



Development of REACT Strategy Materials for 6th Graders¹

(Research Article)

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Abstract

The aim of this study is to develop the REACT strategy instructional materials for 6th graders. The materials were prepared for the 'Supervisory and Regulatory Systems' and 'Sensory Organs' topics in the sixth grade science course. In this study, the materials were also evaluated with the opinions of experts and students. The study group consisted of a total of 76 participants from different backgrounds (academicians, teachers, graduate students, seventh and eighth grade students). The study, while incorporating both quantitative and qualitative data, is primarily structured around a qualitative research design, with quantitative data analyzed descriptively and qualitative data examined through content analysis. The data were collected through REACT strategy material evaluation form and semi-structured interviews. In the analysis of quantitative data, descriptive statistics such as arithmetic mean and standard deviation values were calculated. Content analysis was performed in the analysis of qualitative data. According to the findings, it was found that the materials were suitable for use in terms of content and design, and that they would be useful to teachers and students in the teaching process. Additionally, some deficiencies were expressed by the participants. However, considering the deficiencies and suggestions stated in the findings, changes were made to the materials and the materials were finalized.

Keywords: Instructional materials, REACT Strategy, Sense Organs, Supervisory and Regulatory Systems

INTRODUCTION

In recent years, highly innovative research has been conducted in the field of education in Türkiye, with the aim of enhancing the quality of teaching and learning. In this direction, curriculum programs have been organized by adopting contemporary approaches and models that put the student at the center of education and aim for active participation in the teaching

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process. One of these is the Context-Based Learning (CBL) model, which is based on the constructivist approach. CBL was introduced by some educators working at York University in England. These educators emphasized that teaching science courses solely through theoretical instruction is insufficient, and that science should be connected to real-life contexts (Kutu & Sözbilir, 2011; Yıldırım, 2018). According to Ültay (2014), CBL is a program development model that employs familiar, everyday situations to link new knowledge with students' prior understanding. CBL not only promotes experiential learning, but also enhances the meaningfulness and long-term retention of knowledge (Ültay & Çalık, 2011). The contexts utilized in this model are of considerable importance. Wieringa et al. (2011) defined context as real situations experienced by students in their immediate environment and within the society they live in. Learning shaped around a context is more permanent (Avargil et al., 2012).

Contexts are very important in teaching science and especially biology. Since these lessons include many abstract concepts and Latin words, permanent and meaningful learning can be achieved thanks to contexts (Bennett, & Holman, 2003). Studies have shown that when students discuss contexts, they are more interested in learning science, their motivation for the lesson increases, and they participate more in the lesson (Kutu & Sözbilir, 2011). For example, Ramsden (1997) concluded in his research that CBL was quite effective in learning the content of the subjects. Barker and Millar (1999) concluded that CBL had positive effects on students' conceptual understanding. Dlamini and Lubben (1996) used CBL in their research and found that it had positive effects on students' attitudes towards the lesson. O'Connor and Hayden (2008) concluded in their research that CBL increased students' interest in the lesson and contributed to their ability to relate science topics to real-life contexts. Gilbert et al. (2010) suggested in their research that CBL would be effective and provide a solution to the variables that students had difficulty with in science. Schwartz (2006) stated that in CBL, individuals provided solutions to all kinds of problems and that more permanent learning was achieved in the course.

There are different strategies in the literature where CBL is used in learning environments. One of these is the REACT (Relating, Experiencing, Applying, Cooperating, Transferring) strategy. The REACT strategy is a contextual teaching and learning process developed by CORD (Center for Occupational Research and Development) in the USA (Jelatu et al., 2018). The REACT strategy reveals the relationship with concepts by using contexts. Thus, it helps students learn concepts and transfer what is learned (Kirman Bilgin & Yiğit, 2017). Navarra (2006) stated that implementing the REACT strategy in the classroom helps create a learning environment that supports the learning needs of all students. Navarra (2006) explained the stages of the REACT strategy in his research as in Table 1.

Table 1. *REACT strategy stages*

Stages	Definition
Relating	Making information contextual by establishing connections with prior knowledge and past experiences.
Experiencing	Learning by experiencing, doing-living, creating products, discovering.
Applying	Learning by applying information, uncovering concepts and facts.
Cooperating	Sharing information with peers and learning through collaboration.
Transferring	Using information obtained in new and unfamiliar situations.

In Relating stage, students connect learning outcomes to daily life examples embedded in the materials, such as stories, news items, or realistic situations (Aktaş, 2013). Crawford (2001) notes that this stage links prior knowledge with life experiences. It is the most critical component of the REACT strategy, as these connections facilitate faster and more effective learning (Coştu, 2009). In experiencing stage, students explore the learning outcomes they have related to real-life contexts through hands-on activities, experiments, or classroom practices (Crawford, 2001). Students may engage in various activities, experiments, or educational games. In Applying stage, students are encouraged to relate the outcomes they have explored to real-life situations, or they are asked questions about scenarios they may encounter in daily life. This stage assesses whether the acquired knowledge can be applied to new scenarios and whether the previous steps have achieved their purpose, promoting meaningful and deep learning rather than rote memorization (Ingram, 2003). In Cooperating stage, students work collaboratively in groups, applying the outcomes they have acquired to real-life problems or projects. They share knowledge and communicate with peers within and across groups, while the teacher provides guidance throughout the process. Finally, in the Transferring stage of the REACT strategy, students are assigned tasks related to real-life situations or problems to assess whether the learning outcomes can be applied. The focus is on enabling students to transfer their knowledge to new, previously unencountered situations (Crawford, 2001).

