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Investigation of teacher candidates' skills for preparing the refutational text of biodiversity

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Abstract

The aim of this study is to investigate the science teacher candidates' ability to prepare misconceptions' refutational text (RT). Thirty-five students from the third year of Marmara University Science Teacher Education participated in the study. The type of research method is qualitative, and the pattern is case study. The data collection tools of the research are interview forms about preparing misconceptions' RTs prepared by pre-service teachers and preparing RTs by pre-service teachers. The researchers examined the science teacher candidates' ability to prepare misconceptions' RTs. Lack of knowledge about the misconceptions given to the teacher candidates and the lack of knowledge on the subject content of the given misconception are among the short comings. In order to develop misconceptions' RTs by prospective teachers, the nature and importance of biology, chemistry, physics and laboratory courses given in the undergraduate level should be indicated to the prospective teachers.

Keywords: Biodiversity, science courses, misconception, refutational text, science teacher.

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1. Introduction

They are the smallest building blocks that define the similarities and properties between concepts, objects or events (Carey, 2009). While the meaningful relationship between concept and experience is sometimes structured with new information, it may contradict scientific events and situations (Holding, Denton, Kulesza, & Rigdway, 2014; Ormrod, 2008). Information that contradicts scientific facts and prevents the learning and teaching of proven concepts has been defined as 'misconception' (Brown et al. 2018; Ormrod, 2008). Conceptual misconception is not a mistake. It means that a concept is built on the concept of a scientific mind, without being based on scientific knowledge. Misconceptions are highly resistant to change (Dole & Smith, 1989). Misconceptions arise when students misuse the models or theories (Gunstone, 2015).

1.1. Features of conceptual misconceptions

Researches show that students have misconceptions about science subjects and these misconceptions make it difficult for them to learn new subjects (Gülçiçek, 2002; Koray & Tatar, 2003; Yakışan, Selvi, & Yürük, 2007; Yürük & Çakır, 2000;). Maznichenko (2002) determined some common features of misunderstanding: (1) when a person notices that he misunderstood or made a mistake, he can easily correct it and (2) misconceptions can be reasons for misunderstanding. Conceptual change occurs by changing existing prior knowledge to learn new information (Chi, 2008). Ohlsson (2009) realised that 'the purpose of conceptual change theories is to understand and propose a way to overcome stubborn resistance to change' in An Overview of Contemporary Conceptual Change Theories. Chi (2008) explained three types of learning: (1) incomplete and add – if a student does not have prior knowledge, then prior knowledge is missing and new information must be added in the learning process; (2) filling the gap – a student has correct prior knowledge, but this information may be missing (Carey, 2009); and (3) conflict – a student may have ideas that 'contradict' with concepts to be learned, either in school or from daily experiences (Vosniadou, 2004). In this case, conceptual change is required to learn new information (Chi, 2008).

Misconceptions arise when students misuse the models or theories (Gunstone, 2015). According to Ausubel's theory, students establish a relationship between new knowledge and existing knowledge. If cognitive structures contain wrong concepts, then these wrong concepts interfere with the learning process. Misconceptions stem from interactions between students and their environment. Misconceptions cannot be easily replaced by correct information structures. Correcting misconceptions requires students to be aware of their misunderstanding and dissatisfied with them (Kete, 2006; Lathifa, 2018).

1.1.1. Causes of misconceptions

Students have sources of misunderstanding. These are school teaching (textbook, laboratory experiences and symbolic representation), out-of-school education (daily experiences, media, language and peer interaction) and intuition (Geban & Bayır, 2000). One of the sources of misconception is teachers (Roehring & Kruse, 2005). If the teacher prepares a bad lesson plan and does not prepare that lesson, then wrong concepts may appear in the students' minds. It has been stated that most of the misconceptions of the students are parallel to that of the teachers (Roehring & Kruse, 2005). A series of studies have been conducted in the last 20 years to investigate students' misconceptions about the subject (Garnett & Hackling, 1995; Özmen, 2004). Misconceptions stem from interactions between students and their environment. Most misconceptions are difficult to change. There are some sources that affect the student's misconceptions. These are daily experiences, social environment and intuition, apart from school teaching (Karaer, 2007). Riche (2000) has divided misconceptions into four types: pre-perceived concepts, factual misconceptions, local misconceptions and conceptual misunderstandings (Bransford, 2005).

