

# ELEMENTARY SCHOOL MATHEMATICS TEACHER CANDIDATES' OPINIONS ON INSTRUCTIONAL TECHNOLOGY AND MATERIAL DESIGN LESSON AND VARIOUS MATERIAL EXAMPLES<sup>1</sup>

İlköğretim Matematik Öğretmen Adaylarının Öğretim Teknolojisi Ve Materyal Tasarımı Dersine Yönelik Görüşleri Ve Çeşitli Materyal Örnekler

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## ABSTRACT

Bu çalışmada Türkiye'deki öğretmen yetiştiren lisans programlarında verilen "Öğretim Teknolojileri ve Materyal Tasarımı" (ÖTMT) dersi hakkındaki ilköğretim matematik öğretmen adaylarının görüşlerini belirlemek, materyal tasarlama sürecinin kendilerinde neleri geliştirdiğini düşündüklerine dair görüşlerini ortaya koymak, ayrıca kendi hazırlamış oldukları materyaller ile ilgili görüşlerini belirlemek amaçlanmaktadır. Bu nedenle çalışma ilişkisel tarama türünde betimsel bir araştırmadır. Verilerin analizinde, nitel araştırma tekniklerinden betimsel analiz ve içerik analizi teknikleri kullanılmıştır. Araştırmanın verileri ÖTMT dersini alan 88 ilköğretim matematik öğretmenliği öğrencisine uygulanan "Öğretim Teknolojileri ve Materyal Tasarımı Dersi Değerlendirme Formu"ndan elde edilmiştir. Araştırma sonucunda ilköğretim matematik öğretmen adaylarının, ÖTMT dersinin öğretmenlik mesleği ile ilgili kendilerine tecrübe kazandırdığını belirttikleri ve materyal tasarlama sürecinin yaratıcı düşünme becerilerini geliştirdiğini düşündükleri görülmüştür. Ayrıca öğretmen adaylarının kendi hazırlamış oldukları materyalleri sınıf ortamında sunmalarının hem kendi mesleki gelişimleri açısından hem de onları dinleyen öğretmen adaylarının farklı materyaller ve uygulamalar ile karşı karşıya kalmaları açısından mesleki gelişimlerine katkı sağladığı, bu nedenle bu tür uygulamaların devam etmesinin önemli olduğu düşünülmektedir. Ayrıca çalışmanın bulgular kısmında öğrencilerin tasarladıkları bazı materyallere ve bu materyallerin kullanımlarına yer verilmiştir.

**Anahtar Kelimeler:** Materyal tasarımı, İlköğretim matematik öğretmen adayları, Öğretim teknolojileri ve materyal tasarımı dersi, Materyal örnekleri, Manipülatif

## ÖZET

The aim of this study is to determine the opinions of elementary school mathematics teachers on "Instructional Technologies and Material Design" (ITMD) lesson, how they made a progress during the material design process and on the materials they prepared themselves. Therefore, this study is a descriptive correlational research. Descriptive analysis and content analysis methods, which are among the qualitative research methods, were used in data analysis. The data of the study was obtained from "Instructional Technologies and Material Design Lesson Evaluation Form" applied to a total of 88 elementary school mathematics teacher candidates studying ITMD lesson. It was revealed that elementary school mathematics teacher candidates gained experience in teaching during the ITMD lessons and material design process developed their creative thinking skills. It was also understood that presenting the materials they prepared in the class made a good contribution to their career development both in terms of their own professional development and in terms of the other teacher candidates listening to them came across different materials and practices, so it is important that such practices continue. Also, some of the material examples prepared by the students and information about their usages given in the results section.

**Key Words:** Material design, Elementary school mathematics teacher candidates, Instructional technologies and material design lesson, Material examples, Manipulatives

## 1. INTRODUCTION

Instructional materials are tools given to students by their teachers in different environments during the learning process. These tools can be objects which are easily comprehensible at first sight like printed materials, pictures, models or can be presented in various environments such as voice tapes, videos, CDs, websites and software programmes, which require a better technology to access their content (Kaya, 2006). The term instructional design and technology primarily represents designing instruction and secondly using tools and materials for instructional purposes (Yelken Yanpar, 2014:

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9). Instructional materials provide student motivation and allow students to study more efficiently by giving them access to information and evaluation opportunity (Akkoyunlu, 2002). Instructional technologies and material design lesson and the skills acquired in this lesson by teacher candidates are important.

A well prepared instructional material can provide all activities (drawing attention, presenting information, clues, participation, exercise. and repetition, providing feedback, correcting and evaluation) a teacher performs in an educational environment (Şahin & Yıldırım, 1999). Using materials allows students to learn with more sensual organs as much as possible. For example, visual materials can be extremely efficient especially when supported by other stimulators (audio, action etc.) (Yelken Yanpar, 2014: 10).

A teacher should be someone who can think critically and creatively, has advanced and healthy communication skills, who is a researcher, who always adapts himself, knows developmental and personal characteristics of students, protects the social values and sets a good example for students, has a strong personality, knows how to have fun, uses time efficiently and productively, who can prepare and use prepared materials enriching the learning, thinks scientifically, uses informational technologies effectively, who can assess and evaluate product and process and makes the right decision (Yelken Yanpar, 2014: 72). Therefore, the experiences of teacher candidates in their educational life and pedagogical knowledge are important. When the content of the "Instructional Technologies and Material Design" course was analyzed, concepts related to instructional technologies were seen to be concepts related to "Instructional Technologies", characteristics of various instructional technologies, the importance and use of instructional technologies in teaching process, determining the technology needs of the school or class, preparation and practice of appropriate technology planning, development of two and three dimensional materials through instructional technologies, development of instructional materials (worksheets, activity design, overhead transparencies, slides, visual media (VCD, DVD) materials, computer-based tools), analysis of educational software, evaluation of various teaching materials, internet and distance education, visual design principles, research on the effectiveness of teaching materials, use of instructional technology in the world and Turkey" (YÖK, 2007). This lesson is important for teacher candidates to be trained knowledgeably in a professional manner. However, this lesson has been removed from the compulsory courses of elementary mathematics teaching undergraduate programs in the 2018-2019 academic year in Turkey, and it has been replaced with "Material Design in Mathematics Teaching" course as an elective lesson in the new curriculum. Therefore, this study is important in terms of reviewing the significance of this course in the undergraduate program.

