usability by everyone	11	20.00
Applicability	9	16.36
Accessibility	6	10.90
Updateability/Repeatability	4	7.27
Durability	4	7.27
Portable size	3	5.46
Safety / Not harming the student	2	3.65
Suitability for studying in groups	1	1.82
Being concrete	1	1.82
Allowing student to take an active role	1	1.82
Total	55	100,00

The statements of *Allowing the student to take an active role*, *Suitability for studying in groups*, *Being concrete* were the ones which were made in the least number (1.82%). It was also striking that among the statements made by preservice teachers with respect to *material use* sub-theme, those relating to individual activeness of students or activeness as a group were few in number. The reason for the said fewness of statements, in particular, on activeness of students under the *material use* sub-theme could be the fact that even though material development occurs at the implementation stage, the actual implementation takes place at use of the material stage.

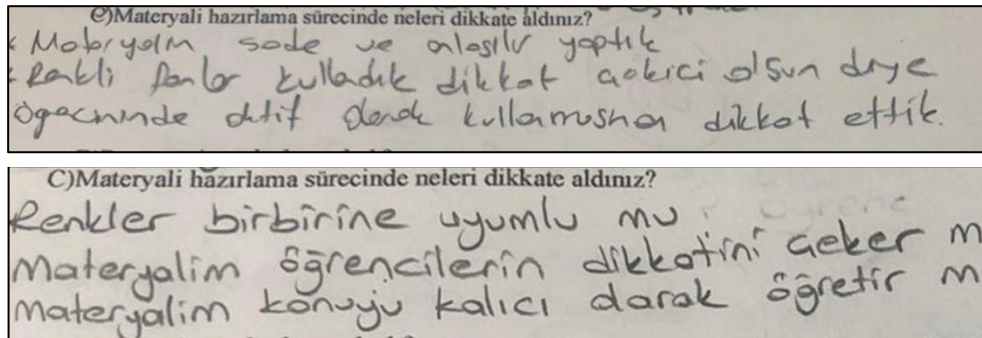
Table 9 presents frequency and percentage values for the interpretations made by preservice teachers with regard to *student* sub-theme.

**Table 9.** Percentage and frequency values for points considered by preservice teachers in material develop with respect to student sub-theme

Student	Frequency(f)	Percentage(%)
Being interesting and motivating	11	29.73
Suitability to the knowledge level of the student	9	24.32
Suitability for age	7	18.93
Conformity with availability level	5	13.52
Suitability for the intelligence of the student (Comprehension Capacity)	1	2.70
Suitability with features	2	5.40
Appealing to student	1	2.70
Conformity with the environment the student is brought up	1	2.70
Total	37	100,00

Among the statements under the *student* sub-theme for which preservice teachers participating in the study made fewer statements, the statement *Being interesting and motivating* was preferred by the highest number of preservice teachers with a ratio of (29.73%). This situation may point out that preservice teachers are aware that mathematics, an abstract lesson, must be endeared to students in the first place. With the ratios of 24.32% and 18.93% respectively *Suitability to the knowledge level of the student* and *Suitability for age* statements also draw attention, and these are the indicators of the fact that preservice teachers focused on the right points for the student while developing materials.

Examples of statements of the preservice teachers participating in the study explaining the points they took into consideration in material developing process with respect to sub-themes of *material use*, *content/design* and *student* are given in Figure 2.



**Fig. 2.** Examples of Statements of Preservice Teachers About the Points They Consider in Material Design with respect to Material use, Content/Design and Student

- E) What did you pay attention to during the material preparation process?
- We made the material plain and comprehensible.
- We used colourful backgrounds for it to strike attention.
- C) We paid attention to students to actively use it.
- Other answers to the same question:
- Are colours coherent with one other, will my material be remarkable for students, will my material be able to teach the topic permanently were in consideration.

## Discussion and Conclusion

In this study, it is aimed to determine the preservice teachers' ability to use their knowledge about material preparation while developing materials in the lesson. In this context two open-ended questions were addressed in writing in order to find out the knowledge of preservice mathematics teachers on material preparation process and the points to be considered in material developing process. The answers given by the students who participated in the study to the questions were gathered under two themes. The first theme was determined to be knowledge of preservice teachers on material preparation process for mathematics lessons. In the second theme, it was determined that they can use this knowledge with the same priorities while developing their materials in the course. In examining distribution of the statements by sub-themes based on these two general themes, it was found that the number of statements made for both themes was close to each other. However, it is striking that there are differences in the priorities of the sub-themes of both themes. Under these two different themes, three sub-themes were determined: *material use*, *content/design* and *student*. When findings for each sub-theme of the research themes were examined, it was found that sub-themes showed a number of differences in terms of the priorities in the statements. It can be said that the reason for this is that the theoretical knowledge of the preservice teachers about preparing the material was due to the change in their priorities when they were developing materials within the scope of the course, that is, when the application was involved.

