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5E Modeline Göre 'Denetleyici ve Düzenleyici Sistemler' ve 'Duyu Organları' Konulu Materyal Tasarımı ve Değerlendirmesi*

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Öz

Bu çalışmanın amacı, altıncı sınıf fen bilimleri dersinde 'Denetleyici ve Düzenleyici Sistemler' ve 'Duyu Organları' konusunda 5E Modeli öğretim materyalleri tasarlamak ve bunları uzman ve öğrenci görüşleri doğrultusunda değerlendirmektir. Araştırmada nicel ve nitel verilerden yararlanılmakla birlikte genel çerçevede ele alındığında bu araştırmada nitel araştırma desenini temel almaktadır. Nicel verilerin çözümlenmesinde betimsel analizden yararlanılırken nitel veriler için içerik analizinden yararlanılmıştır. Çalışma grubu 14 akademisyen, 38 öğretmen, 10 lisansüstü öğrenci ile 14 yedinci ve sekizinci sınıf öğrencisi olmak üzere toplam 76 katılımcıdan oluşmuştur. Veri toplama aracı olarak araştırmacılar tarafından geliştirilen '5E Modeli Materyal Değerlendirme Formu' ve 'Yarı Yapılandırılmış Görüşme Formu' kullanılmıştır. Katılımcıların görüşlerinden elde edilen bulgular, materyallerin amaca uygun olarak hazırlandığını ve öğretim sürecinde kullanılabileceğini göstermesine rağmen bazı eksiklikler tespit edilmiş ve daha sonra bu eksiklikler giderilmiştir. Sonuç olarak materyallerin öğretim sürecinde etkili bir şekilde kullanılabileceği düşünülmüştür.
Anahtar Kelimeler: 5E modeli, denetleyici ve düzenleyici sistemler, duyu organları, materyal tasarlama.

Material Design and Evaluation According to the 5E Model on 'Supervisory and Regulatory Systems' and 'Sense Organs'

Abstract

The aim of this study is to design 5E Model teaching materials on 'Supervisory and Regulatory Systems' and 'Sense Organs' in the sixth-grade science course and to evaluate them in line with the opinions of experts and students. While the study utilizes both quantitative and qualitative data, the overall framework of this study is based on a qualitative research design. Descriptive analysis was used to analyze the quantitative data, while content analysis was used for the qualitative data. The study group consisted of 76 participants, including 14 academicians, 38 teachers, 10 graduate students, and 14 seventh and eighth students. The '5E Model Material Evaluation Form' and 'Semi-structured Interview Form' developed by the researchers were used as data collection tools. Although the findings from the participants showed that the materials were prepared in accordance with the purpose and could be used during the teaching period, some deficiencies were identified. And then, these deficiencies were eliminated. As a result, it was thought that the materials could be used effectively in the teaching process.
Key Words: 5E model, supervisory and regulatory systems, sensory organs, material design.

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Giriş

Education is the cornerstone of a society. The course teaching process is also very important in order to provide education in an effective and efficient way. However, there are some variables that affect the teaching process. One of them is the teaching materials used in the process. Paykoç (1991) defined teaching materials as resources and tools used to provide students with various knowledge, skills, values, and attitudes. Çam Aktaş (2014) named the materials included in the process as teaching materials so that the teaching becomes permanent, enjoyable and enables students to gain experience. Turan and Boyraz (2004), on the other hand, suggested that teaching materials are elements that facilitate the process, increase efficiency, and save time. Therefore, the use of materials is very important for students to be successful in the teaching process, especially in abstract courses such as science. In addition, the use of materials is very useful for teachers in terms of being a guide in the process and making the lesson more planned.

One of the most important steps in the use of materials is the selection and use of appropriate materials. Thus, an effective teaching environment is prepared and students can reach the goals more easily and support the success of the curriculum (Fidan, 2008; Gul & Yalinkilic, 2025; İnal & Çakır, 2021; Sönmez, 2005). When choosing suitable materials, the materials should have some qualifications. The teaching material should have various contributions to the teaching process, students, and teachers. In addition, in terms of content, it should be suitable for the gains to be given to the student, the age range of the student, and the readiness and should cover the subject completely. Thanks to a teaching material with these qualities, the teaching process becomes more effective. Instructional materials should lead students to research within the expected goals and qualifications, and develop their skills to produce original products, solve problems, and work both individually and in groups (Bozpolat & Arslan, 2018). Instructional materials are expected to make the course productive. Therefore, the selection of teaching materials to be used during the course is very important. As a matter of fact, according to Büyükkaragöz and Çivi (1999), for the information to be easier to understand and to be permanent, the course materials must have sufficient qualities and quantities, and be used at the right time. In addition, one of the most important features of the materials is to make complex and difficult abstract terms easier to understand by simplifying them (Fer, 2011).

The approach and learning model adopted while choosing the teaching material is also very important. In this case, in order to have an effective teaching process, materials prepared in accordance with the current curriculum should be preferred. In our country, it is seen that the constructivist approach is based on the current science curriculum. The constructivist approach includes the process of structuring the new information to be learned with the student's prior knowledge (Body, Watson & Aubusson, 2003; Sudarman et al., 2024). The reason why the constructivist approach has become widespread in recent years is that it provides an effective teaching environment by supporting the development of motivation and intellectual skills of the student (Body et al., 2003). This approach has brought new approaches to issues such as curriculum development, identifying and eliminating misconceptions, and assessment and evaluation, especially in science teaching (Akdeniz & Keser, 2002; Driver, 1988; Ma et al., 2025). In learning environments based on the constructivist approach, it is seen that students are actively involved in the learning process, reach information by researching and questioning, and relate the new information they reach with their previous lives. In this process, the teacher guides the student (Adigun, Mpofu, & Maphalala, 2025; Demiralp, 2007; Shunk, 1996; Şaşmaz Ören & Ormancı, 2012).

There are many models based on the constructivist approach. Among these, one of the most useful models is the 5E model (Huang et al., 2025; Keser, 2003; Wilder & Shuttleworth, 2005). In the 5E model, there are activities that make students curious and encourage them to research (Aksoy & Gürbüz, 2013). Although the 5E model is research-based, it is a 5-stage model that also includes experimentation (Boddy et al., 2003). The stages of the 5E model and the activities that can be done in these stages are defined as follows (Akar, 2005; Balcı, 2005; Carin, Bass & Contant, 2005; Ercan Özaydın,

2010; Hançer, 2005; Keser, 2003; Saraç & Bayrak, 2017; Tatar, 2006; Temizyürek, 2003; Wilder & Shuttleworth, 2005):

1. Engage: It is the first step in which students' attention is drawn to the subject. Activities are used to attract students' attention, reveal their prior knowledge, and establish relationships with previous knowledge and skills. These activities can be question-answer, scenario narration, use of visual elements, demonstration, discussion, story content. There is no lecture at this stage.