### 1.1. Purpose

The study aimed to determine the opinions of Elementary School Mathematics Teacher candidates on Instructional Technologies and Material Design lesson. The questions given below are asked for this purpose:

- ✓ What do students studying Elementary School Mathematics Teaching think about instructional technologies and material design lesson?
- ✓ What are the opinions of Elementary School Mathematics Teaching undergraduate students on what the material design process improved in themselves?
- ✓ What do students studying Elementary School Mathematics Teaching think about the materials they designed during instructional technologies and material design lessons?
- ✓ What instructional materials do they design?

The study also presents various materials designed by Elementary School Mathematics Teacher candidates in Instructional Technologies and Material Design lessons. The researcher gave all the theoretical information about the Instructional Technology and Material Design lesson to teacher

candidates during the lesson. Also, she guided the teacher candidates in the process of developing materials. She asked the candidates to plan a 25-minute lesson with the materials they prepared and use them in this lesson.

## 2. METHOD

### 2.1. Model of the Research

The qualitative research method was used in the research. Qualitative research is a type of research in which qualitative data collection methods such as observation, interview, and document analysis are used, and a qualitative process is followed to reveal perceptions and events in a natural environment in a realistic and holistic way (Şimşek & Yıldırım, 2013:45). This study is correlational descriptive research since it was aimed to analyze and review the opinions of elementary school mathematics teacher candidates on Instructional Technologies and Material Design. Descriptive analysis and content analysis methods, which are among the qualitative research methods, were used in data analysis.

### 2.2. Study Group

The study group consisted of 88 students studying at second-grade Elementary School Mathematics Teaching in Necmettin Erbakan University Ahmet Keleşoğlu Faculty of Education Department of Mathematics and Science Education in the spring term of the 2016-2017 academic year.

### 2.3. Data Collection Tool

First, the problem was defined when starting the study. The literature was searched in this regard and former studies were examined. A draft called "Instructional Technologies and Material Design Lesson Evaluation Form" including open-ended questions was prepared by the researchers and this form was revised in accordance with the reviews of four expert lecturers. Also, a Turkish Language Teaching expert was consulted in terms of language suitability of the form. The form was finalized after the pilot study applied later on. The final draft of the form included 4 open-ended questions. Following questions were asked in the "Instructional Technologies and Material Design Lesson Evaluation Form" prepared by the researcher:

- ✓ Write your opinions about the instructional technologies and material design lesson. (What did this lesson contribute to you?)
- ✓ What did the material design process improve in you?
- ✓ How did the instructional technologies and material design lesson affect your opinions about mathematics teaching? Explain.
- ✓ Write down your opinions about your own material.

### 2.4. Data Collection and Analysis

Firstly, the Elementary School Mathematics teacher candidates participated in the study were informed about the study, and it was explained that their answers to the questions asked would be used only for scientific purposes. In this regard, teacher candidates were asked to fill out "Instructional Technologies and Material Design Lesson Evaluation Form". All of the forms given to 88 teacher candidates were collected. However, 1 (one) form was not completely filled out and therefore excluded from the study.

The opinions of the students participated in the study was written by using a coding method which is frequently used in the literature. The opinions of the students are given in quotation marks in the results section and the codes given in the parentheses indicate which student stated the opinion. Descriptive analysis and content analysis methods, which are among the qualitative research methods, were used in data analysis. In the descriptive analysis, an analysis is carried out based on the questions, topics or themes included in the data collection tools such as observations, interviews, and documents. The data are obtained or supported by verbatim quotations (Ekiz, 2009). Content analysis can be easily adapted to use in various areas of social sciences, especially in

qualitative interviews and in the analysis of survey data (e.g. in the coding of open-ended questions in surveys) and direct observation (through audio recording and decoding of transcripts). The most important part of the content analysis is categorizing (Robson, 2015). The four-stage qualitative content analysis method (Şimşek & Yıldırım, 2013) was used in the data analysis of the study:

- ✓ Data coding
- ✓ Category determination
- ✓ Arrangement and definition of the data according to codes and categories
- ✓ Interpretation of the results

In this context, the next step was creating appropriate categories for the research questions and answers, which was one of the most important elements of the study. During this step, an expert was consulted in order to ensure the reliability of the study and the data were examined by the expert. The expert was asked to examine if the categories created by the researcher was appropriate. The categories were also determined by the expert and the ones which were agreed on were detected and the reliability of the study was ensured. It was seen during this process that some answers could represent more than one categories. Therefore, the number of frequencies in the tables and the number of students participating in the study vary.

### 3. RESULTS

The results of the study are organized under two main headings. The first part includes the categories and the frequencies and percentages related to these categories created as a result of the answers to the open-ended questions of elementary school mathematics teacher candidates to the "Instructional Technologies and Material Design Evaluation Form"; prepared by the researcher. Also, some verbatim quotations from the answers are given in the first part. The second part consisted of materials prepared by elementary school mathematics teacher candidates in these lessons and details about them.

#### 3.1. Analyzes of answers given to Instructional Technologies and Material Design Evaluation Form

##### 3.1.1. Elementary School Mathematics Teacher Candidates' Opinions on Instructional Technology and Material Design Lesson

14 different categories were created according to the answers of the teacher candidates for the question "Write your opinions about the instructional technologies and material design lesson. (What did this lesson contribute to you?)" in "Instructional Technologies and Material Design Lesson Evaluation Form". The table showing the categories and the frequencies and percentages related to these categories are given below.

Table 1. Opinions of Teacher Candidates on ITMT Lesson.

No	Categories	f	%
1	Gave experience	20	19.23
2	Gave confidence	5	4.81
3	Improved our point of views	1	0.96
4	Taught patience	1	0.96
5	Improved our reasoning skills	4	3.85
6	Improved our planning skills	2	1.92
7	Ability to design and use practical materials	13	12.50
8	Making lessons more productive and fun	15	14.42
9	Making students more active	11	10.58
10	Making lessons concrete/comprehensible/permanent	16	15.38
11	Information about the teaching profession	9	8.65
12	Felling close to the teaching profession	2	1.92
13	Learning efficient teaching methods	3	2.88
14	Benefiting from the technology	2	1.92

When Table 1 was examined, 19.23% of the elementary school mathematics teacher candidates stated that they gained experience and 15.38% believed that material design made the lesson more concrete, comprehensible and permanent. It is followed by the fact that it made lessons more productive and fun with 14.42%. The data in Table 1 also shown in the Figure 1 for visual understanding.