Statements of preservice mathematics teachers who participated in the study on their knowledge of material preparation process were found to be on *content/design*, *student* and *material use* respectively from the highest number of statements to the lowest while the order of statements of preservice teachers for the points they considered in material developing process was found to be *content/design*, *material use* and *student* sub-themes from the highest number of statements to the lowest one. In other words, it was found that among three sub-themes determined, preservice teachers used the *content/design* sub-theme in their statements more than the other two sub-themes. We can state that this is primarily due to the fact that material design is started to be made in accordance with the learning outcomes and goal and this is due to the *content/design* sub-themes. While preparing the teaching materials, the conformity of the material to the goal or learning outcomes is expressed as the goal-tool relationship. And it is emphasized that teaching materials suitable for this goal-tool relationship will be selected and prepared (Demirel, et al., 2004). It was observed that preservice teachers focused on characteristics of students after they performed material developing application. It can be said that the reason for this is that when they are developing the material, their thoughts are constantly in the material they are working on and focusing on it.

It was seen that the mostly preferred statements under *content/design* sub-theme regarding both knowledge of preservice teachers on material preparation process and the points to be considered material development, for mathematics lessons were *Support to realization of learning outcomes/Suitability for learning outcomes*, *Suitability for goal and conformity with*

the subject, *Remarkable colours/Coloured materials* with the different percentage. High percentage of the statement of *suitability for the subject* is an important point as subject is a very broad expression in the knowledge of preservice teachers on material preparation process. It is insufficient to focus on the subject here, so what will it serve in the subject? It can be stated that this is due to the insufficient knowledge of the preservice teachers about the distinction between subject, goal and learning outcomes. When this situation is compared with the data in the second theme, it is seen that the percentage of the expressions of *suitability for the subject* has significantly decreased in the percentage of the expressions in the *content/design* sub-theme of the second theme. This may be due to the fact that they focused on different things while developing materials, and the data support this. Besides, it was also observed that the statements of *Supporting correct and valid content of the lesson* was highlighted few in number. Similarly, the points they consider in material development; the statements, *Support to learning, Compliance with learning-teaching principles* proved to be the statements that were asserted by the preservice teachers in the least number. In other words, fewness of statements in terms of contribution to educational-instructional activities drew attention for the two themes. This also showed that they focused on firstly *Suitability for learning outcomes of material* and then different visual properties of the material, especially its striking properties with the *Remarkable colours/Coloured materials, Visuality / Aesthetic, Supporting with congruent figures, pictures and graphs, Correct scaling statements*. This may be due to the awareness that the first thing that will be noticed by the preservice mathematics teachers both of the themes will be the visual properties of the material. The excess of the expressions of being interesting and motivating in the under *student* sub-theme contact can be said as a support of this. This shows that the expressions under the sub-themes are mutually supportive. Moreover, the conclusion drawn from the study by Yanpar et al., (2006) suggesting that lesson materials should meet the criteria such as colour, suitability for the level of student, size, originality, authenticity, emphasis, conformity with achievements supports the *content/design* sub-theme determined in terms of size and conformity with achievements within the scope of this study.

The second mostly used statements of preservice teachers' knowledge of material preparation process were those on *student* sub-theme and it was understood that they also attached importance to student from their knowledge of material preparation process for mathematics lessons. NCTM (2000), emphasizes that for effective mathematics teaching, teachers should be aware of what students know and what kind of support they need to learn the subject how they will learn better. This supports the answers in the *student* sub-theme. In addition, it drew attention that preservice teachers took into account *age, availability, suitability with features of students* in their statements regarding *student* sub-theme on one hand while on the other they considered the factor of *being interesting and motivating for students*. Rosita (2016), said that teachers should provide and develop materials appropriate to the characteristics and social environment of the student. This study supports our work with its emphasis on student characteristics of the student. This corresponds to the conclusion drawn from the study by Kuloğlu (2019) conducted with Turkish language teachers which stated that a vast majority of preservice teachers primarily focused on attracting attention of students with the materials they designed. The aforementioned result is also similar to that of the study conducted by Yanpar et al., (2006) by which they examined lesson materials produced by preservice manually or by using computer in terms of creativity and in which they concluded that preservice teachers handled in detail the criteria of the material such as colour, suitability for the level of student, size, originality, authenticity, emphasis, conformity with achievements and then created their design. Furthermore, it was seen that the statement of *being interesting and motivating* under the *student* sub-theme for the second theme was the one preferred by the highest number of preservice teachers. It can be said that the reason for this is that the preservice teachers were

aware of mathematics, which is an abstract lesson, and this abstract lesson must be endeared to students in the first place. In order to increase their effectiveness in the preparation and development of teaching materials, the materials should motivate the student and attract their attention (Mc Alpine & Weston 1994). This study supported the findings of our study. Moreover, the statements *Suitability to the knowledge level of the student* and *Suitability for age* also drew attention indicating that preservice teachers focused on the right points for the student when developing materials.