There are studies in the literature on the REACT strategy in different fields of science. In these studies, different research findings were reached indicating that the REACT strategy was quite effective especially in teaching biology subjects (Erdoğan Karaş & Gül, 2019; Gül, 2016; Gül et al., 2017; Kaya & Gül, 2021; Karslı Baydere & Aydın, 2019; Karslı Baydere & Kurtoğlu, 2020; Karslı & Yiğit, 2017). For example, in the study conducted by Gül (2016), it was revealed that teaching based on the REACT strategy did not create a statistically significant difference in students' motivation, attitudes and inquiry learning skills, but it ensured the permanence of learning. Gül et al. (2017) used the REACT strategy for teaching the excretory system subject and investigated its effects on academic achievement, inquiry learning skills and motivation. According to the results of this research, the REACT strategy was found to enhance student achievement and improve perceptions of inquiry learning skills. Karslı Baydere and Aydın (2019) designed materials suitable for the REACT strategy to investigate students' conceptual understanding and retention of understanding on the subject of the eye. In this research, it was determined that the explanation-supported REACT strategy had positive effects on students' conceptual understanding of the subject of the eye and the retention of this conceptual understanding. Erdoğan Karaş and Gül (2019) conducted research on teaching the subject of cell division with the REACT strategy and examined attitude and motivation variables. Karslı Baydere and Kurtoğlu (2020) used the REACT strategy for teaching the subject of biodiversity and investigated its effect on students' understanding. As a result of the research, it was seen that the REACT strategy provided permanent and effective learning. Kaya and Gül (2021) determined that the REACT strategy was effective in students' learning of the subject of the digestive system. They also concluded that the REACT strategy had positive effects on attitude and motivation towards the course. A review of the selected studies reveals that their findings are largely consistent with one another.

It is known in the literature that biology includes quite abstract topics and is perceived as difficult by students. One of the important and difficult to learn topics of biology is the subjects of 'Supervisory and Regulatory Systems' and 'Sense Organs' (Dyanti & Raharjo, 2018; Güneş & Güneş, 2005; Köse, 2013; Rahmatika & Utami, 2021). Therefore, the effective teaching of these subjects was examined in various studies (Beker Baş & Karamustafoğlu, 2020; Fabris et al., 2020; Kara & Kefeli, 2018; Karşlı Baydere & Aydın, 2019; Kiras & Bezir Akçay, 2016; Okur Akçay, 2016; Özay Köse & Çam Tosun, 2011; Polat & Yılayaz, 2016; Yıldız et al., 2017).

As a result, the conclusion drawn from the studies examined above is that the subjects of 'Supervisory and Regulatory Systems' and 'Sense Organs' are understood more easily when appropriate teaching methods and strategies are employed. Moreover, these methods and strategies make the course more effective and create a more supportive teaching environment. Considering that one of the strategies that has positive effects in learning environments is the REACT strategy, the use of this strategy can be effective in teaching the subjects of 'Supervisory and Regulatory Systems' and 'Sense Organs'. Therefore, developing materials based on the REACT strategy for these subjects can contribute to the literature and guide teachers in the instructional process. Therefore, in this study, it was aimed to prepare instructional materials based on the REACT strategy in accordance with the teaching of the subjects of 'Supervisory and Regulatory Systems' and 'Sense Organs', which are covered within the scope of the sixth grade science course. While the materials prepared for this purpose were being finalized, opinions of experts and students were taken into consideration. Thus, the research questions are as follows separately in terms of expert and student opinions:

1. What are the experts' opinions on the materials prepared according to the REACT strategy for the topics of 'Supervisory and Regulatory Systems' and 'Sense Organs'?
2. What are the students' opinions on the materials prepared according to the REACT strategy for the topics of 'Supervisory and Regulatory Systems' and 'Sense Organs'?

METHOD

Design of Research

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

The study group consisted of different participants determined by the convenience sampling method from different cities in Türkiye. Since the data collection process coincided with the pandemic period, detailed demographic information (e.g., participants' specific provinces or institutions) could not be obtained, particularly from academicians, teachers, and graduate students. Therefore, the participants were selected through convenience sampling and were reached primarily via the researchers' academic/professional networks and their referrals. In this way, individuals from various cities across Türkiye participated in the study. However, the lack of detailed regional or institutional data is acknowledged as a limitation of the research.