1.2. Conceptual change

Learning takes place by changing students' current understanding and adding new knowledge to what is there. This is called conceptual change or a learning model. If students have an interaction between new and existing concepts, then learning occurs. The assimilation of new knowledge and learning process can be prevented if the new knowledge does not correspond to the previous knowledge of students (Hewson, 1991). Research has reported that students' misconceptions or prejudice are resistant to change by traditional teaching methods (Duschl & Drew, 1991). Duit, Treagust, and Widodo (2008) summarised how the misconceptions can be prevented as follows: changing the content structure of teaching, using new teaching tools, changing teaching strategies, meta-learning strategies and applying teachers' constructivist approach.

Conceptual change occurs when existing prior knowledge is insufficient and new information is understandable, reasonable and useful (Posner, Strike, Hewson, & Gertzog, 1982). Posner et al. (1982) suggested the following criteria to change students' misunderstandings: (1) students are not satisfied with their current knowledge; (2) students should find new information understandable; (3) Students should find new information reasonable; and (4) new concept should be efficient. Many methods based on conceptual change approach were tried to be developed in order to provide effective and meaningful learning. One of them is refutational texts (RT) (Hynd, Alverman, & Qian, 1997).

1.3. Refutational texts

RT provides meaningful learning and plays an important role in eliminating misconceptions (Alvermann & Hague, 1989; Chambers & Andre, 1997; Hynd et al., 1997; Mikkilä, 2001; Tekkaya, 2002; Wang & Andre, 1991;). Students may have misconceptions that conflict with scientific explanations. Research has shown that texts to correct misconceptions are effective to facilitate conceptual change in these situations (Guzzetti, Snyder, Glass, & Gamas, 1993). In the text, the reasons for students' misconceptions have examples showing that these misconceptions are insufficient (Geban & Bayır, 2000; Hynd et al., 1997). Some of the countries with studies examining the use of RT are as follows: Australia (Palmer, 2003), Canada (Kendeou & Broek, 2007), China (Chiu & Wong, 1995), Cyprus (Diakidoy, Kendeou, & Ioannides, 2002), Finland (Mikkila, 2001), Italy (Mason & Gava, 2007), Taiwan (Tsai & Chou, 2002) and Turkey (Çakır, Geban, & Yürük, 2002; Çaycı, 2007; Tekkeya, 2003). Despite the importance of RTs in the literature, it has been shown that they are not widely used in science books (Tippett, 2009). RTs include three basic components: (1) a common misunderstanding statement; (2) a clear rejection of this misperception; and (3) a signal that alerts the reader to the possibility of another understanding (Guzzetti, 2000; Maria & MacGinite, 1987).

1.4. Biodiversity education and misconceptions

Çepel (2007) defined biodiversity as follows: 'Biodiversity or biodiversity is a concept that express the richness of living species in a living environment, their genetic characteristics, habitats and the ecological relationship that take place in these habitats'. Loss of biodiversity is one of the most important global environment problems of today and tomorrow (Menzel & Bogeholz, 2010; UNCED, 1992). The main purpose of environmental education to create environmental literacy that enables everyone to acquire the knowledge, value, attitude, commitment and skills necessary to protect and improve the environment (UNESCO, 1978). Environmental education can be a bridge for biodiversity education (Gayford, 2000). The purpose of biodiversity education is biodiversity literacy. Biodiversity education is essential to protect nature and raise awareness (Tombulak et al., 2004). It is important for teachers to successfully implement biodiversity education in schools about biodiversity and its loss (Fiebelkorn & Menzel, 2013).