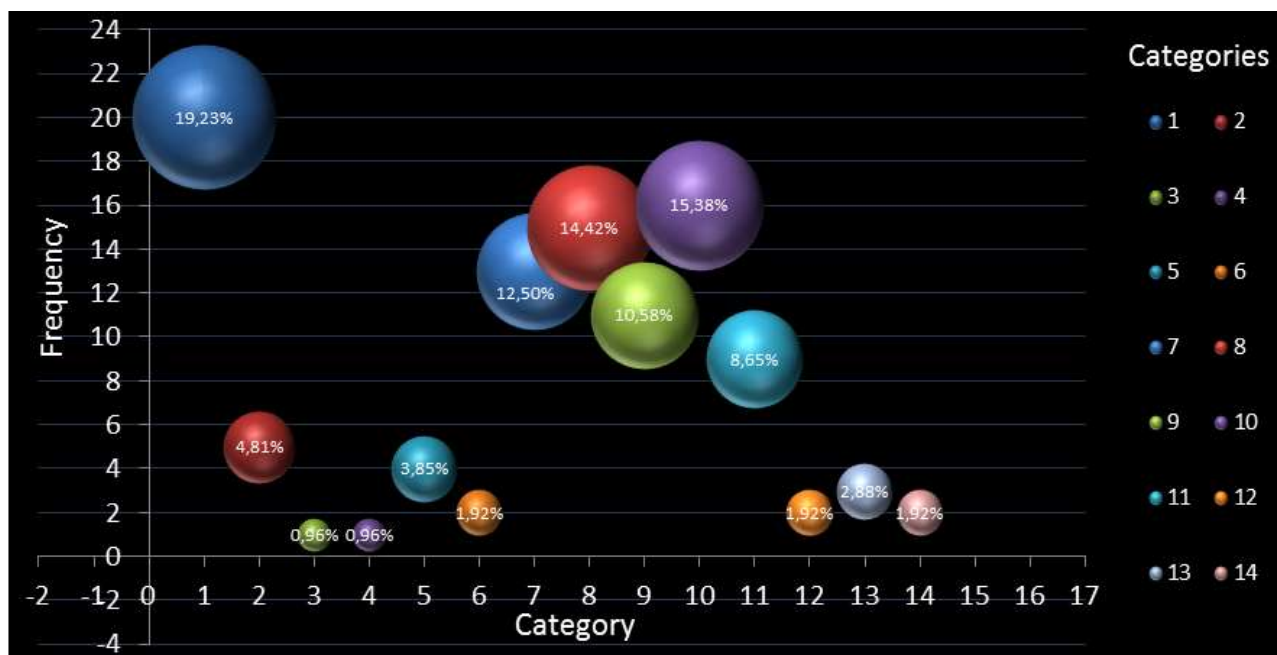


Figure 1. The Frequency and Percentage Graph about Opinions of Teacher Candidates on Itmt Lesson According to Table 1. (The size of bubbles shows the percentages of categories).

Some of the verbatim quotations from the elementary school mathematics teacher candidates about instructional technologies and material design lesson are given below:

*"It is definitely a very useful lesson. Visuality and modeling are very important these days. So, knowing how to design materials would make a great contribution to our teaching experience. Because it draws attention and makes things concrete. Also, we had quite fun during the lesson."* (Student 81).

*"This lesson taught me how I should benefit from the technology to make students understand mathematical concepts and operations. In fact, I saw that educational materials could help students focus on the lesson and have more productive learning. If I become a teacher in the future, I think I will be able to teach more properly using what I learned in this lesson."* (Student 12).

*"Instructional technologies and material design lesson gave us the opportunity to make our field more concrete, teach the lesson in a more fun way and assess our own performances."* (Student 8).

*"This lesson showed me how to teach the topics in the future in a more concrete and catchy way."* (Student 85).

*"This lesson taught us how to take control of our excitement within the community and enabled the emergence of effective, different, innovative ideas. It helped us improve ourselves both theoretically and practically."* (Student 11).

*"Foremost I want to mention that it was a difficult and challenging lesson. Because preparing material requires effort and labor. However, it makes it easier for the students to learn and do it in a fun way, so it is also worth the effort. What this lesson contributed to me is that it provides suggestions and information about how to teach the lesson and which methods to use."* (Student 83).



"In instructional technologies and material design lesson, I learned that topic can be simplified with the help of various visual and practical materials and these materials make lessons easier to understand for students. If I become a teacher in the future, I will use this kind of materials to be more beneficial to my students. I got an idea on materials in almost every subject." (Student 60).

"In this lesson, I have found answers to my questions such as how a teacher should be like, how teachers behave, how and what they talk, how they teach effectively, what material is, how it is used, what happens when it is used etc. I think it made a great contribution to me. The educational lessons I have taken so far were mostly theoretical. This lesson is a kind of lesson that you can practice and produce ideas." (Student 9).

"In this lesson, I learned how to teach a lesson using a material. I saw that teaching the lesson in a monotonous manner is boring and not productive for students, and it is beneficial to make the lesson more attractive by using a material. I learned how to examine the lesson and the learning outcome when designing materials and accordingly design a useful material that would help me teach more easily." (Student 45).

"This lesson has an important place for our future life. Because when we work in schools where there are not enough materials in the future, we need to design these necessary materials for the students to have equal education with other students." (Student 13).

"This lesson gave us the opportunity of seeing; knowing and using the materials that we can use during our lessons in the future and also help to improve ourselves professionally. We saw different ideas and imaginations while our friends were using their materials while following our classmates' lectures." (Student 77).

### 3.1.2. The Opinions of Elementary School Mathematics Teaching Undergraduate Students on What the Material Design Process Improved in Themselves

26 different categories were created according to the answers of the teacher candidates for the question "What did the material design process improve in you?" in "Instructional Technologies and Material Design Lesson Evaluation Form". The table showing the categories and the frequencies and percentages related to these categories are given below.

Table 2. Opinions of Teacher Candidates on the Effects of Material Design Process.