Accordingly, a total of 76 persons participated in the study, including 14 academicians specialized in science and biology education, 38 science and biology teachers, 10 graduate students in science and biology, and 14 seventh and eighth grade students. The reason for selecting seventh and eighth grade students was that they were familiar with the subject since they had been taught the subjects in this unit before. In addition, the study group consisted of 7th and 8th-grade students who had previously studied the same topics (“Regulatory and Supervisory Systems” and “Sense Organs”) and had also been exposed to the REACT strategy in a different subject. This prior experience with both the content and the strategy enabled the students to provide informed and reliable evaluations of the developed materials, including their effectiveness, usefulness, and potential benefits. While the materials and evaluation form were delivered to the expert participants in the sample via online environment, semi-structured interviews with the students were conducted face-to-face.

Research Instruments

REACT strategy material evaluation form

The “REACT Strategy Material Evaluation Form” was prepared by the researchers as a data collection tool. While preparing the forms, different material evaluation forms in the literature were also utilized (Bilgican, 2017; Büyükkol Köse, 2019). The following steps were followed while preparing the material evaluation forms:

1. The qualities, which a material should have, were determined (Karamustafaoğlu, 2006; Yaşar, 2004).
2. The main headings of the form were created in line with the determined qualities (such as the suitability of the material for the model and strategy, the suitability of the material in terms of design).
3. Statements that are appropriate for the material qualities were written in accordance with the main headings created.
4. The draft of the evaluation form was created by preparing the statements in the form as previously 50 five-point Likert type items and 4 open-ended questions.
5. Due to the inability to reach an adequate sample size during the pandemic, a pilot study of the form was not conducted. Consequently, its validity and reliability were assessed solely through expert evaluations. Therefore, the draft evaluation form was presented to the opinions of 6 participants, 2 academicians from biology education, 1 academician from science education, 1 biology teacher, and 2 graduate students studying in the field of biology and science.
6. In line with expert opinions, the items were evaluated one by one, their semantic integrity and the semantic features they were intended to convey were considered, and various spelling and punctuation errors were corrected. In addition, items 26, 38 and 47, which were initially prepared, were found to be unnecessary and incomprehensible and were removed from the form. Errors in open-ended questions were also corrected and additions were made to enrich the meanings of the questions. After the corrections, the final version of the test consisted of

47 Likert-type items and 4 open-ended questions. Sub-dimensions in the Material Evaluation Form and a sample item for each dimension were shown in Table 2.

Table 2. *Sub-dimensions in the material evaluation form and a sample item*

Sub-dimensions in Material Evaluation Form	Sample Item
Compatibility of the content of the material with the REACT strategy	The activities in the Relating stage provide contexts from real-life contexts.
Suitability of the material in terms of design	The texts used in the material are written appropriately and legibly in terms of point size, font, etc.
Contribution of the material to the course/teaching	Thanks to the materials, subjects can be taught in a more organized and planned way.
Contribution of the material to the teacher	The material makes it easier for the teacher to get feedback from students.
Contribution of the material to the students	The material ensures active participation of students in the lesson.

Additionally, the open-ended questions in the Material Evaluation Form included:

(1) Would you like to use materials prepared according to the REACT strategy in your lesson?

(2) What are the advantages of materials prepared according to the REACT strategy? In what ways does using these materials contribute to your lesson?

(3) What are the disadvantages of instructional materials prepared according to the REACT strategy?

(4) If you have anything you would like to add about the materials you evaluated, please state it.

Semi-structured interview form

Semi-Structured Interview Form was prepared to get the opinions of the 7th and 8th-grade students about the materials prepared with the REACT strategy. There are seven open-ended questions in the materials prepared with the REACT strategy. While preparing the questions, the age group of the students was considered and expert opinions were obtained regarding the questions. The interview questions included: (1) Do you believe that the materials create a desire to learn the subject or topic? Why? (2) Are the images used in the materials attractive and sufficient? (3) Do the materials cover the topic in its entirety? (4) Are the materials sufficient for you to learn the subject? (5) Are there any disadvantages to the materials? What are they? (6) Are there any advantages of the materials? What can they contribute to you? (7) Do the materials relate the topic to real-life contexts?

Preparation of Materials and an Example of Application of REACT Strategy

Instructional materials were prepared in line with the stages and purposes of the REACT strategy, considering the grade level and readiness of the students. According to this:

In the activities at the 'Relating' stage, students were given situations and stories that they could encounter in real-life contexts, and it was aimed for them to reach information by finding concepts hidden in the situations/stories. In the activities at the 'Experiencing' stage, it was aimed for students to experience the information they associated by trying, doing and living. In the activities at the 'Applying' stage, the transfer of the discovered concepts to real-life contexts is at the forefront. For this reason, questions were asked about the problem situations that students could experience in real-life contexts, thus determining whether the discovered information was transferred to real-life contexts. In the activities at the 'Cooperating' stage, students were encouraged to think about problems from real-life contexts by working in cooperation with the group under the guidance of the teacher. In the activities at the 'Transferring' stage, students were given homework to understand the level of learning outcomes achieved.