The biodiversity convention was adopted at the 'World Summit' in Rio in 1992. In this contract, BD was divided into three basic types: species, genes and ecosystems. Species diversity refers to the

diversity of species in a region, genetic diversity and the diversity of genes in species (Dikmenli, 2010). Ecosystem diversity includes diversity of habitats, biotic communities, ecological processes and diversity in ecosystems. An ecosystem is defined as 'a dynamic complex and living environments of plant, animal and micro-organism communities' (Dikmenli, 2010). Broadly speaking, BD is defined as a whole formed by genomes, individuals, species, populations, different ecotypes, subspecies, ecosystems and ecological events. In other words, IC is the biodiversity of genes, species, ecosystems and biomes or life forms found all over the world (Leksono, 2014; WWF and WCEE, 1996).

It is believed that the competencies of teachers are one of the factors that determine the success of biodiversity education. However, according to some studies, there is a lack of information about teachers related to biodiversity. According to the findings of the 'Biodiversity in the Next Millennium' conducted by the American Museum of Natural History, it was revealed that only 38% of the teachers are familiar with the concept of biodiversity and are not competent enough to teach biodiversity issues (Fiebelkorn & Menzel, 2013). It was also found that most of the students did not know about biodiversity (İndemann-Matthies et al, 2009). Another study also revealed that biology teachers have problems in understanding the full meaning of biodiversity (Summers, Corney, & Childs, 2004). In in-service training for primary school teachers in the UK, it was revealed in an in-depth interview on biodiversity issues that the concepts of biodiversity were understood and explained very simply. Dikmenli (2010), a biology teachers in Turkey, also reported that there is limited knowledge of biodiversity. Fiebelkorn and Menzel (2013) found that prospective teachers in Costa Rica equated biodiversity with species diversity and had misconceptions about genetic diversity. He found that most of the teacher candidates in Banten Indonesia did not understand the concept of biodiversity and conservation (Leksono, 2014).

The problems of this research are determined as follows:

- How are the science teacher candidates' skills to prepare RTs?
- What are the difficulties of science teacher candidates in preparing RTs?

2. Methods and materials

2.1. Research pattern

The type of this study is qualitative and its pattern has been determined as a case study. Qualitative research is a type of research that tries to find answers to questions such as why, what and how by examining a situation in depth (Yıldırım & Şimşek, 2011). Case studies with a research design (environment, individuals, events, processes etc.) are investigated with a holistic approach and focus on how they affect the related situation and how they are affected by the related situation.

2.2. Research group

35 students studying in the third-grade science education in Marmara University, in the 2018–2019 fall semester, participated in the study. By reading the RT written by these students, good (6), middle (6) and bad (6) RTs were selected and 18 RTs were analysed qualitatively.

2.3. Creating the rubric

The rubric scoring key was made by using the steps shown in Figure 1 (Andrade, 1997).

Figure 1. Creating the rubric key

While preparing the rubrics, the literature was first searched for the RTs. Elements of misconception, interpretative and rebuttal correction texts were researched and expressions that should be included in the rubrics were added. Scoring, expression and identification were determined by two expert researchers. Before the draft rubric, the texts were evaluated with the interpreter and the digester prepared together. However, with the feedback was received, it was determined by the expert researchers that the rubric was not suitable and that it should be divided into two. In line with the feedback, arrangements were made in rubrics. The rubrics is prepared as two separate rubrics, each of which is 10 questions, rebuttal and interpretive. Cronbach's alpha value of the rubric was found to be 0.893.

Table 1. Reliability coefficient of the rubric (Cronbach's alpha value)

Cronbach's alpha	No. of items
0.893	10

2.4. Validity and reliability studies of the rubrics

The two types of reliability that should be addressed for rubric scoring are inter-rater compatibility and rater-reliability. Coherence consistency between raters also shows a correlation between raters (Tinsley & Weiss, 2000). Coherence between raters can be enhanced by adequately defining the criteria by which scores will be awarded. If there are no expressions in scoring, scorers can concentrate on different expressions. Subjective ideas can be minimised and consistent scores can be achieved by raters (Newell, Dahm, & Newell, 2002). In this study, the conceptual error correction texts were scored by two independent raters in order to ensure the reliability of the rubrics scoring key.