No	Categories	f	%
1	Patience	5	4.63
2	Cooperation	1	0.93
3	Self-confidence	1	0.93
4	Sense of responsibility	1	0.93
5	Planning/Planned work	12	11.11
6	Analytical thinking	1	0.93
7	Aesthetical thinking	1	0.93
8	Effective thinking	1	0.93
9	Ability to think	11	10.19
10	Creativity/ Creative thinking	13	12.04
11	Changing the point of view/Ability to think differently	4	3.70
12	Ability to produce ideas	5	4.63
13	Collaboration with friends	1	0.93
14	Realizing/Materializing math	10	9.26
15	Imagination	9	8.33
16	Ability to empathize with students	9	8.33
17	Abstract thinking ability	1	0.93
18	Reasoning skills	1	0.93
19	Hand skills	7	6.48
20	Ability to design	4	3.70
21	Using time efficiently	1	0.93
22	Communication	1	0.93

23	Information about curriculum	1	0.93
24	Research skills	2	1.85
25	How to overcome monotonous teaching	1	0.93
26	Teaching ability	4	3.70

As seen in Table 2, 12.04% of the elementary school mathematics teacher candidates stated that material design process improved their creativity/creative thinking skill and 11.11% learned how to plan and work as planned with the help of this. It was followed by the ability to think with 10.19%. The visual representation of Table 2 also shown in Figure 2.

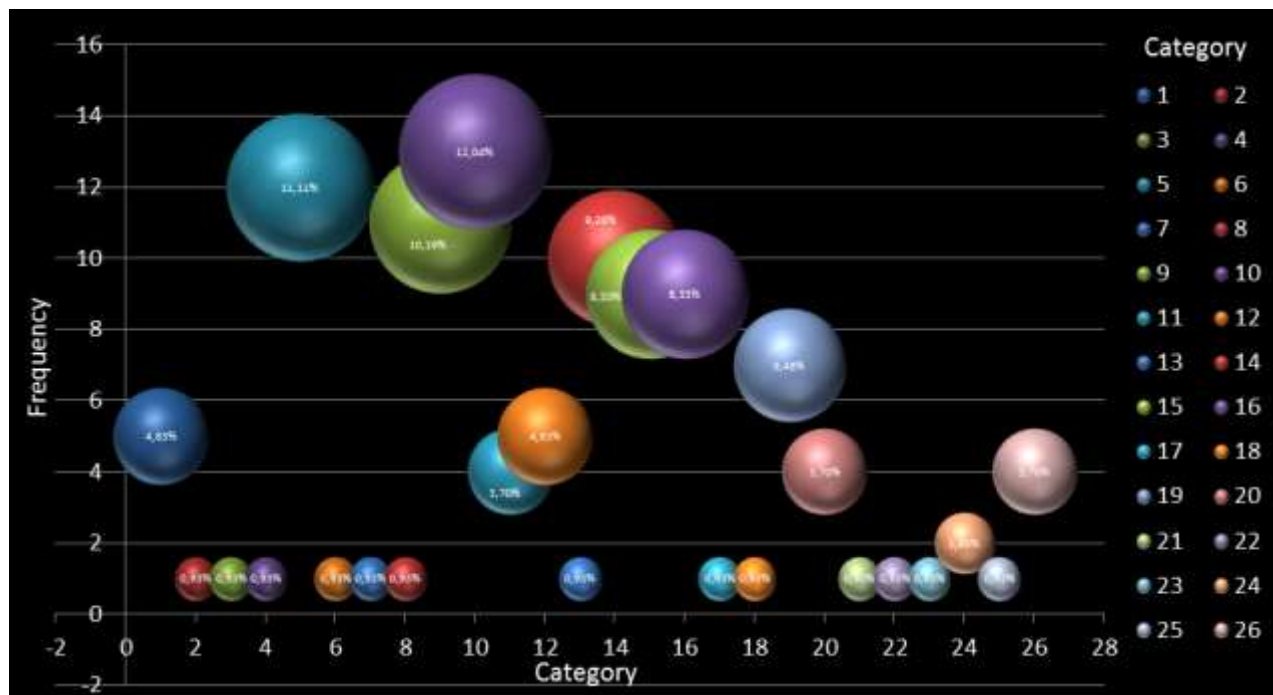


Figure 2: The Frequency and Percentage Graph about the Opinions of Teacher Candidates on the Effects of Material Design Process According to Table 2. (The size of bubbles shows the percentages of categories ).

Some of the verbatim quotations from the elementary school mathematics teacher candidates about their answers to the question "What did the material design process improve in you?" are given below:

*"I learned to think like students and empathize with them. I realized how efficient the student level is on the material. I learned how to make the students realize a concept rather than defining it." (Student 75).*

*"First, it improved my sense of responsibility. Because designing and preparing process of material requires time." (Student 83).*

*"I tried to think creatively during the material design process. I tried to create a colorful and remarkable design. I improved my designing skill. I examined all outcomes of the topic that I created my design for, so it improved my knowledge on that topic. I believe that I improved my creative thinking skill." (Student 45).*

*"It improved out designing and thinking skills. We came up with some ideas about how to draw student attention. We felt that we were free from the ties of the classical system." (Student 80).*

*"It improved my designing, imagination, and empathy skills. I also believe that I protect the environment because I use waste cardboard when preparing my material. It was useful in terms of teaching an abstract idea in a concrete way and thinking analytically." (Student 86).*

*"I came up with many problems when preparing my material. I had different perspectives thanks to my material. For example, I realized that I could teach my topic in different ways*

*but I used to know only one method before. I had a good time when preparing my material and also I gained different perspectives and improved my hand skills." (Student 2).*

*"Designing process was painful for me. I made a great effort. However, even for me, the material was surprising at the end. I became more confident. It was a great feeling to be able to create something." (Student 81).*

*"It improved my hand skills. I learned how to create new ideas. I learned cooperative work. I learned how to be more helpful to my students. I learned to empathize. I looked at my material from students' perspective and I developed it accordingly." (Student 22).*

*"It taught me multidimensional thinking and how to create more beautiful things by planning, writing down and working through the ideas." (Student 82).*

*"I think it improved my creative thinking skills and my ability to make mathematical concepts more comprehensible and ordinary. Now I see the topics by imagining what kind of a game can be developed to teach them." (Student 24)*

### 3.1.3. Opinions on How Instructional Technologies and Material Design Lesson Affected Their Opinions about Being a Math Teacher

22 different categories were created according to the answers of the teacher candidates for the question "How did the instructional technologies and material design lesson affect your opinions about mathematics teaching?" in "Instructional Technologies and Material Design Lesson Evaluation Form". The table showing the categories and the frequencies and percentages related to these categories are given below.