The stories (contexts), homework and the fill-in-the-blank activity in each stage were also prepared originally by the researchers. In all designed activities, attention was paid to students' relating the subject to real-life contexts and their ability to work both in groups and individually. In addition, emotional and cognitive processes such as ensuring that students enjoy the subject during the lesson, ensuring that the subject is learned by doing and experiencing, making the teaching process efficient, and concretizing abstract concepts were taken into account. The materials were designed separately for each of the subtopics ('Nervous System', 'Endocrine Glands' and 'Sense Organs') in the 'Supervisory and Regulatory Systems' and 'Sense Organs' chapter. An exemplary introduction to the content and implementation of the instructional material developed for the subtopic of the nervous system is structured as follows:

The lesson begins with the Relating stage, which includes activities designed to connect prior knowledge with the new topic. The first activity in this stage is a story-based task. Students are asked to read the story carefully and identify keywords they believe are related to the subject matter. These key concepts are then discussed through guiding questions, and students are encouraged to establish links between the concepts and everyday life situations. In the experiencing stage, two experiments are conducted using the Predict–Observe–Explain (POE) method. Students follow the given instructions during the experimental process and learn through active engagement and hands-on practice. After completing the experiments, reflective questions are posed to reinforce the intended learning outcomes. Finally, student groups are assigned tasks to prepare presentations for the following session. The Applying stage commences with the presentation of these assignments. This stage continues with the provision of real-life examples, after which students are asked questions related to situations they may encounter in their real lives. In the Cooperating stage, students are presented with problem-based scenarios that require group discussion and joint problem solving. Once the groups generate solutions and answer the related questions, their findings are compared and discussed with those of other groups. This approach enables students not only to collaborate within their own group but also to exchange and contrast ideas with peers from other groups. Finally, the Transferring stage involves presenting students with real-life situations to evaluate the extent to which they can apply the knowledge and skills they have acquired in everyday

contexts. The distribution of activities for the REACT strategy in the material according to learning outcomes and implementation time was shown in Table 3.

Table 3. *The distribution of activities for the REACT strategy according to learning outcomes and implementation time*

Recommended Class Hours	REACT Stages	Topic Title	Learning Outcomes
1 class hour	Relating and Experiencing	Nervous system, parts of the nervous system, central and peripheral nervous system, reflex	- Explains the nervous system, the functions of the central and peripheral nervous systems on a model.
1 class hour	Experiencing		
1 class hour	Applying		
1 class hour	Cooperating and transferring		
2 class hours	Relating	Endocrine glands, functions of the endocrine glands, transition from childhood to adolescence, adolescent health	- Realizes the importance of endocrine glands for the body.
2 class hours	Experiencing		- Explains the physical and psychological changes that occur during the transition from childhood to adolescence.
2 class hours	Applying		- Discusses what can be done to pass adolescence in a healthy way, based on research data.
1 class hour	Cooperating		- Discusses the effect of supervisory and regulatory systems on the regular and coordinated functioning of other systems in our body.
1 class hour	Transferring		
1 class hour	Relating	Sense organs, structures of sense organs, health of sense organs, relationship between sense organs, technology	- Explains the structures of the sense organs by showing them on a model.
1 class hour	Experiencing		- Demonstrates the relationship between the senses of smell and taste with an experiment he/she designed.
1 class hour	Applying		- Gives examples of defects in the sense organs and the technologies used to eliminate these defects.
1 class hour	Cooperating and transferring		- Discusses the precautions that should be taken to protect the health of the sense organs.

For each activity within the instructional materials, multiple alternatives were initially developed, from which the most suitable ones were selected. The chosen activities were submitted for expert review, revised in line with the feedback received, and subsequently incorporated into the materials. In forming the panel of experts, both teachers and academics were included, thereby ensuring that insights were gathered from individuals with diverse qualifications and professional experiences. This approach contributed to strengthening the content validity of the materials, ensuring that they were not only theoretically sound but also pedagogically and practically appropriate.

Following the expert review, the materials were also presented to students for evaluation. Feedback from students provided an additional perspective on the ecological and practical

validity of the materials, as their applicability to real classroom contexts was directly assessed. From the perspective of validity, the involvement of multiple stakeholders (teachers, academics, and students) enhanced both the content validity and the face validity of the instructional materials. In terms of reliability, the consistency of feedback across different groups of experts and students provided evidence that the materials are likely to yield stable and replicable outcomes when applied in similar contexts.

Data Analysis

In the study, the quantitative data obtained from Likert-type questions in the material evaluation form were analyzed by descriptive manner. Thus, 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). Additionally, the content analysis was performed for the data obtained from open-ended questions of both material evaluation form and semi-structured interviews. Thus, codes were created. Categories were obtained by grouping similar codes.