The validity of the rubric scoring key should be handled in terms of structure, content and criteria. Whether the content expressions have an off-topic statement, the structure is related to whether the intended structure is expressed in all important aspects with scoring criteria and the criterion is how the scoring criteria reflect the relevant performance (Jonsson & Svingby, 2007; Moskal & Leyden, 2000). The rubric structures prepared in this research are arranged according to the content and criteria. It was prepared as 'Rubric for Evaluating Interpreting Texts' and 'Rubric for Evaluating Rebuttal Texts'.

3. Data collection tools

In this study, two different qualitative data collection tools were used in order to evaluate the science teacher candidates' skills in preparing misconceptions and the difficulties they experienced in preparing misconceptions.

3.1. Prepared RTs of teacher candidates

In the RTs, students explained a misconception based on scientific expressions in two different ways as 'rebuttal' and 'interpretive' text. In Appendix 2, the refutation and interpretive text are given as an example. It was expected to include the basic elements stated by Guzzetti (2000) and Maria and Mac Ginitie (1987) in the RTs. The first misconception sentence is the scientific explanation and examples explaining what would or would not happen if the information in the second misconception was correct, thus explicitly refusing misconceptions and explanations and examples that clarify the misconception.

3.2. Interview form about preparing teacher candidates' RTs

This interview form is a structured interview form. The structured interview form consists of two questions: (1) Where did you find it difficult to write the RT? (2) What should be in the RT?

4. Application

The research was carried out in the third-grade science teaching course in Science Education in the 2019–2020 academic year. In the first stage of the research, information about misconceptions, diagnosis and elimination was given by the lecturer (also one of the researchers). In the meantime, the structure, types and preparation of RTs were explained and examples were made with prospective teachers. In the second part of the research, prospective teachers were asked to find the misconceptions about biodiversity identified in the literature. Some misconceptions detected are as follows:

1. The species has always been exhausted, so we do not have to worry about a few lost animals or plants.

2. All species have been discovered.

3. There is nothing we can do to protect the Earth's biodiversity. Habitat loss is the number one cause of extinction.

4. Species coexist in ecosystems due to similar needs.

5. New species will be replaced by evolution.

6. Losing a species will not affect people.

Pre-service teachers wrote RTs (rebuttal and interpretive) for these six chosen misconceptions. Examples of rebuttal and interpretive texts are given in Appendix 1. Then, prospective teachers were asked to fill out the interview form, based on which questions they found difficult while writing the text to correct their misconceptions.

5. Data analysis

The analysis of the data obtained in the research was interpreted using descriptive analysis.

5.1. Rubric for assessing RTs

Interpretive and RTs prepared by prospective teachers to correct misconceptions about biodiversity were evaluated with the rubrics prepared by the researchers. The rubrics consist of 20 items each (Appendix 2). None of the items has reverse materials. It is prepared using a 3-point Likert-type scale (3: very good, 2: good and 1: bad). The rubric was filled out by the researchers according to RTs of each student. In addition, the texts written by prospective teachers were grouped as very good, good and bad. The texts written by 18 students in total, who were selected randomly from each group, were analysed through descriptive analysis.

Table 2. The criteria and provisions of the Likert-type rubric evaluated for RTs

Point	Rebuttal texts	Interpretive texts
Very Good	**Full expression**	**Full expression**
(3)	It started with the sentence 'If this statement was true …'. Discontent phrases about misconception are included. Conceptual misconception is correctly expressed. Rationale and examples are presented in a correct and understandable way. The difference between conceptual misconception and accurate information is based on a scientific cause. The contradiction between correct information and conceptual error is clearly shown. The correct scientific explanation is given at the end of the text. The text is convincing.	The misconception is written correctly. The misconception is translated into a question sentence. The misconceptions re correctly understood. Rationale and examples are presented in a correct and understandable way. The difference between conceptual misconception and accurate information is based on a scientific cause. The contradiction between correct information and conceptual error is clearly shown. The correct scientific statement was given at the end of the text. The text is convincing.
Good (2)	The expression is incomplete. Rationale and examples are presented but not sufficient. Scientific information is missing in the text. The text is not convincing enough.	The expression is incomplete. Rationale and examples are presented but not sufficient. Scientific information is missing in the text. The text is not convincing enough.
Bad (1)	The misconception is not specified. Scientific information has been given incorrectly or not at all.	The misconception is not specified. Scientific information has been given incorrectly or not at all.