Table 3. Opinions of the Teacher Candidates on the Effects of this Lesson on Teaching Mathematics.

No	Categories	f	%
1	Teaching is enjoyable	7	6.54
2	I love teaching mathematics more	2	1.87
3	It made me happy to be a mathematics teacher	6	5.61
4	It affected my perspective on teaching positively	6	5.61
5	Making mathematics teacher more loveable with materials	4	3.74
6	It is possible to teach and have fun	1	0.93
7	I realized that I am a teacher candidate	5	4.67
8	I felt enthusiastic about being a teacher	2	1.87
9	I realized that teaching is difficult	1	0.93
10	It did not affect my perspective on teaching	2	1.87
11	Teaching math is not only solving problems	5	4.67
12	How to teach mathematics	2	1.87
13	Mathematics teachers play a big role	2	1.87
14	Mathematics teachers are effective/important for a student's entire life	1	0.93
15	How to be an effective teacher	3	2.80
16	Fundamentals of mathematics knowledge must be well-established	1	0.93
17	It encouraged	2	1.87
18	It improved my perspective	1	0.93
19	Everything belongs to mathematics	3	2.80
20	Mathematics can be transformed into shape/materialized	7	6.54
21	How to make mathematics not boring/fun with materials	27	25.23
22	The necessity of material use	17	15.89

As seen in Table 3, 25.23% of the elementary school mathematics teacher candidates stated that materials make the lesson not boring and fun, so they plan to use materials to color their lessons in the future when they become a mathematics teacher and 15.89% believed the necessity of material use. It was followed by the fact that teaching became fun and the lesson could be materialized with 6.54%. The data gathered from teacher candidates about effects of ITMT lesson on teaching mathematics is represented in Figure 3.



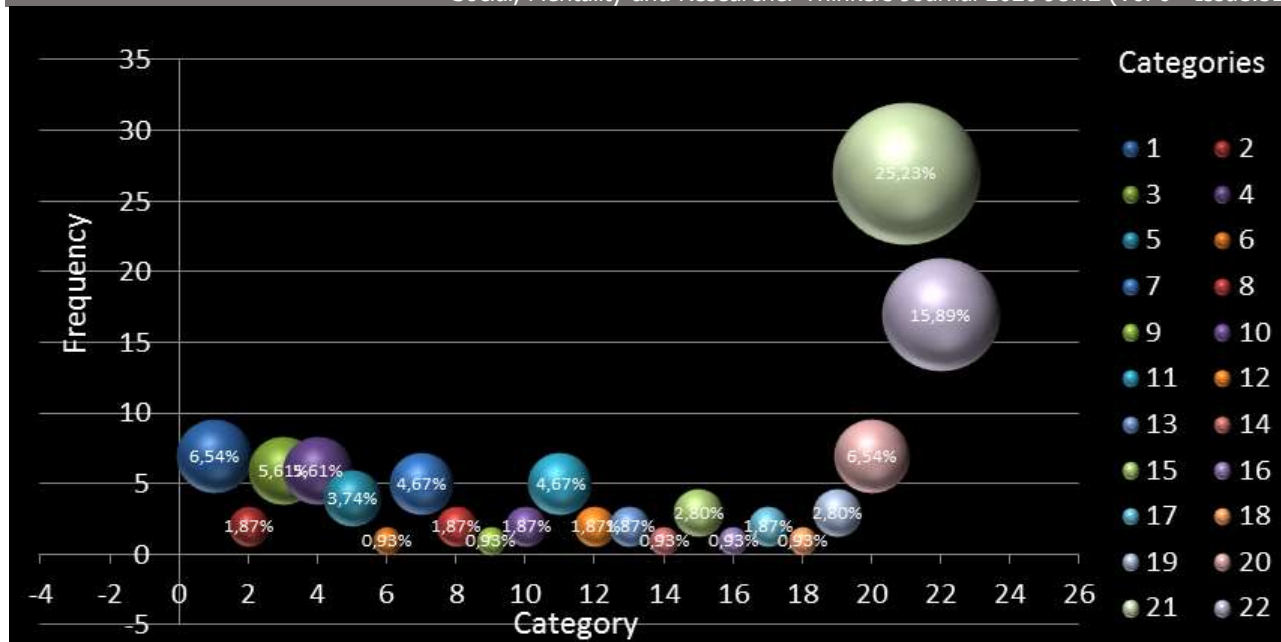


Figure 3. The Frequency and Percentage Graph about the Opinions of Teacher Candidates on Effects of the ITMT Lesson on Teaching Mathematics According to Table 3. (The size of bubbles shows the percentages of categories).

Some of the verbatim quotations from the elementary school mathematics teacher candidates about their answers to the question "How did the instructional technologies and material design lesson affect your opinions about mathematics teaching? Explain." are given below.

*"I always wanted to be a math teacher so I'm here. I knew this job was a little difficult. I knew it required devotion. But I realized that it was a job that needed more attention than we thought when I first practiced teaching. I need to choose my words very carefully because my mistake may cause very bad results. Since mathematics is a lesson comprehended by abstract thinking skills, material use makes it easier to teach the lesson because it makes the lesson concrete." (Student 70).*

*"It taught me that mathematics teaching isn't that difficult. While teaching students something, I learned that it would be easier to teach them by attracting their interest in the lesson thanks to materials. Instead of just giving information to the students, I saw that it was easier and more effective to explain the subject by making it fun rather than only teaching pure knowledge. It made mathematics teaching easier." (Student 28).*

*"I saw that teaching mathematics is not just solving problems and teaching the lesson in front of whiteboard" (Student 60).*

*"I saw that studying mathematics teaching and working in this profession is not difficult, on contrary it is fun. Unlike what people think, mathematics is not a difficult lesson. It is not only the numbers and the obscures as everybody believed, but also it has an entertaining side, but also thought-provoking." (Student 22).*

*"Mathematics could be taught to students in a much more enjoyable, fun and useful way. Students could learn how to find out the reason behind the topic much more easily without memorizing the rule. Material design lesson made us feel more positive to mathematics teaching, and I also felt that I could work as a teacher and feel good while doing it." (Student 77).*

*"It made me aware of my profession. I think I showed to my relatives and friends who have no idea about the existence of such homework, that mathematics can be taught in this way as well. Also, I decided to teach using materials in the future after I saw the materials my friends created. Even I had fun while using the material. I'm sure students can learn better." (Student 24).*

"While we were at our school ages we always studied mathematics in an abstract way by only trying to understate it from written sources, we thought that mathematics would be explained only in this way. I realized that we could explain mathematics in a concrete way and make mathematics fun after the instructional technologies and material design lesson." (Student 8).