The qualitative data analysis was performed collaboratively by the researchers to ensure thoroughness and consistency. Potential points of disagreement were discussed together until agreement was reached, which helped strengthen inter-rater reliability. Each participant's responses to the open-ended questions were reviewed individually to identify recurring ideas. Responses with similar content were grouped into codes, taking into account the sub-dimensions of the Likert-scale items. These qualitative insights were also used to complement and support the quantitative findings. From the generated codes, broader categories were developed, and the related opinions within each category were analyzed and quantified. In addition, semi-structured interviews with students were video-recorded. The recordings were carefully examined, and students' statements were extracted and reviewed one by one. Similar statements were combined to form codes, which were then organized into categories. The resulting codes and categories showed strong alignment with both the open-ended questions and the sub-dimensions of the Likert-type items, ensuring consistency across qualitative and quantitative analyses.

FINDINGS

Findings for the First Research Question

Within the scope of the first research question, expert opinions on the 'Supervisory and Regulatory Systems' and 'Sense Organs' material were examined. The analysis results for each sub-topic in the chapter 'Supervisory and Regulatory Systems' and 'Sense Organs' were shown in Table 4.

Regarding the topic 'Nervous System' in Table 4, it was seen that the lowest value is 'contribution of the material to the teacher (M= 4.18)' and the highest value is 'suitability of the material in terms of design (M= 4.41)'. The overall arithmetic mean was calculated as 4.30. 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. As regarding the topic 'Endocrine Glands' in Table 4, the analysis results showed that the lowest value is 'contribution of the material to the teacher (M= 4.15)' and the highest value is 'suitability of the material in terms of design (M= 4.41)'. The overall arithmetic mean was calculated as 4.29. 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. According to the analysis results related to 'Sense Organs' in Table 4, it was determined that the lowest value is 'contribution of the material to the teacher (M= 4.18)' and the highest value is 'suitability of the material in terms of design (M=4.41)'. The overall arithmetic mean was calculated as 4.30. 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.

Table 4. Findings obtained from material evaluation form

Sub-topics	Sub-dimensions in Material Evaluation Form	M	SD
Nervous System	Compatibility of the content of the material with the REACT strategy	4.21	0.59
	Suitability of the material in terms of design	4.41	0.66
	Contribution of the material to the course/teaching	4.37	0.64
	Contribution of the material to the teacher	4.18	0.65
	Contribution of the material to the students	4.30	0.70
	Overall Values for 'Nervous System' Material	4.30	0.65
Endocrine Glands	Compatibility of the content of the material with the REACT strategy	4.21	0.62
	Suitability of the material in terms of design	4.41	0.66
	Contribution of the material to the course/teaching	4.35	0.64
	Contribution of the material to the teacher	4.15	0.69
	Contribution of the material to the students	4.28	0.70
	Overall Values for 'Endocrine Glands' Material	4.29	0.61
Sense Organs	Compatibility of the content of the material with the REACT strategy	4.21	0.59
	Suitability of the material in terms of design	4.41	0.66
	Contribution of the material to the course/teaching	4.36	0.64
	Contribution of the material to the teacher	4.18	0.65
	Contribution of the material to the students	4.29	0.70
	Overall Values for 'Sense organs' Material	4.30	0.59

In the study, content analysis of the open-ended questions in the 'REACT Strategy Material Evaluation Form' was also conducted. First, the codes were extracted and classified. And then, categories were created. The categories were named as 'positive opinions (Table 5)', 'negative opinions (Table 6)' and 'suggestions (Table 7)'.

Table 5. The expert opinions on "Positive Opinions"

Codes	Number of opinions	Sample expressions
Contributions to students	49	"It connects with real-life contexts (E2)." "It Improves collaboration and communication among students (E3)." "It is interesting and motivating (E7)."

Contributions to teacher	5	"It contributes to measurement and evaluation (E1)." "It makes it easier for the teacher to individually evaluate students' levels of understanding (E2)." "It provides an opportunity to evaluate students' development when implemented (E1)."
Contribution to the course and teaching	48	"It offers a learning environment based on student-centered activities (E6)." "It allows students to learn by doing and experiencing (E24)." "It provides permanent learning. Removes memorization (E1)."
Content and design of the material	12	"It is a very good material in terms of visuality, memorability and brainstorming (E1)." "It is an advantage to include different teaching methods (E23)." "Students create a product (E5)."

E: Expert

As a result of the analysis of the 'positive opinions' category, 4 codes were determined (Table 5). These were defined as; 'contributions to the student', 'contributions to the teacher', 'contributions to the course and teaching', 'content and design of the material'. When the findings were detail examined, it was seen that 49 experts stated that the material can contribute positively to the students. These positive contributions are; attracting attention to the lesson, generating new ideas, relating to real-life contexts, communicating, thinking in detail, questioning, developing high-level thinking skills, developing problem-solving skills, discovering knowledge, and arousing curiosity. According to the findings, 5 of the participants stated that the material could make positive contributions to the teacher and expressed these contributions as guiding the teacher, facilitating measurement and evaluation for the student, and activating the students' prior knowledge. In the positive opinions category, when the findings of the code 'contributions to the course and teaching' were examined, it was seen that 48 participants stated this opinion. The findings indicate that the practice contributed to the learning process in various ways. Participants reported that learning became more concrete, a student-centred and active environment was created, learning by doing and experiencing was supported, rote learning was avoided, and lessons became more efficient, structured, and motivation. In the study, codes were also created from the opinions of 12 participants regarding the 'content and design of the material'. It was stated by these 12 participants that the content of the material was appealing to the five senses, included rich and diverse methods, provided opportunities for information transfer, enabled cooperation, offered clues about the subject, and could result in the production of a product. In the study, Table 6 showed the expert opinions on "negative opinions".