5.2. Interview form about pre-service teachers' RTs

Pre-service teachers' thoughts on writing RTs of their misconceptions were determined with open-ended questions. Opinions obtained from open-ended questions, understanding/not understanding the misconception, knowing/not knowing the difference between the rebuttal and interpretive text,

lack/abundance of knowledge about biodiversity issue and knowing/not knowing the elements that should be in the misconception text.

5.3. Validity and reliability of the research

A number of strategies have been proposed to improve the quality of qualitative research (Lincoln & Guba, 1985). Concepts of credibility instead of the concept of internal validity, transferability instead of the concept of external validity, consistency instead of internal reliability and confirmability instead of external reliability are used. In this study, in order to increase the credibility of the research, two faculty members who are knowledgeable about the research subject and specialised in qualitative research methods examined all the processes of the research; they conveyed their criticism and comments to the researchers. In the study, it was tried to explain in detail how the data were collected in order to increase the transferability and external validity of the research. It proposes the concept of consistency in qualitative research instead of the concept of reliability in research (Lincoln & Guba, 1985). As it is not possible to imitate the facts exactly, consistency rather than reliability is at the forefront in qualitative research. In this framework, the process of planning and realising the research has been tried to be explained with its details and reasons. In qualitative research, the researchers' diversification was used in the study so that it can be confirmed that it replaces external reliability. The secondary researcher took part in the analysis of the data obtained from the research. The consistency between two researchers was considered as external reliability, in short.

6. Results

In the research, the ability of prospective teachers to write texts for correcting misconceptions about biodiversity was examined. The findings obtained are presented as tables.

6.1. Findings related to science teacher candidates' skills for preparing correction concepts of misconceptions

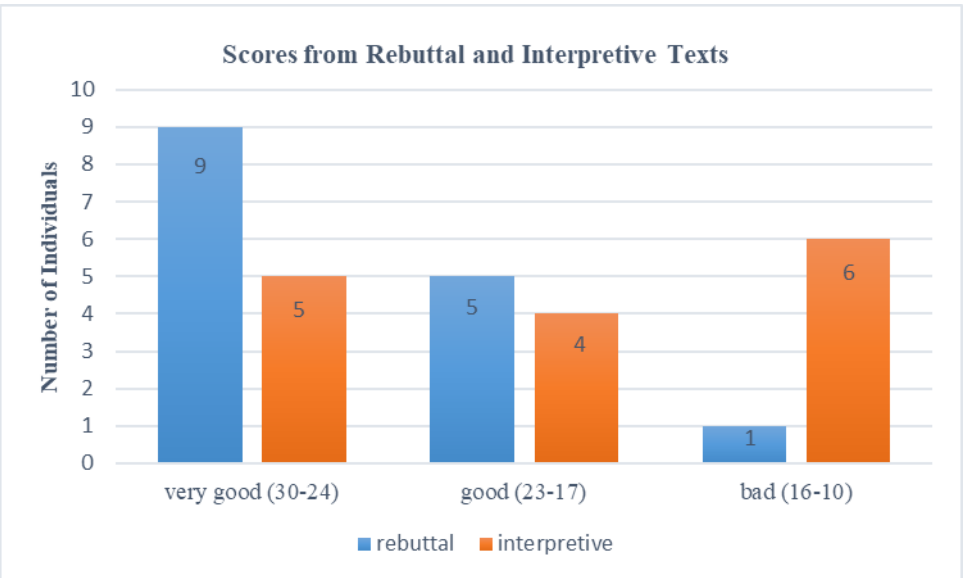

Figure 2. Prospective teachers' scores from the rebuttal and interpretive texts

When the prospective teachers look at Figure 2, it is seen that the rebuttal text writing skill is stronger than the interpretive text writing skill.