2. Explore: After giving a brief information about the activities, the teacher guides the process without active participation. Students can work individually or in groups. Students who are given a question, situation or problem are expected to solve it. At this stage, students may be asked to do activities such as experimentation, concept map, question-answer, group work, and poster preparation.

3. Explain: It is the step where the teacher is most active in the classroom. The teacher sees the mistakes of the students and corrects them. At this stage, the teacher can benefit from methods and techniques such as lectures, presentations, questions, and answers.

4. Elaborate: Learned knowledge and concepts are reinforced. It is expected that the acquired knowledge will be used in different problem situations. The activities are aimed at reconciling and blending students' old knowledge with newly acquired knowledge. The teacher is the guide.

5. Evaluate: At the end of the learning process, it is the step in which the students' knowledge structuring criteria and the products they reveal are evaluated and controlled.

When we look at the general purposes, functioning, steps, and previous studies in the literature, it is seen that the 5E model will be very effective for the teaching process. On the other hand, 'Supervisory and Regulatory Systems' and 'Sense Organs' are among the most difficult to understand as they contain too many abstract terms. In the studies conducted, it ranks first among the subjects that are difficult to understand both in primary and secondary education (Gül, 2020; Güneş & Güneş, 2005; Yıldız, Şimşek, & Ağdaş, 2017). Therefore, using materials based on the 5E model in teaching this subject can be effective in achieving success. For this reason, materials based on the 5E model were designed and evaluated in this study. For this purpose, the research questions are as follows separately in terms of expert and student opinions:

a) In terms of expert opinions;

1) What are the opinions on the materials prepared according to the 5E Model about the Nervous System?

2) What are the opinions on the materials prepared according to the 5E Model about Endocrine Glands?

3) What are the opinions on the materials prepared according to the 5E Model about Sense Organs?

b) In terms of student opinions;

4) What are the students' views on the materials prepared according to the 5E Model?.

Material and Method

Although quantitative and qualitative data are used in the research, when considered in the general framework, descriptive method based on qualitative research design was used in this research. The ethics committee permission was obtained for the applications.

Study Group

Because the research's main purpose was to develop guide materials for teachers and researchers, it was necessary to obtain expert opinions regarding their usability. The study group was determined using a convenience sampling method. There were a total of 76 participants in the study group. In the study, 14 academicians and 38 science and biology teachers who are experts in science and biology education and 10 graduate students studying science and biology were selected as the study group. In addition, a total of 14 students studying in the seventh and eighth grades were asked about

the corrected materials after expert opinion. The reason why seventh and eighth grade students were chosen is that they have already learned these subjects in line with the curriculum.

Data Collection Tools

The '5E Model Material Evaluation Form' and 'Semi-Structured Interview Form' were prepared by the researchers as data collection tools. The '5E Model Material Evaluation Form' has been prepared in order to get expert opinions on the materials and to give the materials their final version with revisions made according to expert opinion. While preparing the '5E Model Material Evaluation Form', expressions in similar data collection tools used in the literature were also used (Bilgican, 2017; Büyükkol Köse, 2019). The following steps were considered during the preparation of the form:

1. The properties that should be in qualified materials were determined (Karamustafaoğlu, 2006; Yaşar, 2004).

2. According to the qualifications determined for the material, sub-dimensions such as the suitability of the material for the model and the suitability of the material in terms of design were created.

3. Criteria, expressions or items that may be suitable for the created sub-dimensions are written.

4. Among the expressions, 50 five-point Likert-type and 4 open-ended questions were selected and a draft form was created.

5. The draft form was presented to the opinion of 3 faculty members from the biology and science department, 1 biology teacher and two graduate students studying biology and science.

6. As a result of the evaluation, the form was rearranged and the final form was prepared. Accordingly, each item was evaluated individually, considering its semantic integrity and intended semantic features, and various spelling and punctuation errors were corrected. Additionally, items 26, 38, and 47, originally prepared, were deemed unnecessary and incomprehensible and were removed from the form. Errors in open-ended questions were also corrected, and additions were made to enrich the meaning of the questions (Appendix 1).

The 'Semi-Structured Interview Form' was prepared to get the opinions of the students about the materials prepared with the 5E model. For the validity and reliability of the interview questions, the above-mentioned field experts were consulted (Appendix 2).

Preparation of Materials

Instructional materials were prepared in line with the steps and purposes of the 5E model, considering the grade level and readiness of the students. According to this:

- While designing the activities in the engage step, it is aimed to draw the attention of the students to the lesson and the subject in accordance with the purpose of the step and to reveal their preliminary knowledge.
- While designing the activities in the explore step, it is aimed that the students can produce solutions to the given problems and reach the desired information in the meantime.
- In the explain step activities, incomplete and incorrect information was also explained to the student, while questioning the extent of the knowledge reached.
- In the elaborate step, attention was paid to use the new knowledge that the students constructed while solving the problem and their old knowledge together.
- In the activities in the evaluate step, an evaluation was made on the extent to which the students learned the information to be given.

While designing the materials, various activities were prepared considering the above-mentioned purposes. Many different methods and techniques such as experiment stations, role playing, concept maps, filling in the blanks, puzzles, and matching were used in the activities. Based on the prepared activities, the students were allowed to work collaboratively individually and in groups, and the development of both affective and cognitive processes and skills, such as the ability of students to express their ideas freely, to strengthen their communication skills, to produce original products, to conduct research, and to embody abstract concepts, were also considered.

Teaching materials have been designed under separate headings for three different topics as 'Nervous System', 'Endocrine Glands' and 'Sense Organs'.

Data Analysis

Descriptive analysis was made for the data obtained with Likert-type questions in the material evaluation form used in the research, and content analysis was performed for the data obtained from open-ended questions and semi-structured interviews. The data obtained from Likert items were analyzed with the IBM SPSS 22 program, and their arithmetic mean and standard deviation values were calculated. In the interpretation of arithmetic means in the study, values between 1.00 and 1.80 were defined as 'very low'; values between 1.81 and 2.60 as 'low'; values between 2.61 and 3.40 as 'medium'; values between 3.41 and 4.20 as 'high' and values between 4.21 and 5.00 as 'very high' (Kutu & Sözbilir, 2011). During the analysis of open-ended questions, content analysis was performed and codes were created. Categories were obtained by grouping similar codes. During the semi-structured interview, the answers were obtained by video recording and codes and categories were created through content analysis.

To give more detail about the analysis process, qualitative data analysis was conducted jointly by the researchers. Issues that could lead to disagreements were evaluated jointly by the researchers, and a consensus was reached. This effort was made to increase inter-rater reliability.