Table 6. *The expert opinions on "Negative Opinions"*

Codes	Number of opinions	Sample expressions
Lack of time	32	"It can be time consuming (E17)." "There may be problems in completing the curriculum in terms of time (E33)."

Teacher-based negativity	7	"There may be negative effects depending on the application method of the practitioner (E17)." "Difficulty in classroom management (E20)." "Not determining the student's prior knowledge (E12)"
Student-based negativity	8	"It may not appeal to every student. If a student doesn't understand the subject, they may become bored (E6)." "It may be difficult to implement in large groups (E6)."
Material-based negativity	19	"Too many questions will overwhelm the student, and visuals could be more relevant and attention-grabbing (E14)." "Using materials in every lesson will distract the lesson from its purpose over time (E9)." "Students who do not like to read will not want to read texts (E8)."

As a result of the analysis of the 'negative opinions' category, 4 codes were determined (Table 6). These were defined as; 'lack of time', 'teacher-based negativity', 'student-based negativity', 'material-based negativity'. In addition, 5 participants stated that the material did not have any negative aspects. When the findings were examined in detailed, the code 'lack of time' had the highest value. According to this, 32 participants stated that the application of the materials may not be completed in the given time period. The opinions related to the code 'teacher-based negativity' were stated by 7 participants, and it was stated that these negativities would increase the workload by straining the teacher by class management, application errors and preparing the material. The code 'student-based negativity' was created with the opinions of 8 participants. These participants expressed these negativities as; crowded class size, the material may not appeal to every student, students may get bored if they cannot understand the subject, and the balance between duty and responsibility may not be established in group work. The code 'material-related negativity' was created based on the opinions of 19 participants. These negativities were mostly in the form of increasing the visual and concrete elements in the material. In the study, Table 7 showed the expert opinions on "suggestions".

Table 7. *The expert opinions on "Suggestions"*

Codes	Number of opinions	Sample expressions
Content and design of the material	12	"Activity 2: Instead of asking "What is insulin used for?", you could ask a question like "Why is injecting insulin important for Ecem's mother?" My general suggestion would be to ask questions referring to the event you provided. Considering that you don't need a text to ask the question "What is insulin used for?" "More educational images could be used. (E2)"

When the opinions received from the experts regarding the 'Suggestions' category are examined, it is seen that 12 participants did felt the need to offer suggestion (Table 7). These participants made suggestions about the material content. Participants mostly made suggestions to correct some of the questions in the activities or to enrich the visuals. After all the expert opinions received, the findings were evaluated and the materials were finalized by making corrections on the materials.

Findings for the Second Research Question

In the study, 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. Within the scope of the second research question, the students' opinions on the materials prepared according to the REACT strategy were received. Content analysis was applied to the data collected from the students through semi-structured interviews. Categories and codes were created. As a result of the analysis of the students' opinions, 4 codes were determined. These were defined as; 'contribution to the student', 'contribution to the course/teaching', 'content and design of the material' and 'no negative comments' (Table 8).

Table 8. *Students' opinions and sample statements*

Code	f	Sample Statements
Contribution to the student	19	-We can relate to daily life (S1). -It allows us to empathize (S13). -Comment ability on subject can increase (S2).
Contribution to the course/teaching	30	-The materials cover the subject in its entirety (S12). - It can ensure the permanence of the information we learn (S5). -It allows us to understand the subject more and expand it (S11). - It can create interest and enthusiasm in the lesson (S7). -We can learn quicker, faster.
Content and design of the material	44	-The visuals are interesting (S3).
No negative comments	14	-There is no negative aspect. (S1) -I couldn't see any negative aspect (S6).

S: Student

When Table 8 was examined, it was seen that there were 19 opinions regarding the code 'contribution to students' among the positive views received from the students. These opinions were that students can empathize with both themselves and with living beings and events in the outside world, their communication skills increase, their interpretation power increases and they can relate the information they learn to real-life contexts. There were 30 opinions regarding 'contribution to the course and teaching'. These opinions were generally in the forms of creating interest in the course, permanent and easy learning, fast learning, focusing on the course and attracting attention. There were 44 opinions regarding the code 'content and design of the material'. These opinions were mostly in the form of the material being visual and its ability to teach the subject. It was also determined that the material was informative, understandable, entertaining and awareness-raising. As seen in Table 8, 14 students stated that there were no negative features in the materials.