Table 3. Examining RTs by text type

Misconceptions	**Interpretive text**	**Rebuttal text**
New species will be replaced by evolutionary species.	In three different RTs, it was seen that two texts were not written in accordance with rubric, but scientific information about conceptual misconception was explained. If a teacher candidate was observed that he started RT with a question, he stated the misconception at the beginning of the text based on the scientific reason for the difference between the error and the correct information. At the same time, the teacher candidate who knew the scientific information correctly stated the correct expression at the end of the text, and his examples were correct and understandable and RT was persuasive, understandable and correct according to rubric. It was observed that the teacher candidate got a good (2) score from items 3 (where the student understood the misconception sentence correctly), 4 (explanation of why the concept was wrong with the reason and examples) and 6 (clearly stated the contradiction between the correct concepts and the conceptual error). It is seen that the teacher candidate cannot fully understand the misconception sentence, why the concept is wrong, cannot explain it fully and correctly with the reasons and examples and cannot fully express the contradiction between correct information and conceptual misconception.	In three different RTs, it was seen that two texts were not written in accordance with rubric, but scientific information about conceptual misconception was explained. If the misconception is in the RT, the teacher candidate wrote the conceptual misconception at the beginning of the text, and continued in the text as 'if this expression was true …' the student could not explain why the concept was wrong with justification and examples. The difference between conceptual misconception and correct information is grounded incomplete with scientific knowledge. The contradiction between correct information and misconception has not been clearly expressed. Scientific knowledge is known to be incomplete by the student. The students correctly understood the misconception sentence. The student included the correct statement at the end of the text. The student' rebuttal text; it is understandable, accurate and persuasive.
Losing a species will not affect people.	Looking at the average score values for each item, the pre-service teachers who wrote RT related to this misconception received very good (3) for this item; items 5, 6 and 9 received good (2); items 2, 3, 4 and 7 were	It is seen that the conceptual misconception is at the beginning of the text in all there texts and the refuting text started as 'if this statement was true...'. The reason why the concept was wrong was explained

	close to the good criteria; item 8 was close to the very good criteria. It has been observed that pre-service teachers wrote the misconception about the text when starting. It was observed that two of the teacher candidates included the correct expression at the end of the text. It was revealed that most of the pre-service teachers were missing the concept of misconception, could not fully understand the misconception sentence and could not explain why the misconception was wrong with reasons and examples. At the same time, the texts of the majority of prospective teachers are persuasive, understandable and not entirely accurate. It is revealed in the RTs that scientific knowledge is lacking; the contradiction between correct knowledge and conceptual misconception is not fully demonstrated; and examples and rationale are not exactly correct and understandable.	with the reasons and examples. The texts show dissatisfaction sentences. It is seen that students cannot fully base the difference between conceptual misconception and correct knowledge with scientific knowledge. The contradiction between true knowledge and conceptual error was analysed as clear but incomplete. Scientific knowledge is well known by students. Students understood the misconception completely and correctly. All of the students included the correct expression at the end of the text. The rebuttal texts of the students were not completely convincing, understandable and correct.
All species have been discovered.	It is seen that each teacher candidate gets 3 points from the first item and 2 points from items 4, 9 and 10. For items 2, 3 and 8, it was revealed that the average was closer to 2 points. It was observed that the average of the items 5 and 6 was close to 1 point and item 7 was close to 2 points. It has been observed that teacher candidates wrote the misconception when starting the text. However, it is seen that most of them do not start the text with a question. They do not fully understand the misconception sentence and do not include correct expression at the end of the text. It was analysed that they explained the concept of the wrong reason with the reason and examples; the examples and the reasons were at a good level; and the text was good, not convincing, understandable and	In all there texts, it was seen that the students started the text with a conceptual misconception. The text contained the phrase 'if this was the right thing…' and explains why the concept was wrong with reasons and examples. Discontent statements are given incomplete. The difference between conceptual error and true knowledge is based on scientific knowledge. The contradiction between true knowledge and conceptual delusion is fully stated. It is seen that scientific knowledge is well known by the students; the misconception sentence is understood correctly and full and correct expression is included at the end of the text. In addition, all there RTs were observed to be persuasive, understandable and accurate.