All of them shows that both themes that include focus on similar expressions under the *student* sub-theme. We can say that this is due to the fact that the preservice teachers used their sufficient knowledge about the *student* sub-theme during the preparation of the material in the same way while making the material. It is remarkable that the percentage of preservice teachers' expressions of *being interesting and motivating* during the preparation of the material increased 3 times in the percentage of their expressions about the points to be considered while developing the material. The reason for this can be explained by the fact that the lack of information at this point during the preparation of the material disappears when the material is considered more concretely during the construction phase. In addition expression of the *Suitability for the intelligence of the student (Comprehension Capacity)* under the *student* sub-theme in both of themes coincides with Rosita, et. al. (2017) which idea such that material design contributes to the development of students' mathematical understanding skills.

It is noteworthy that the statements given under the *material use* sub-theme with regard to knowledge of preservice teachers on material preparation process for mathematics lessons are few in number. In addition to this, it was seen as a result of the analyses that among the statements of preservice teachers for the *material use* sub-theme, the statements were followed by *To be simple and straightforward*, *Safety /Not harming the student* and *Durability*. The study by Şahin and Yıldırım (2004) also supports this research as the researchers put emphasis on the fact that materials to be reused later should be durable and underlined the importance of improvability and repeatability of such materials. Winn and Holliday, (1982) emphasizes that we focus our attention on only a small part of the message presented to us due to the experiences and emotions we had before and therefore the materials should be simple. Özer and Tunca (2014) pointed that preservice teachers pointed out importance "simplicity and understandability" when developing and using materials, supports this study. In addition to these studies the fact that it was stated in the study by Kuloğlu (2019) that preservice teachers mentioned the necessity of durability of materials to be prepared. Scarcity of statements regarding activeness of students as a group drew attention under the sub-theme of *material use* regarding knowledge of preservice teachers on material design process. It can be said that the reason for this is that the preservice teachers did not think about the lecturing using materials phase of the material.

It was also found that among the statements used for the *material use* sub-theme with respect to points considered by preservice teachers in material development process, the order of statements, from the mostly used statement to the fewest one respectively, was *To be simple and straightforward*, *Usability by everyone* and *Applicability*. The statements of *Allowing the student to take an active role*, *Suitability for studying in groups*, *Being concrete* were the fewest ones made by preservice teachers in this study. The statement of *To be simple and straightforward* was highly underlined in both sub-themes. Furthermore, the fewness of statements *for activeness of students* under *material use* sub-theme of the theme points to be considered in material development may be attributed to the fact that even though material development stage is an implementation stage. The actual implementation takes place in

lecturing using materials; therefore, students may not have clearly imagined this in *material use* sub-theme without being able to exercise the said implementation. In general, it is seen that the percentage of the expressions regarding the *material use* sub-theme increased in the second sub-theme, which may be because the preservice teachers focused entirely on the material and the features it should carry while developing the material. There is a striking situation between these two themes. *Allowing the student to take an active role and Durability* statements have become very important for preservice teachers for the first theme in which preservice teachers' information about preparing materials for statements is given, whereas in the second theme, where the points to be considered in material developing are mentioned, very little attention has been given. It can be said that this is due to the fact that preservice teachers especially focus on the situation related to material making and ignore durability considering the possibility of encountering situations that they did not expect within the means available.

In conclusion, in light of these findings, it provided basic ideas from the sample studied about to what extent preservice teachers used their knowledge about material preparation while developing the material. In three sub-themes, when compared with the data in the first and second themes, it is seen that there is a significant decrease and increase in the percentage of expressions in the sub-themes. This indicates the differences in the use of preservice mathematics teachers' knowledge about material preparation while developing material. At this point, the preservice teachers can be said that there are some deficiencies from one side, while it is reflected in the statements of adequate information from one side.

In light of findings of this study conducted with preservice mathematics teachers, following recommendations are made:

- (1) Considering some differences exist re. priorities of the use of pre-service mathematics teachers' knowledge on material preparation while developing materials, it may be appropriate to give preservice mathematics teachers a hands-on training rather than a theoretical one in order to improve the efficiency of the lessons.
- (2) Considering the insufficient knowledge of preservice teachers regarding the distinction of subject, goal, and learning outcomes, it is recommended to eliminate these within the scope of the course.
- (3) It is recommended to examine the preservice teachers' ability to use their knowledge about material preparation while lecturing using materials.

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