"I learned that mathematics could be taught in a fun way, without boring the children. I understood that because even we had fun during the lesson. I learned that small and simple materials could eliminate the prejudices against the teacher because mathematics has been regarded as a difficult lesson, and materials could make students love the teacher." (Student 30).

"We saw that simple tools we used to see as unnecessary could affect students. We realized that mathematics teaching could affect a student's entire life and therefore it had high importance in student lives." (Student 13).

"As it is difficult for everyone to understand mathematics, we also have some questions in our minds as teacher candidates, for example how to explain mathematics, how to teach it and how students could use it in their lives. I actually think that we can make students understand the lesson more easily by using materials." (Student 21).

"I learned that materials are very important in mathematics lessons. Presenting the lesson with concrete materials, drawing student attention and keeping the eyes on the teacher and material during the lesson make teaching easier for teachers and make it more fun." (Student 52).

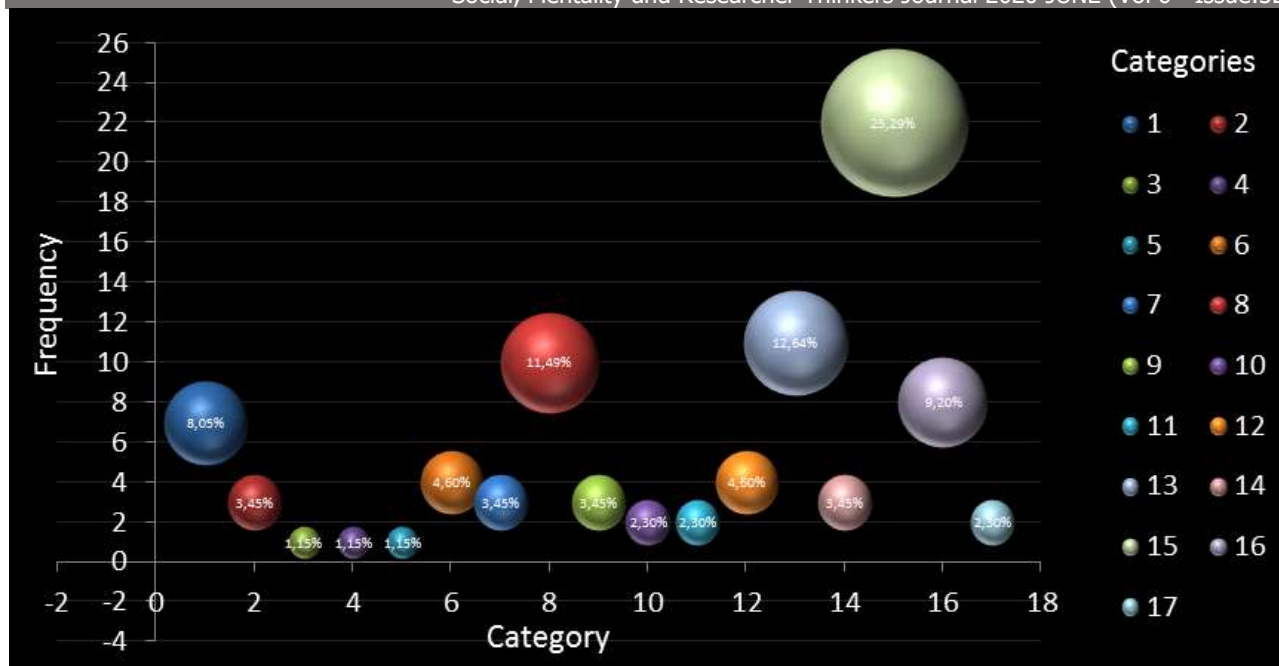
### 3.1.4. Opinions of Teacher Candidates on the Instructional Materials They Designed

17 different categories were created according to the comments of the teacher candidates for the statement "Write down your opinions about your own material." in "Instructional Technologies and Material Design Lesson Evaluation Form" and frequencies and percentages of these categories are given in the table below.

**Table 4.** Opinions of Teacher Candidates on the Materials They Designed

No	Categories	f	%
1	Useful and multi-purpose material	7	8.05
2	Not a very creative material	3	3.45
3	A material with few pieces of equipment that can be used for different subjects	1	1.15
4	A material that can be used repeatedly	1	1.15
5	A material that stimulates the dialogue between teacher and student	1	1.15
6	An interesting and easy to apply material	4	4.60
7	Not interesting but relevant	3	3.45
8	Good and relevant	10	11.49
9	A good idea but could be better	3	3.45
10	The best I can make	2	2.30
11	I don't have an idea	2	2.30
12	A material making students active	4	4.60
13	Useful and creative	11	12.64
14	Instructive and educative	3	3.45
15	Interesting and entertaining	22	25.29
16	A material making the subject more concrete	8	9.20
17	Efficient and cost-effective	2	2.30

When Table 4 was examined, it was seen that 25.29% of the elementary school mathematics teacher candidates considered their materials as interesting and entertaining. 12.64% thought that their materials were useful and creative, and 11.49% thought it was good and relevant. Also, 9.20% stated that they developed a material that makes the subject concrete. The graph created according to the data listed in Table 4 is given below.



**Figure 4.** The Frequency and Percentage Graph about the Opinions of Teacher Candidates on the Materials They Designed According to Table 4. (The size of bubbles shows the percentages of categories).

Some of the verbatim quotations from the elementary school mathematics teacher candidates about their comments to the statement "Write down your opinions about your own material." are given below.

*"First of all it was difficult to build it but I think I made a creative material. It is entertaining, surprising and didactic."* (Student 59).

*"I think my material is good-looking, entertaining and didactic, and that I made an incredible effort to build it. It could be a little smaller and a root sign could also be used along with spring mechanism. However, it would be difficult to work on this tool. In general, I find my material successful."* (Student 1).

*"I tried to keep the material as simple and colorful as possible. I think it is also good as an idea. Of course, there were things I thought that I could change afterward."* (Student 11).