DISCUSSION and CONCLUSION

According to the findings obtained in the study, similar results were reached as a result of the analysis of the data collected for all three materials prepared according to the REACT strategy. Therefore, the findings of these three materials were evaluated within a general

framework. Accordingly, the findings obtained from Likert-type questions regarding the materials reflected the common views of the experts that the materials were prepared in accordance with the purpose. When the findings were examined according to the sub-dimensions, it was stated by the participants that the content of the material was prepared in accordance with the REACT strategy. For example, stories were selected in the relating stage and key concepts related to the subjects were hidden in the story. Thanks to the stories and the question-answer activities prepared afterwards, students are expected to brainstorm and reach important concepts and information about the subject based on events they may experience in their real-lives. Similarly, Aktaş (2013) stated that students can effectively learn by associating new information with their past experiences and real-life contexts at this stage. These activities enable students to draw their attention to the subject. In addition, the activities used in the relating stage are prepared in a way that will reveal students' knowledge. The activities in the experiencing stage mostly included experiments prepared with the POE method. In this way, students can have the opportunity to try their own knowledge, make observations, gain experience and discover information. They can also learn to work collaboratively during this time. According to Crawford (2001), the experience stage should include various in-class applications and experiments so that students can try and discover the information they have acquired. For the applying stage, it was aimed to create a class discussion environment by highlighting the situations that students encounter in their daily lives. In this way, students will be able to relate the information to their daily lives. Ingram's (2003) research argued that this situation will help students to internalize information by keeping them away from memorization. In the collaborating stage, students were given problem situations that they encountered or could encounter in real life and were asked to solve them cooperatively in groups. With the activities in the collaborating stage, students had the opportunity to work on problem-solving activities in groups or realistic scenarios given from daily life and produced solutions to possible problems they may encounter. In this way, students both shared the information they learned with each other and communicated (Crawford, 2001). In the transferring stage, problem situations were given again, but this time, attention was paid to problems that students may not have encountered in daily life. Thus, the activities in the transferring stage presented students the opportunity to transfer the new information they have learned to situations they have not encountered before. Kirman Bilgin and Yiğit (2017) stated in their research that concepts can be learned and transferred to daily life events as a result of establishing a relationship between these contexts and concepts. Therefore, it is very important that the activities used in the materials are compatible with the REACT strategy in terms of content. The REACT strategy is a strategy that focuses on the student and also has the teacher as a guide in the teaching process. What is important is that the students can learn information through the contexts they create in daily life. For this reason, great attention was paid to this in the content of the activities used in the stages. As a result, these practices specified for each stage of the REACT strategy in the materials were found sufficient according to expert opinions and it was revealed that the issues that should be in each of the stages were fulfilled.

The 'Material design' sub-dimension is also one of the important criteria to be evaluated. Materials that are appropriate and carefully prepared in terms of design can attract students' attention to the course. They can also make the activities during the course more enjoyable.

For this reason, the design features such as colors, visuals, font type and size should be of a quality that can draw the student into the subject. Considering these reasons in the research, design features were included as a sub-dimension in the material design evaluation form. As a result of the analysis of the findings regarding the sub-dimension of material suitability in terms of design, it was determined that the design of all three materials was suitable according to the participants. One of the most important elements in material design is visuals. Visual elements that were found insufficient by the participants in the initial versions of the materials were corrected and increased, and the materials were given their final form. Thus, the materials were revised in a way that would attract more attention from the students in terms of formal features and emphasize important points in the subject. As a result, the findings regarding the sub-dimension of 'suitability of the material in terms of design' showed that the materials are suitable for use in terms of design.

Another important feature selected for the evaluation of the materials is the contribution of the material to the course, that is, to teaching. When the findings of all three materials were evaluated in general, it was determined that the material had positive contributions to the course or teaching. For example, the activities in the materials were prepared in line with the learning outcomes in the curriculum. In addition, attention was paid to ensure that the activities had qualities that would enable students to concretize abstract concepts, increase their interest in the course and their communication in the classroom, and provide a rich learning experience, making the lesson more planned and organized. When the studies in the literature are examined, it has been determined that materials prepared with the REACT strategy by Crawford (2001) and Crawford and Witte (1999) help the learning process to be carried out in a planned manner. Ayvaci et al. (2016) concluded in their research that concepts were concretized after the lesson with materials prepared using the REACT strategy and that REACT was effective in learning. Karşlı Baydere and Bülbül (2021), and also Tatlı and Bilir (2021) stated in their research that conceptual understanding was strengthened when the REACT strategy was used. Again, Gül (2016), Karşlı Baydere and Aydın (2019), Karşlı Baydere and Kurtoğlu (2020) suggested that such materials provide permanent learning. As a result, it can be said that the findings of this research overlap with the findings of different studies conducted in the literature. Therefore, it is anticipated that the contributions of the material to the teaching process will be at a very high level and that the material will make the lesson productive.