During the analysis of the open-ended questions, each participant's responses were individually examined to extract key words. Findings with similar meanings were combined to create codes. The sub-dimensions encompassing the Likert items were considered when creating the codes, and the findings obtained from the data were also intended to support the Likert item data. Categories were created based on the generated codes, and the opinions related to the codes within these categories were analyzed and quantified. Video recordings were taken during the semi-structured interviews with the students. During the analysis, the video recordings were reviewed in detail, and students' sentences were extracted one by one. Then, similar opinions were combined based on student feedback. During this process, codes were first created, and categories were then created based on the codes. The codes and categories were found to be consistent with the open-ended questions and the sub-dimensions of the Likert-type items.

Results

The results of the study were evaluated respectively according to the research questions.

Findings of the First Research Question

Within the scope of the first research question, expert opinions on the 'Nervous System' material were examined. The findings obtained as a result of the analyzes are shown in Table 1.

Table 1. Findings Regarding the Evaluation of 'Nervous System' Material

Sub-dimensions in Form	$\bar{x}$	sd
Suitability of the material in terms of design	4.41	0.58
Contribution of the material to the lesson/teaching	4.37	0.60
Compatibility of the content of the material with the 5E model	4.36	0.53
Contribution of the material to the teacher	4.32	0.67
Contribution of the material to the students	4.30	0.67
Values of the Overall Material	4.35	0.55

When Table 1 is examined, it is seen that the lowest value is 'Contribution of the material to the teacher' and the highest value is 'Suitability of the material in terms of design'. The general arithmetic

mean of the material was calculated as 4.35. Accordingly, it can be said that the arithmetic mean value for each sub-dimension in the form is close to each other and at a high level.

Findings of the Second Research Question

Within the scope of the second research question, expert opinions on the 'Endocrine Glands' material were examined. The findings obtained as a result of the analyzes are shown in Table 2.

Table 2. Findings Regarding the Evaluation of 'Endocrine Glands' Material

Sub-dimensions in Form	$\bar{x}$	sd
Suitability of the material in terms of design	4.41	0.58
Contribution of the material to the lesson/teaching	4.37	0.61
Compatibility of the content of the material with the 5E model	4.35	0.52
Contribution of the material to the teacher	4.28	0.74
Contribution of the material to the students	4.26	0.72
Values of the Overall Material	4.34	0.56

When Table 2 is examined, it is seen that the lowest value is 'Contribution of the material to the students' and the highest value is 'Suitability of the material in terms of design'. The general arithmetic mean of the material was calculated as 4.34. Accordingly, it can be said that the arithmetic mean value for each sub-dimension in the form is close to each other and at a high level.

Findings of the Third Research Question

Within the scope of the third research question, expert opinions on the 'Sense Organs' material were examined. The findings obtained as a result of the analyzes are shown in Table 3.

Table 3. Findings Regarding the Evaluation of 'Sense Organs' Material

Sub-dimensions in Form	$\bar{x}$	sd
Suitability of the material in terms of design	4.42	0.58
Contribution of the material to the lesson/teaching	4.41	0.60
Compatibility of the content of the material with the 5E model	4.36	0.55
Contribution of the material to the teacher	4.33	0.67
Contribution of the material to the students	4.32	0.66
Values of the Overall Material	4.37	0.56

When Table 3 is examined, it is seen that the lowest value is 'Contribution of the material to the students' and the highest value is 'Suitability of the material in terms of design'. The general arithmetic mean of the material was calculated as 4.37. Accordingly, it can be said that the arithmetic mean value for each sub-dimension in the form is close to each other and at a high level.

Content analysis of the open-ended questions in the '5E Model Material Evaluation Form' was conducted. First the codes were extracted, then the codes were classified and categories were created. The categories are named as 'positive opinions (Table 4)', 'negative opinions (Table 5)' and 'suggestions (Table 6)'.

Table 4. Analysis of Expert Opinions in the "Positive Opinions" Category

Codes	Number of opinions	Sample expressions
Contributions to students	47	"Interest and curiosity in the course increase. Group work enhances communication." "It provides students with the opportunity to compare the information they learn with daily life." "It provides the ability to express themselves."
Contributions to teacher	4	"It allows students to highlight their skills." "I think it has many advantages for teachers, especially in terms of effective time management and planning." "Its benefit to teachers is the opportunity to assess students individually."
Contribution to the lesson/teaching	60	"Students become more active. They learn by trying things out. It provides more lasting learning." "It provides concrete experiences and ensures lasting learning. It also helps students learn by doing and experiencing by keeping them active throughout the process." "It makes learning easier and more fun." "It makes the lesson more structured. It makes students active, not passive."
Content and design of the material	31	"Visualizes" "Material richness" "Appeals to the five senses with a constructivist approach" "Enables the course to appeal to different senses."

When the findings belonging to the '**positive opinions**' category in Table 4 are examined, it is seen that 47 experts stated that the material contributed positively to the students. These contributions are; attracting students' interest in the lesson, arousing curiosity, associating their knowledge with daily life, enabling students to activate knowledge, increasing communication, expressing themselves, discovering information, thinking creatively, and thinking multi-dimensionally. Considering the content analysis findings, all 4 experts stated that the material would contribute positively to the teacher. These contributions are; helping the teacher in assessment and evaluation, being a guide, helping the teacher to use the time effectively, and making it easier to understand the student's prior knowledge. According to the content analysis findings, 60 experts stated that the material contributed positively to the lesson and teaching. These contributions are; learning by doing, regular learning, permanent learning, rich learning, drawing attention to the lesson, social learning, motivation to the lesson, meaningful learning, peer education, activating the lesson, motivating the lesson, facilitating learning, concretizing, making learning fun. 31 experts stated that the content and design of the material contributed positively. These experts stated that the activities included in the material are rich and versatile, the visuals are interesting, the students' prior knowledge can be revealed with the activities in the material, and they will make the subject more understandable.

Table 5 showed the analysis of expert opinions in the "negative opinions" category.

Table 5. Analysis of Expert Opinions in the "Negative Opinions" Category

Codes	Number of opinions	Sample expressions
Lack of time	31	"Time constraints" "It requires a long time to implement. Current curricula don't allow for this." "It can cause the outcomes to exceed the timeframe. Involving each student in the process and ensuring active experiences can sometimes create time constraints."
Teacher sourced	12	"Negativity can occur if not implemented correctly." "Classroom management can become difficult." "Classroom management can become difficult when providing classroom interactions." "It requires a lot of effort on the part of the teacher."
Student sourced	16	"There may be some who cannot express their opinions freely because decisions are made as a group." "There is a dependency on class size." "It can accustom students to being present."
Material sourced	15	"Because too many arguments are included, students become less selective in their knowledge over time." "There may be a tendency toward formulaic knowledge. Some information may be insufficient to question." "There is a question in the first material of the 5E model. Is the figure a face or an old mo? In old mo, a person, this figure, and this question form can be removed from the material. Other than that, there are no negative aspects." "Instead of filling in the blanks, more emphasis can be placed on diagrams like concept networks and fishbones."
No negative characteristics	16	"I would like to point out that I didn't see any downsides." "I couldn't find any downsides."