*"My material was interesting and exciting for students. They were having fun doing something on my material. Not only students but also other people who observed me practicing the material before the lesson loved to use it. It was an easy and easily understandable material."* (Student 64).

*"It could be more creative, but it was still good. I could teach two different topics using my material. I spent a lot of time thinking about it. The result was satisfying. Even if it was difficult, I am happy that I took that lesson and developed this material."* (Student 78).

*"I think my material is good. However, it has some deficiencies. I believe that it will be even more useful when there is time and opportunity to develop the material."* (Student 55).





*"It was a creative and entertaining material that would draw student attention easily and provide permanent knowledge."* (Student 27).

*"I enjoyed creating my material. The production process was very difficult for me, but I had fun and learned a lot during this. I imagined students using the material while creating it, so I wrote the numbers very carefully. I paid attention to the decoration. Since I could create what I designed, I felt so pleased with my material. I think students will like and have fun while using it."* (Student 31).





### 3.2. Some Instructional Materials Designed by Elementary School Mathematics Teacher Candidates

Some of the material samples designed by the students during the ITMD lesson with information about their usage and the photos of these samples are given in the Table 5.




Table 5. Some of the Material Samples Designed by the Students during the ITMD Lesson

No	<ul style="list-style-type: none"> <li>• Grade level</li> <li>• Subject that the material is used for</li> <li>• Usage of the material</li> </ul>	Photos
1	<ul style="list-style-type: none"> <li>• 7<sup>th</sup> grade</li> <li>• Transformation Geometry</li> <li>• Usage of the Material: When used for reflection, the reflection axis is created by pulling the mirror to an axis which is determined as the reflection axis. When used for translation, only the coordinate plane is used by closing the mirrors.</li> </ul>	
2	<ul style="list-style-type: none"> <li>• 7<sup>th</sup> grade</li> <li>• Circles and Discs</li> <li>• The material is designed to be used both in teaching the subject and in the practicing process. There are magnets on the nose and body of the material. Various concepts of circles and discs can be introduced by using these magnets and attaching different apparatus to the material. There are questions about the mathematical concepts in the "Math Dictionary" part which is inside the head of the material. There are questions about the subjects in the "Let's See What You Know" part which is inside the body of the material.</li> </ul>	
3	<ul style="list-style-type: none"> <li>• 7<sup>th</sup> grade</li> <li>• Lines and Angles</li> <li>• Various angles can be created by using colorful and silvery wires placed in the drawer on the side of the material. The concepts such as equal angle and bisector are introduced to the students by showing on the material. Students can practice by creating several problems with the help of pipettes, silvery wires, letters, and numbers. The material can also be used for teaching circles.</li> </ul>	
4	<ul style="list-style-type: none"> <li>• 8<sup>th</sup> grade</li> <li>• Square Root</li> <li>• The material is created with the inspiration of ATM machines. There are 20 card slots and the square roots of the full square numbers between 1 and 400 under each slot. After putting the card into the card slot, the square root of the number falls from the open space under the material. The material can be used for overlearning the square roots. Also, by replacing the square roots in the material with questions, the material can be used to solve problems in different subjects by putting cards into the slots.</li> </ul>	



<p>5</p>	<ul style="list-style-type: none"> <li>• 6<sup>th</sup> grade</li> <li>• Addition and Subtraction of Integers</li> <li>• The material was inspired by the rail system. The train stops on the rails with the help of the magnets on the rails and under the train. In direction with the train moves, students can do operations with integers on the material.</li> </ul>	
<p>6</p>	<ul style="list-style-type: none"> <li>• 7<sup>th</sup> grade,</li> <li>• Angles in Circles</li> <li>• The material was designed to show the center angle, the perimeter angle in the circle and the arcs they face, and then to determine the relationship between these angles and the arcs. When the small circle is in the center, it acts as the central angle and by moving the angle arms, the relationship between the central angle and the arc it faces is determined. Then, the small circle in the center is moved by placing its center on the circle and it acts as the perimeter angle. The relationship between the perimeter angle and the arc it faces is determined by moving the arms.</li> </ul>	
<p>7</p>	<ul style="list-style-type: none"> <li>• 6<sup>th</sup> grade</li> <li>• Addition and Subtraction of Integers</li> <li>• The material is based on the principle of moving the penguin by rotating the arm on it and making operations with integers.</li> </ul>	
<p>8</p>	<ul style="list-style-type: none"> <li>• 5<sup>th</sup> grade</li> <li>• Reading and Writing Natural Numbers</li> <li>• The material is used to make the students read and write maximum nine-digit numbers and identify the periods, digits and digit values of these numbers.</li> </ul>	



<p>9</p>	<ul style="list-style-type: none"> <li>• 7<sup>th</sup> grade</li> <li>• Circles and Discs</li> <li>• The material was designed to show the radiuses and diameters of the inner, middle and outer circles by attaching the wooden apparatus to the nail in the center. Secant and tangent concepts are shown by using the antenna. The angle concept can also be explained by using the antenna. The lower disc is attached to the material to explain the same concepts for the discs.</li> </ul> <p>Runners move on the material. The distance between the two runners determines the circumference of the circle. Also, the runners and the strings and numbers below the material are used to model various problems</p>	
<p>10</p>	<ul style="list-style-type: none"> <li>• 8<sup>th</sup> grade</li> <li>• Transformation Geometry</li> <li>• The base of the material is designed as metal. Therefore, the wooden shapes are attached to the material using magnets and the material is designed to use for teaching rotation and reflection subjects. Also, markings can be done on the ground using board markers.</li> </ul>	
<p>11</p>	<ul style="list-style-type: none"> <li>• 6<sup>th</sup> grade</li> <li>• Decimal Notation</li> <li>• The material has 3 rotation mechanisms with digits on it. The first digit to the left of the comma is shown as "units digit", the second digit is "tens digit", and the third digit is "hundreds digit". There are three identical cubes which have a 10 cm edge on the right of the comma. Since the first digit after the comma represents the "tenths digit", it means that the cube includes 10 identical pieces of wood. There are also painted ones of these 1/10-pieces of wood. As many painted pieces of wood as it requires are put into the cube according to the numerical values of the given number.</li> <li>• The second cube after the comma represents "hundredths digit" is consists of 100 identical sticks. As many 1/100-pieces of painted wood as required for the expanded forms of the number are put into it.</li> <li>• The third cube after the comma consists of 1000 identical wooden unit cubes. Since this is the "thousandths digit", as many 1/1000-painted cubes as required for the expanded forms of the number are laced in it.</li> <li>• Students create expanded forms of different numbers by using painted wood pieces.</li> </ul>	