The contribution of instructional materials to teachers and students is also among the important features that a material should have. In fact, Duman (2013) and Karamustafaoğlu (2006) touched upon this issue in their studies and stated that materials should guide teachers and students. When the findings were evaluated in terms of the contribution of materials to teachers, it was determined that the overall scores were high, as in other sub-dimensions. Therefore, it can be said that the materials may allow the teacher to easily receive feedback and to conduct measurement and evaluation during the process. As a result of the analysis of qualitative data in the study, it was stated by experts that the material could make positive contributions to the teacher. These contributions were exemplified as the material being guiding and facilitating measurement and evaluation for the student. Since the activities in the materials are presented ready-made with instructions and explanations, they can help teachers

conduct the lesson more planned and effectively. In the studies conducted by Crawford (2001) and Crawford and Witte (1999), it was stated that materials prepared in accordance with the REACT strategy were useful in the planned execution of the learning process. On the other hand, when the findings regarding the sub-dimension of the material's contribution to the student were examined, it was seen that similar results were obtained in all materials and that they were also scored at a high level. According to the findings, the prepared materials provide students with a learning environment far from rote learning, provide them with the opportunity to learn by doing and experiencing, increase students' interest in the subject, reveal their prior knowledge, and develop their communication skills. Because, as a result of the analysis of the data obtained from open-ended questions and interviews, statements such as the materials' attracting interest in the lesson, generating new ideas, relating to daily life, communicating, thinking in detail, questioning thinking, high-level thinking skills, problem-solving skills, discovering information, increasing students' curiosity, and providing motivation also support this idea. On the other hand, when the research results are examined, it is thought that if the materials are used, students will learn to use the information in their lives, they will be able to do group work and produce original products and reinforce the subjects. Especially in the REACT strategy, it is very important for students to be able to relate the information to their daily lives and use it. In the material evaluation, there was a very high level of participation in the statement regarding the student's ability to relate the information to daily life and use it, which is included in the sub-dimension. On the other hand, when compared with different research findings regarding the contribution of the materials to the student, similar results were reached (Kaya & Gül, 2021; Karşı Baydere & Akın Yanmaz, 2021; Keleş & Dede, 2020). For example, Kaya and Gül (2021) found that activities based on the REACT strategy increased students' attitudes and motivation towards the course, while Keleş and Dede (2020) found that they increased students' inquiry learning skills. These results cover the variables presented for evaluation regarding the sub-dimension of the material's contribution to the student. As a result, it is assumed that the materials may have positive contributions to the learning process as a result of both expert opinions on Likert-type and open-ended questions and semi-structured interviews with students.

In addition to the positive opinions expressed above, some expert opinions obtained from open-ended questions mentioned the disadvantages or negative properties of the material such as 'lack of time'. In the literature, it was seen that Erdoğan Karas and Gül (2019) touched upon this issue in their research. In the research, a decrease in students' motivation was detected. Although this situation does not comply with the analysis results made about the materials, students stated that one of the reasons for this decrease was that the application took time (Karas & Gül, 2019) and similar arguments made by experts for this study. Similarly, in the studies conducted by Gül et al. (2017), Ültay (2012), Ültay and Alev (2017), it was concluded that it took more time to complete the activities. In conclusion, this finding is also supported by the literature highlights the importance of considering the time required to implement REACT-based activities when designing instructional materials. However, the present study did not investigate the factors that might influence the time required to implement these activities. Therefore, further research is needed to examine how factors such as teachers' familiarity with

the REACT strategy, classroom management, curriculum time constraints, class size, and school facilities may affect the implementation of REACT-based activities.

As a result, considering the corrections made after the design and expert opinions and the student opinions at the last stage, it is seen that these materials are designed as a learning tool suitable for the REACT strategy. It can be said that the materials are prepared in a way that is as compatible as possible with the principles that should be included in instructional materials in the literature (Demirkuş et al., 2017; Duman, 2013). Therefore, it is thought that if the materials are used in the learning environment, they will yield effective results in terms of all the sub-dimensions identified in the research.

Suggestions

Based on the results, the following recommendations can be made:

- In future research, the effects of these materials on the learning process can be examined experimentally and their effects on various variables can be investigated.
- During the expert review process, some observations suggested that certain teachers might not have had a comprehensive understanding of the REACT strategy. Therefore, it is recommended that teachers who will use the developed materials be provided with information about the REACT strategy and, if necessary, receive in-service training to support its effective implementation.
- According to both different studies in the literature and the findings of this study, teachers stated that such materials can be disadvantageous in terms of suitability and effective use of time, especially for crowded classes. Therefore, it is considered appropriate to test these materials with an application in which the researchers who developed the material are also involved in the process, instead of using them directly by the teacher.
- Similar materials can be developed for different units and topics of biology or for different grade levels.

Ethics Approval

All procedures performed in the study were in accordance with the ethical standards of Atatürk University. Ethic approvals were obtained with the decision (reference no: E-56785782-050.02.04-2300056432) of the Social and Human Sciences Ethics Committee.

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