The opinion of 31 experts on the category of '**negative opinions**' is about the lack of time. According to the opinion of 12 experts, negative effects may be caused by the teacher. Experts stated that these negativities are due to reasons such as application error, classroom management, and the increase in the workload of the teacher. 16 experts stated that negativities may be caused by students. These negativities may be due to reasons such as the crowded classroom size, the material accustoming the students to the readiness, and the fact that the materials will limit the students. 15 experts stated that there may be material-related negativities. According to expert opinions, there are visual deficiencies, there are too many questions and there are negativities. Finally, 16 experts did not state any negative statements about the materials.

Table 6 showed the analysis of expert opinions in the "negative opinions" category.

Table 6. Analysis of Expert Opinions in the "Suggestions" Category

Codes	Number of opinions	Sample expressions
For the teacher	4	"It is also important that the teacher who will use the materials in the classroom can use them effectively."
For the material	9	"It should be easy to understand." "It would be better to determine and write down the teacher's presentation and content in advance during the explanation stages for each material." "The evaluation phase for the three materials could be expanded to include multiple choice, fill-in-the-blank, and other forms."
For the course	11	"It would be more effective if planned with class hours in mind." "The questions related to the activities were repeated in several steps. This could cause students to become bored and lose interest in the lesson."

When the opinions received from the experts regarding the '**Suggestions**' category are examined, it is seen that 50 participants did not feel the need to offer any suggestions. 4 of the remaining participants stated suggestions for the teacher. 9 experts made suggestions about the material itself. Finally, 11 experts made recommendations for the course.

After all the expert opinions received, the data were evaluated and the materials were finalized by making corrections on the materials. The students were given detailed information about the purpose and use of the materials, which were corrected and finalized after expert opinions, and then the students were asked to examine the materials.

Findings of the Fourth Research Question

Within the scope of the fourth research question, the students' opinions on the materials prepared according to the 5E Model were received. Content analysis was applied to the data collected from the students through semi-structured interviews. Categories and codes were created. The categories created are 'positive views' and 'negative opinions'. The codes were created in accordance with the sub-dimensions in the material evaluation form. Table 7 shows the analysis of students' opinions in the "positive opinions" category.

Table 7. Analysis of Students' Opinions in the "Positive Opinions" Category

Codes	Number of opinions	Sample expressions
Contributions to students	8	"It strengthens friendships." "It can foster empathy and communication with each other through group work."
Contribution to the lesson/teach.	28	"The materials cover the subject thoroughly." "The materials allow us to learn more about the subject and learn it faster. Learning is permanent, and the material stays in our memory longer." "They allow us to listen more and focus more."

Content and design of the material	55	"The questions, activities, and visuals spark curiosity." "The materials are sufficient to explain the topic." "The visuals are engaging." "They enable group work." "The design is very effective."

As a result of the content analysis, 8 opinions were reported about the contribution of the material to the student when the findings about the '**positive opinions**' category were examined. These views are that the students' communication skills increase and they can empathize with each other and towards the living things and events in the outside world. There are 28 opinions about the contribution of the material to teaching and the course. These views are in the form of permanent learning, arousing enthusiasm for the lesson, fast learning, endearing the lesson, attracting interest, and arousing curiosity, and easy learning. Finally, 55 opinions on the code related to the content and design of the material were found. When these views are evaluated in general, it is seen that the material is related to the ability to teach the subject, the visuals and content of the material.

Table 8 showed the analysis of students' opinions in the "negative opinions" category.

Table 8. Analysis of Students' Opinions in the "Negative Opinions" Category

Codes	Number of opinions	Sample expressions
No negative characteristics	11	"There are no disadvantages."
Contact	1	"Disagreements may arise in group work."
Question length	2	"The length of the questions makes it difficult."

Regarding the '**negative opinions**' category, 11 students could not find any negative aspects about the material. 1 student stated that there would be a disagreement in group work. 2 students stated that the questions were long.

Discussion, Conclusion and Suggestions

When the findings obtained from the material evaluation form in the study are examined, it is seen that the scores obtained from the expert opinions about the three materials are very close to each other and they agree with the Likert type statements. According to this result, it can be said that the materials were prepared in accordance with their purpose.

When the findings of the sub-dimensions in which the materials are evaluated are examined, it is seen that there is a similar situation and there are findings showing positive opinions about the materials being prepared in accordance with the 5E Model. The findings of the sub-dimension of the content of the material revealed that the content of the material was quite effective and appropriate.

According to expert opinions, the activities designed and the items used in all three materials can attract the attention of the students. In addition to attracting their attention, these activities are suitable for arousing curiosity about the lesson and the subject, for thinking and thus revealing their prior knowledge. The activities in the explore step are designed in such a way that they can experience, observe, and discover information. Students will actively participate in the process during these activities. The activities and explanations in the explain step were designed by the teacher in a way to complete the missing information of the students and correct their erroneous information and misconceptions. In the activities designed in the explain step, the teacher is at the forefront. In the elaborate step, activities including homework presentations, puzzles, and concept maps were designed to deepen the acquired knowledge and enable them to use this knowledge in new situations. The evaluate step is the last step. At this stage, activities for the evaluation of the teaching process were designed and the extent to which the students structured the knowledge was also measured. As a result, the content of the material prepared with the 5E Model was prepared in accordance with the model. This result shows that the material will be effective in the teaching process. With the activities in the materials, students get opportunities such as experimenting and observing, doing group work, and exploring. When the studies on the 5E Model in the literature are examined, similar findings are reached. For example, Bıyıklı and Yağcı (2014) stated that students formed hypotheses and were able to test these hypotheses while teaching the lessons with the 5E model. Özbudak Kılıçlı and Özkan (2017), on the other hand, stated that students discovered information in activities conducted with materials based on the 5E model. When these sample studies are examined, it is seen that they coincide with the findings of this study.

Considering the findings of the suitability of the materials in terms of design, it is seen that all the values of this sub-dimension are at a very high level. This gives the result that the design of the material is suitable for the course and teaching. It is seen that the design elements such as images, color harmony, font size in the material are quite understandable and interesting. In the first design phase of the materials, some deficiencies were observed in this regard and these deficiencies were completed after expert opinions. For this, the visuals were increased, they were made more relevant and understandable, so the materials took their final form. The design of the material is just as important as its content. One of the most important qualities that attract students' interest in the course and material is design. As a matter of fact, Nikolou et al. (1998) stated that the visual materials they prepared on the subject of "Plant Cell" provided a teaching environment that did not limit students and got positive results from the materials.