**4. CONCLUSION, DISCUSSION, and RECOMMENDATIONS**

The study aimed to determine the opinions of elementary school mathematics teacher candidates on Instructional Technologies and Material Design lesson. In this regard, teacher candidates were asked to fill out "Instructional Technologies and Material Design Lesson Evaluation Form". When the results obtained from the study were examined, it was seen that elementary school mathematics teaching undergraduates had positive beliefs on instructional technologies and material design lesson. When the opinions of the students participating in the study about ITMD lesson and materials were analyzed, 19.23% stated that using materials allowed students to gain experience and 15.38% stated that it made the lesson more comprehensible, concrete, and provided permanent knowledge. It is followed by the fact that it made lessons more productive and fun with 14.42%. 12.50% of the participants stated that they learned how to design useful materials with the help of this lesson and gained experience in using it.

The fact that 19.23% of the teacher candidates who participated in our study stated that this lesson helped them gain experience in teaching profession is consisted with the results of the study by Güneş and Aydoğdu İskenderoğlu (2014) revealing that the biggest contribution of ITMD lesson to elementary school mathematics teacher candidates was providing teaching experience and gaining a sense of teaching. The rates of our study results showed that 15.38% of the teacher candidates stated that they could make the lesson concrete, which is consistent with the results of the study by Çakmak, Taşkiran and Bulut (2016) revealing the fact that teacher candidates found ITMD lesson necessary in undergraduate education and ITMD lesson was beneficial in making the lessons concrete, developing cognitive and hand skills and improved the group work performance. 12.04% of the elementary school mathematics teacher candidates stated that material design process improved their creativity/creative thinking skill and 11.11% learned how to plan and work as planned with the help of this. It was followed by thinking ability with 10.19%. Also, 9.26% of the participants stated that they learned how to make the mathematics materialized/concrete.

When the opinions of teacher candidates about the effects of this lesson on their perspectives upon teaching mathematics were examined, it was seen that 25.23% of the elementary school mathematics teacher candidates stated that materials make the lesson not boring and fun, so they plan to use materials to color their lessons in the future when they become a mathematics teacher and 15.89% believed the necessity of material use. It was followed by the fact that teaching became fun and the lesson could be materialized with 6.54%. 5.61% of the teacher candidates stated that this lesson changed their opinions about teaching in a positive way and made them feel happy to be a mathematics teacher in the future.

In a study on the opinions of mathematics teacher candidates about using materials in mathematics lessons by Ünlü (2017), teacher candidates defined teaching materials as "facilitate teaching", "visual", "concrete", "designed using creativity", "technological", "ready-to-use or designed" tools which "facilitate teaching" and the majority of the candidates stated that they would use materials in their lessons when they become teachers in the future. This is consistent with our study. 25.29% of the elementary school mathematics teacher candidates considered their materials as interesting and entertaining. 12.64% thought that their materials were useful and creative, and 11.49% thought it was good and relevant. Also, 9.20% stated that they developed a material that makes the subject concrete. 8.05% stated that they created a material which is useful and has multipurpose use. When the opinions of the teacher candidates on the instructional materials they designed were examined, it was seen that most of them had positive assessments. However, the majority of the participants claimed that they could prepare better materials when they try to design material again. They stated that they saw the advantages and disadvantages of their materials during their presentations of the materials they prepared.

At the end of the research, the opinions of the primary school mathematics teacher candidates whose thoughts also emerged about using teaching materials in the mathematics lesson can be gathered around the following three themes:

1. Materials make abstract concepts concrete.
2. Materials make learning easier by simplifying the subject.
3. The materials make the learning permanent.

It was revealed at the end of the study that elementary school mathematics teacher candidates in the sampling gained experience in teaching during the ITMD lessons and material design process developed their creative thinking skills. It was also inferred that presenting the materials they prepared in the class made a good contribution to their career development both in terms of their own professional development and in terms of the other teacher candidates listening to them came across different materials and practices, so it is important that such practices continue. Also, it is recommended that this kind of lessons should be included in teacher training undergraduate programs more.

A similar study was carried out by Uzunöz, Aktepe, and Gündüz (2017). Our study is consistent with the studies in which teacher candidates stated that ITMD lesson provided professional gain such as ease, efficiency, experience, permanence, concreteness, productivity, entertainment, control, imagination, visualization, material, hand skills, approach, benefit, guidance, clarity. Our study is also consistent with the findings of the study by Uzunöz et al. who concluded that ITMD lesson contributed to the individual and social development of teacher candidates, positively changed their perspectives on educational environments and developed critical and creative thinking skills through projects. Peker, Küçükgençay, and Acar (2018) also reached compatible results with this research; that the ITMD course creates a significant difference in teacher self-efficacy and increases the attitudes towards the teaching profession, the same researchers concluded in their another study in 2018 that ITMD lesson was effective in acquiring professional achievements. Öztürk and Zayimoğlu Öztürk (2015) reached a similar conclusion as well; they understood that teacher candidates made important contributions to their personal and professional development thanks to this lesson.

In sum, this study revealed that ITMD lesson helped the teacher candidates to gain experience, developed creativity/creative thinking skills during the material design process, taught them planning and working as planned, contributed to their thinking skills and taught them how to make mathematics materialized/concrete. This lesson was considered to be of great importance in the development of teacher candidates considering their opinions about this lesson's effect on their beliefs about teaching. They stated that materials made their lessons not boring and fun, they would use materials in the future when they become a teacher, they believed the necessity of materials, they enjoyed teaching and materials made their lessons concrete, using materials affected their perspective upon teaching positively and they felt happy to become teachers in the future. However, despite all these studies, this lesson was removed from must-courses of the new curriculum of elementary school mathematics teaching undergraduate program during the 2018-2019 academic year in Turkey. Instead of this lesson, two new lessons, namely "Instructional Technologies" as a vocational course and "Material Design in Mathematics Teaching" as restricted elective course were included. The effects of these changes will be seen in the following years. It is thought that teacher candidates may have some difficulties in their careers since the "Material Design in Mathematics Teaching" course is among the elective courses and there would be teacher candidates who will graduate without taking this course.

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