In the findings regarding the contribution of the materials to the course and teaching, it was concluded that the materials would be productive and useful for the teaching process. The activities designed in the material are suitable for the learning outcomes in the curriculum, are capable of embodying abstract concepts and attracting students' attention to the lesson. Maier (2002) stated that thanks to the materials, students' interest in the lesson increased. Boddy et al. (2003) stated that the materials made the lesson more fun. When the findings are examined, it is seen that the designed materials have the qualities specified in these studies.

Another important quality of the material is the contribution to the teacher and the student. The designed materials should contribute to both the teacher and the student throughout the teaching process. Duman (2013) and Karamustafaoğlu (2006) emphasized the importance of this in their research and said that the materials should be a guide for teachers and students. When the findings related to these sub-dimensions are examined, it is seen that these are also quite high. This situation leads us to the conclusion that the material also contributes to students and teachers, just like in other sub-dimensions. When the findings were examined, it was concluded that thanks to the materials, the teachers could easily get feedback, plan the lesson, and make assessment and evaluation in the process. There are instructions in the materials and these instructions are a guide for both teachers and students. Expert opinions also support this result. It is thought that students can work collaboratively thanks to the activities. Learning can take place more effectively as a result of working in cooperation. At the same time, affective skills such as communication, self-expression, and higher motivation in the lesson can

also develop. In addition to these, the prepared materials can provide teaching by putting the students at the center of the teaching process, by removing the students from memorization, and by doing-living. Thanks to the materials, it is expected that the student's interest in the lesson will increase. In addition, the designed activities were prepared for students to reinforce the subject. It can be said that the findings obtained as a result of expert and student opinions are quite high and positive in terms of the applicability and effectiveness of the materials. These results are in line with the studies in the literature. For example, Çolak Seymen (2019) stated that students structure their knowledge and actively participate in the learning process in learning environments where materials designed based on the 5E Model are used. Özbudak Kılıçlı and Özkan (2017), on the other hand, concluded that the materials prepared with 5E contributed to the students' use of their knowledge and skills and stated that the materials increased the curiosity of the students.

As a result, it was concluded that the findings obtained from the Likert type questions in the study were quite positive in general and sub-dimensions of the material, appropriate in many respects, and would be effective for the teaching process. However, in addition to all the positive results, there were also some disadvantages between expert and student opinions. For example, it has been concluded that there are opinions that it may be difficult to apply in crowded classrooms, that there may be problems in classroom management, and that if it is not applied correctly, it will not be able to reach the time in the curriculum. In the literature, Erdoğru (2011) emphasized the importance of these points in his research and suggested that teachers should be given in-service training on the 5E model so that there would be no negativity. In the light of the findings obtained in this study, it is recommended to consider the following points:

1. The materials can be applied in the course and their effects on the teaching process can be investigated through certain variables.
2. Teachers can be informed about the subject by giving an in-service training on the 5E model.
3. Materials with similar qualities can be prepared for different subjects at different grade levels including biology.

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EXTENDED SUMMARY

Bir toplumun gelişiminin mihenk taşı eğitimdir. Eğitim sürecinin etkili ve verimli bir şekilde yürütülmesinde ders öğretim süreci önemli bir rol oynar. Bununla beraber öğretim sürecini etkileyen çeşitli faktörler bulunmaktadır. Bu faktörler arasında önemli olanlardan biri şüphesiz öğretim materyalleridir. Paykoç (1991)' göre öğretim materyalleri öğrencilere bilgi, beceri, değer ve tutumlar kazandırmak amacıyla başvurulan ve bu süreçte kullanılan önemli temel kaynak veya araçlar olarak tanımlanmaktadır. Çam Aktaş (2014) ise öğretim materyallerini öğrenciler için dersi daha zevkli hale getiren, öğretimde kalıcılığı artırarak öğrenciler öğrenmeyi kolaylaştıran materyaller olarak tanımlamıştır.

Soyut kavramların sıklıkla yer aldığı fen bilimleri derslerinde kavramların somut hale getirilerek öğrencilerin öğrenmelerinin kolaylaştırılması ve başarı düzeylerinin artırılmasında öğretim materyalleri etkili araçlardır. Zira materyaller öğretim sürecinde öğretmene rehber olma ve derslerini daha planlı bir şekilde yürütmesinde faydalı olabilmektedir. Elbette bu süreçte materyalin kullanımı kadar uygun materyal seçimi de önemli bir faktördür. Uygun materyallerin kullanımı öğrenme ortamının etkili bir şekilde hazırlanmasını olanaklı kıldığı gibi öğrencilerin daha kolay bir şekilde hedeflere ulaşmasında ve öğretim programının başarılı yürütülmesinde destekleyici olmaktadır (Fidan, 2008; Gul ve Yalinkilic, 2025; İnal ve Çakır, 2021; Sönmez, 2005). Kullanılan materyallerin belli niteliklere sahip olması da materyal seçiminde önemli bir husustur. Örneğin, materyallerin içerik açısından öğretim programında belirtilen kazanımlara, öğrencinin yaşı veya hazır bulunuşluk düzeyine uygun olmalıdır (Bozpolat ve Arslan, 2018).

Öğretim materyalinin seçiminde öğretim programında benimsenen yaklaşım ve öğrenme modelleri de dikkate alınmalıdır. Türkiye'de fen bilimleri öğretim programı yapılandırmacı yaklaşım temel alınarak hazırlanmıştır. Yapılandırmacı yaklaşımın son yıllarda yaygınlaşmasının nedeni, öğrencinin motivasyonunun ve entelektüel becerilerinin gelişimini destekleyerek etkili bir öğretim ortamı sunmasıdır (Body, Watson ve Aubusson, 2003). Bu yaklaşım, özellikle fen öğretiminde müfredat geliştirme, yanlış anlamaların belirlenmesi ve giderilmesi, ölçme ve değerlendirme gibi konularda yeni yaklaşımlar getirmiştir (Akdeniz ve Keser, 2002; Driver, 1988; Ma vd., 2025). Yapılandırmacı yaklaşıma dayalı öğrenme ortamlarında, öğrencilerin öğrenme sürecine aktif olarak katıldıkları, araştırarak ve sorgulayarak bilgiye ulaştıkları ve ulaştıkları yeni bilgileri önceki yaşamlarıyla ilişkilendirdikleri görülmektedir. Bu süreçte öğretmen, öğrenciye rehberlik etmektedir (Adigun, Mpofu ve Maphalala, 2025; Demiralp, 2007; Shunk, 1996; Şaşmaz Ören ve Ormancı, 2012).

Yapılandırmacı yaklaşıma dayalı çeşitli öğretim modelleri mevcuttur. Bu modeller içinde en popüler olanlardan biri 5E modelidir (Huang vd., 2025; Keser, 2003; Wilder & Shuttleworth, 2005). 5E

modeli adını İngilizce isimlerinin baş harflerinden alan, öğrencilerde merak uyandıran, araştırma yapmaya teşvik edici çeşitli etkinlikler içeren beş basamaktan oluşmaktadır (Aksoy & Gürbüz, 2013). Bu basamaklar şu şekilde sıralanır: (1) engage (girme), (2) explore (keşfetme), (3) explain, (4) evaluate (derinleştirme), (5) evaluate (değerlendirme). Alan yazın incelendiğinde 5E modelinin öğretim süreci için oldukça etkili olduğu görülmektedir. Diğer taraftan 'Denetleme ve Düzenleyici Sistemler' ile 'Duyu Organları' konularının da öğrenciler tarafından oldukça zor anlaşıldığı ve öğrenme güçlüğü çekildiği bilinmektedir (Gül, 2020; Güneş ve Güneş, 2005; Yıldız, Şimşek ve Ağdaş, 2017). Dolayısıyla bu konuların öğretiminde 5E modeline dayalı materyaller kullanmak başarıya ulaşmada etkili olabilir. Buradan hareketle çalışmada 5E modeline dayalı öğretim materyaller tasarlanarak uzman ve öğrenci görüşleri doğrultusunda değerlendirilmiştir.

Çalışma genel çerçevede ele alındığında nitel araştırma yaklaşımına dayalıdır. Çalışma grubunu 76 katılımcı oluşturmaktadır. Söz konusu katılımcıların bir kısmı fen bilimleri ve biyoloji eğitimi alanında çalışan akademisyenler, öğretmenler, lisansüstü öğrencilerden (14 akademisyen, 38 öğretmen, 10 lisansüstü öğrenci) oluşmaktadır. Ayrıca uzman katılımcı görüşleri sonrası düzeltilen materyaller hakkında da görüşlerine baş vurulmak üzere yedinci ve sekizinci sınıflarda öğrenim gören 14 öğrenci de çalışma grubuna dâhil edilmiştir.

Çalışmada veri toplama aracı olarak araştırmacılar tarafından geliştirilen '5E Model Materyal Değerlendirme Formu' ve 'Yarı Yapılandırılmış Görüşme Formu'ndan yararlanılmıştır. Veri toplama araçlarının geliştirilmesi sürecinde alan yazından yararlanılmış (Bilgican, 2017; Büyükkol Köse, 2019), gerekli geçerlik ve güvenirlik süreçlerine dikkat edilmiştir. Öğretim materyalleri 'Sinir Sistemi', 'Endokrin Bezleri' ve 'Duyu Organları' olmak üzere üç farklı konu için ayrı ayrı tasarlanmıştır. Öğretim materyalleri 5E modelinin basamakları ve amaçları doğrultusunda, öğrencilerin sınıf düzeyi ve hazır bulunuşlukları dikkate alınarak hazırlanmıştır. Buna göre:

- Girme basamağındaki etkinlikler tasarlanırken, basamak amacına uygun olarak öğrencilerin dikkatini derse ve konuya çekmek ve ön bilgilerini ortaya çıkarmak amaçlanmıştır.
- Keşfetme basamağındaki etkinlikler tasarlanırken, öğrencilerin verilen problemlere çözüm üretebilmeleri ve bu esnada istenilen bilgiye ulaşabilmeleri amaçlanmıştır.
- Açıklama basamağı etkinliklerinde, öğrenciye eksik ve yanlış bilgiler de açıklanmış, ulaşılan bilginin düzeyi sorgulanmıştır.
- Derinleştirme basamağında, öğrencilerin problemi çözerken oluşturdukları yeni bilgi ile eski bilgilerini bir arada kullanmalarına dikkat edilmiştir.
- Değerlendirme basamağındaki etkinliklerde, öğrencilerin verilecek bilgiyi ne ölçüde öğrendikleri konusunda bir değerlendirme yapılmıştır.

Uygulamalar sonrası toplanan nicel veriler betimsel analize tabi tutulurken, nitel veriler içerik analizi ile çözümlenmiştir. Materyallerin çeşitli alt boyutlara göre değerlendirilmiştir (içerik, tasarım, derse ve öğretime katkı, öğretmene ve öğrenciye katkı). Bulgular alt boyutlarda genel olarak benzer sonuçlara ulaşıldığını ve olumlu yönde görüşlerin olduğunu ortaya koymuştur. Materyalin içeriği alt boyutu ile ilgili olarak; içeriğin oldukça etkili ve 5E modeline uygun tasarlandığı, öğrencinin ilgisini çekebilecek nitelikte olduğu, düşünme becerilerini geliştirdiği ve ön bilgilerini ortaya çıkarmaya yönelik etkinlikleri barındırdığı uzman görüşleri doğrultusunda tespit edilmiştir. Buna göre materyallerin öğretim sürecinde başarıyı yakalama adına etkili bir şekilde kullanılabileceği sonucuna ulaşılmıştır.

Materyalin tasarım özelliklerine yönelik bulgular incelendiğinde; olumlu görüşlerin oldukça yüksek düzeyde olduğu belirlenmiştir. Buna göre materyalin tasarım özellikleri açısından fen bilimleri dersine ait ilgili konuların öğretimine uygun olduğu görülmüştür. Özellikle materyallerde yer alan görseller, renklerin uyumu, yazı tipi ve boyutu gibi özellikler oldukça beğenilmiştir. Ancak bu olumlu özellikler yanında bir takım eksiklikler de az da olsa belirtilmiştir. Ancak uzman görüşleri doğrultusunda bu eksiklikler olabildiğince düzeltilmeye çalışılmıştır.

Materyallerin derse ve öğretime katkısına yönelik elde edilen bulgulara bakıldığında, öğretim süreci için oldukça yararlı olduğu uzman görüşleri doğrultusunda tespit edilmiştir. Uzman görüşlerine göre materyalin içerdiği etkinlikler öğretim programındaki kazanımlarla uyum içindedir. Bulgulara

göre uzman görüşleri materyallerin öğrenciler ve öğretmenler için de yararlı olduğunu düşündürmüştür. Söz konusu görüşler incelendiğinde öğretmenlerin materyaller sayesinde kolayca geri bildirim alabildiği, dersi planlayabildiği, süreçte ölçme ve değerlendirme yapabildiği ifade edilmiştir.

Çalışmada ulaşılan bulgular genel olarak değerlendirildiğinde 5E modeline uygun hazırlanan öğretim materyallerinin birçok bakımdan uygun olduğu ve öğretim sürecinde kullanıldığında etkili sonuçlar vereceği sonucuna varılmıştır. Ancak tüm olumlu sonuçların yanında uzman ve öğrenci görüşleri arasında bazı olumsuzluklar da bulunmuştur. Örneğin kalabalık sınıflarda uygulanmasının zor olabileceği, sınıf yönetiminde sıkıntılar yaşanabileceği, doğru uygulanmadığı takdirde müfredatta yer alan zamana yetişemeyeceği yönünde görüşlerin olduğu sonucuna varılmıştır. Literatürde Erdoğru (2011) araştırmasında bu noktaların önemine vurgu yaparak herhangi bir olumsuzluk yaşanmaması için öğretmenlere 5E modeli konusunda hizmet içi eğitim verilmesini önermiştir. Bu çalışmada elde edilen bulgular ışığında aşağıdaki hususların dikkate alınması önerilmektedir:

1. Derste materyaller uygulanabilir ve öğretim sürecine etkileri belirli değişkenler üzerinden araştırılabilir.

2. Öğretmenlere 5E modeli hakkında hizmet içi eğitim verilerek konu hakkında bilgi verilebilir.

3. Biyoloji de dâhil olmak üzere farklı sınıf seviyelerinde farklı dersler için benzer niteliklere sahip materyaller hazırlanabilir.

Appendix 1
5E Model Material Evaluation Form

5E Modeline Uygun Öğretim Materyalleri Değerlendirme Formu

Demografik Bilgiler

Aşağıda size uygun olan şıkkı işaretleyiniz.

O Lisans öğrencisi (Fen Bilgisi Eğitimi) **O** Lisans öğrencisi (Biyoloji Eğitimi)

O Akademisyen **O** Fen Bilgisi öğretmeni **O** Biyoloji öğretmeni

Bulunduğu İl

.....

Kurum Adı:

.....

Materyal Değerlendirme Formu

*İncelediğiniz her bir materyali aşağıdaki kriterlere göre 1 **ile 5** puan aralığında değerlendiriniz.*

Materyal I: Sinir Sistemi **Materyal II:** İç Salgı Sistemi **Materyal III:** Duyu Organları	**Materyal I**	**Materyal II**	**Materyal III**
Materyalin İçeriğinin 5E Modeline Uygunluğu			
1. Girme basamağında yer alan etkinlikler öğrencinin konuya dikkatini çekmektedir.			
2. Girme basamağındaki yer alan etkinlikler öğrencilerin ön bilgilerinin farkına varmasına yardımcı olmaktadır.			
3. Keşfetme basamağında yer alan etkinlikler öğrencilere kendi bilgilerini deneme, gözlem yapma, deneyim kazanma ve bilgiyi keşfetme imkânı sağlamaktadır.			
4. Keşfetme basamağı öğrencilerin işbirlikli çalışmalarına fırsat vermektedir.			
5. Açıklama basamağında yer alan etkinlikler öğretmenin öğrencilere konu hakkında açıklamalar yaparak, sunulan bilgileri tekrar etmesine imkân sağlamaktadır.			
6. Açıklama basamağında sorulan sorular öğrencilerin kavramı öğrenme düzeylerini yoklamaya ve sınıfta tartışma ortamı oluşturmaya uygundur.			
7. Derinleştirme basamağında yer alan etkinlikler sayesinde öğrenilen bilgiler diğer disiplinlerle veya kavramlarla ilişkilendirilerek yeni durumlara uygulanır.			
8. Derinleştirme basamağındaki etkinlikler öğrencilerin kavramsal anlama yeteneklerini geliştirmeye yardımcı olmaktadır.			
9. Değerlendirme basamağında yer alan etkinliklerle öğrenciler ilk dört basamaktaki bilgilerini değerlendirerek bilginin farkına varırlar.			
10. Değerlendirme basamağında yer alan etkinlikler öğrencilere, öğrendikleri yeni bilgileri daha önceden karşılaşmamış oldukları durumlara transfer etme imkânı sunmaktadır.			
Materyalin Tasarım Açısından Uygunluğu			
11. Materyalde kullanılan renkler abartısız ve uyumlu olup öğrencilerin ilgilerini çekecek niteliktedir.			
12. Materyalde vurgulanması gereken yerlerde resim, renk, işaret vb. öğeler kullanılmıştır.			
13. Materyalde kullanılan görseller net ve anlaşılırdır.			
14. Materyalde kullanılan görseller öğrenci seviyesine uygundur.			
15. Materyalde kullanılan görseller ilgi çekicidir.			
16. Materyalde kullanılan görseller konuyla bir bütünlük içerisindedir.			
17. Materyalde kullanılan görseller konuyu anlamaya yardımcı olur.			

Appendix 1 (Devamı)

18. Materyalde kullanılan dil öğrenci seviyesine uygun, açık ve anlaşılırdır.			
19. Materyalde kullanılan metinler punto, yazı tipi vb. açısından uygun ve okunaklı yazılmıştır.			
Materyalin Derse/Öğretime Katkısı			
20. Materyalde kullanılan etkinlikler öğretim programındaki kazanımlara uygundur.			
21. Materyalde kullanılan etkinlikler derse olan ilgiyi artırmaya katkı sağlar.			
22. Materyalde kullanılan etkinlikler konuyla ilgili soyut kavramları somutlaştırır.			
23. Materyalde kullanılan etkinlikler dersi daha verimli hale getirir.			
24. Materyalde kullanılan etkinlikler/sorular bilimsel konularda sınıfta tartışma ortamı sağlar.			
25. Materyal sayesinde ders daha düzenli ve planlı bir şekilde işlenebilir.			
26. Materyal zengin öğrenme yaşantıları sunar.			
27. Materyal gerçek yaşamdan olaylarla öğrenmeyi sağlar.			
28. Materyal öğretmen ve öğrenciler için aktif bir sınıf ortamı sağlar.			
29. Materyal sınıf içi iletişimi arttırır.			
30. Materyalde kullanılan etkinlikler, öğretim programının öngördüğü sürede uygulanabilir.			
Materyalin Öğretmene Katkısı			
31. Materyal öğretmenin öğrencilerden dönüt almasını kolaylaştırır.			
32. Materyal etkili bir biçimde ölçme-değerlendirme yapmaya imkân sağlar.			
33. Materyal, öğretmene belli bir plan dahilinde öğretim yaparak zamanı etkili kullanmasına kılavuzluk eder.			
34. Materyal, öğretmenin dersi planlı yürütmesine yardımcı olur.			
35. Materyal öğretmen için derste kullanabileceği yardımcı bir araç rolü üstlenir.			
36. Materyal içerdiği farklı aktiviteler sayesinde öğretmenin dersi daha etkili yürütmesine imkân sağlar.			
Materyalin Öğrenciye Katkısı			
37. Materyal öğrencilerin derse aktif katılımını sağlar.			
38. Materyal öğrencilerin derse ve konuya karşı ilgi ve merakını arttırır.			
39. Materyal öğrencinin ön bilgilerini ortaya çıkarmaya yardımcı olur.			
40. Materyal öğrenciler arasındaki iletişimi güçlendirir.			
41. Materyal öğrencilerin bilgiye kendilerinin ulaşmasına yardımcı olur.			
42. Materyal öğrencilerin grup çalışması yapmasını destekler.			
43. Materyal öğrencilerin özgün bir ürün ortaya koyabilmesini sağlar.			
44. Materyal öğrencilerin konuyu pekiştirmesine yardımcı olur.			
45. Materyal öğrencilere öğrendikleri bilgileri günlük hayatlarında kullanmalarına yardımcı olur.			
46. Materyal öğrenciyi ezberden uzaklaştırabilir.			
47. Materyal öğrenciye yaparak yaşayarak öğrenme fırsatı sağlar.			

AÇIK UÇLU SORULAR

1) 5E Modeli' ne göre hazırlanan materyalleri dersinizde kullanmak ister misiniz?

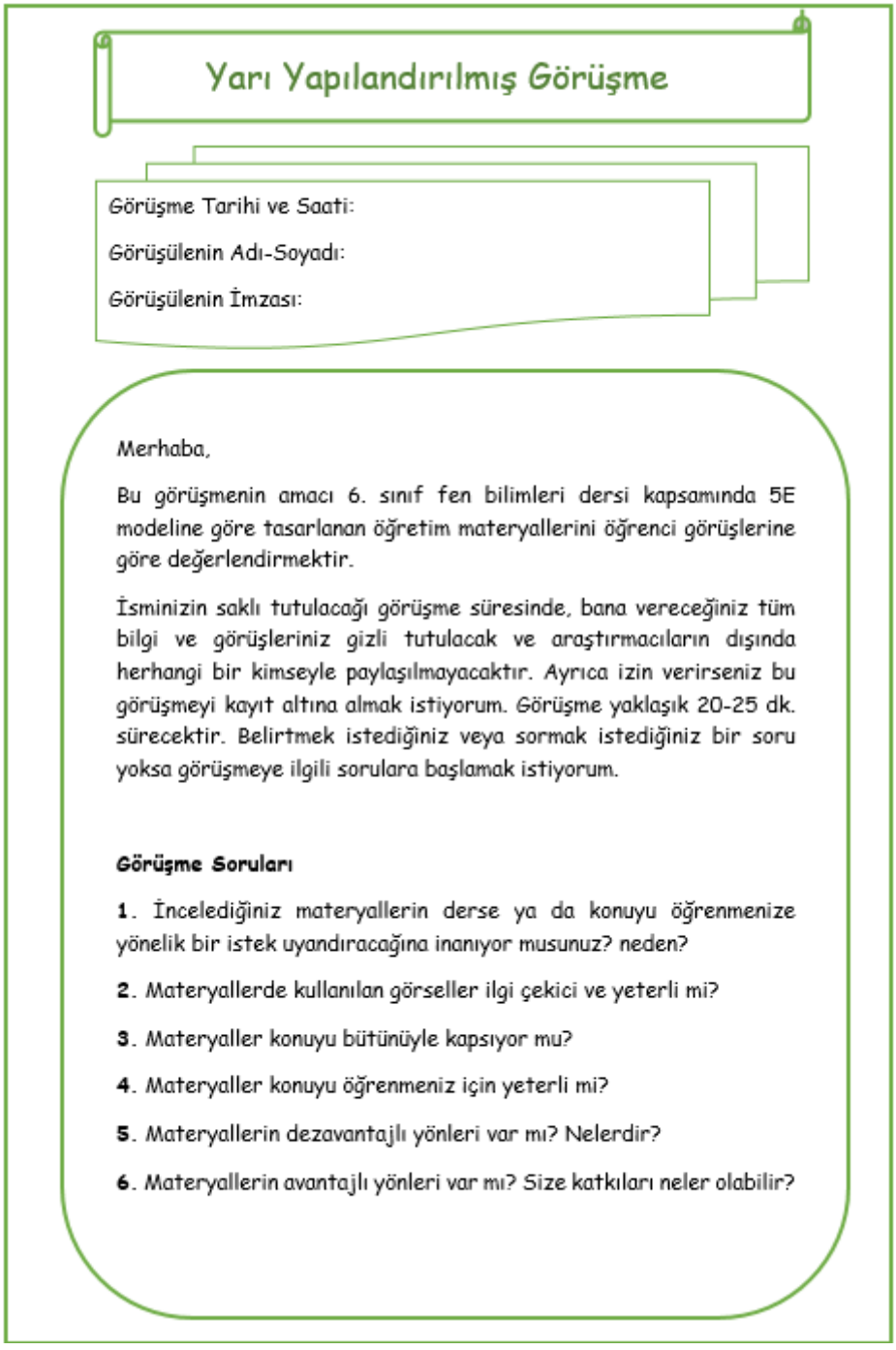
2) 5E Modeli' ne göre hazırlanan öğretim materyallerinin avantajları nelerdir? Bu materyalleri kullanmak dersinize hangi yönlerden katkı sağlar?

3) 5E Modeli' ne göre hazırlanan öğretim materyallerinin olumsuz yönleri nelerdir?

4) Değerlendirdiğiniz öğretim materyalleri ile ilgili eklemek istediğiniz varsa belirtiniz.

Appendix 2

Semi-Structured Interview Form



Yarı Yapılandırılmış Görüşme

Görüşme Tarihi ve Saati:

Görüşülenin Adı-Soyadı:

Görüşülenin İmzası:

Merhaba,

Bu görüşmenin amacı 6. sınıf fen bilimleri dersi kapsamında 5E modeline göre tasarlanan öğretim materyallerini öğrenci görüşlerine göre değerlendirmektir.

İsminizin saklı tutulacağı görüşme süresinde, bana vereceğiniz tüm bilgi ve görüşleriniz gizli tutulacak ve araştırmacıların dışında herhangi bir kimseyle paylaşılmayacaktır. Ayrıca izin verirseniz bu görüşmeyi kayıt altına almak istiyorum. Görüşme yaklaşık 20-25 dk. sürecektir. Belirtmek istediğiniz veya sormak istediğiniz bir soru yoksa görüşmeye ilgili sorulara başlamak istiyorum.

Görüşme Soruları

1. İncelediğiniz materyallerin derse ya da konuyu öğrenmenize yönelik bir istek uyandıracağına inanıyor musunuz? neden?
2. Materyallerde kullanılan görseller ilgi çekici ve yeterli mi?
3. Materyaller konuyu bütünüyle kapsıyor mu?
4. Materyaller konuyu öğrenmeniz için yeterli mi?
5. Materyallerin dezavantajlı yönleri var mı? Nelerdir?
6. Materyallerin avantajlı yönleri var mı? Size katkıları neler olabilir?