	accurate. It is seen that teacher candidates do not know scientific information completely and correctly and even know it incorrectly. It was analysed that candidates had difficulty in basing the difference between conceptual misconception and correct information for a scientific reason, and that the contradiction between misconception and correct information could not be clearly stated.	
Species coexist in the ecosystem due to similar needs.	It was discussed that one of the three RTs examined was not written in accordance with the rubric. The teacher candidate, with his good and bad aspects of the conceptual error, explained with advantages and disadvantages. Since it is written in this way, the conceptual error RT cannot be examined according to rubric. In the interpretive conceptual error RT prepared by the remaining two prospective teachers; it is apparent that prospective teachers started the RT with the question concerning the conceptual misconception. However, RTs of prospective teachers are not convincing, understandable and correct. Sufficient examples and justification could not be seen in teacher candidates to explain why the concept was wrong. In addition, it is seen that prospective teachers are not able to present scientific knowledge accurately and adequately.	It was discussed that one of the three RTs examined was not written in accordance with the rubric. It was seen that the other two texts started with the sentence of conceptual delusion. However, one of the texts does not contain the expression 'if this statement was the right thing …'. The reason why the concept is wrong is well explained by the reasons and examples. Expressions of discontent are not included in the texts. The difference between true information and conceptual misconception is based on a scientific cause incomplete. The contradiction between true knowledge and conceptual error is not disclosed. Scientific knowledge is known to be lacking by misconception sentence. The correct statement is not included at the end of the text. The rebuttal texts of the students are not convincing, understandable and correct.
Species have always been depleted, so we do not have to worry about a few lost animals or plants.	In the three RTs examined, it is seen that the candidates wrote the conceptual error while starting the text. However, none of the texts have a question sentence. It is observed that students cannot fully understand the misconception sentence. The students' examples and reasons for why the concept is wrong are well stated. It is seen that students cannot base the difference between correct	It is seen that prospective teachers started the texts with the misconception and continued as 'if this expression was true…'. The reason why the concept is wrong is explained incompletely with the reasons and examples. In the texts, the sentences of dissatisfaction are not sufficient, but incomplete. The difference between correct information and misconception has not been fully grounded on a

	knowledge and misconception for a scientific reason. At the same time, it is seen that prospective teachers cannot accurately and fully explain the contradiction between conceptual error and correct information. Scientific knowledge about misconception is little and incomplete known to students. The majority of students did not include correct expression at the end of the text. Students' examples and rationale are well understood and correct. RTs of students could not be found persuasive, understandable and correct in line with the analyses.	scientific cause. The contradiction between true knowledge and conceptual error has not been clearly demonstrated. Scientific knowledge is negatively known to students. The correct expression at the end of the text is not complete, but incomplete. However, even though the refuting text is not complete, it is persuasive, understandable and correct.
Nothing we can do to protect Earth's biodiversity; loss of habitat is the number one cause of extinction.	The misconception is stated in the introduction part of all three texts. However, in a RT other than two texts, the question sentence related to misconception was not seen. It was revealed that the students could not fully understand the misconception sentence correctly. The reasons and examples of students about why the concept is wrong are determined at the good level. The scientific difference between conceptual misconception and correct information could not be based on a scientific reason correctly. The contradiction between true knowledge and conceptual error has not been clearly demonstrated. Scientific knowledge is incomplete and little known to students. At the end of the text, students were not able to write the correct expression exactly. The students' examples and rationale are not sufficient. Students' texts have not been analysed as fully convincing, accurate and understandable.	In all three texts, it is seen that the text started with the misconception. Except for the other two texts, in a RT, there is no sentence 'if this statement was true …'. The reason why the concept is wrong is well explained by the reasons and examples. The sentences of discontent are included in the texts, albeit incomplete. The difference between conceptual misconception and correct information has not been completely based on scientific knowledge. The contradiction between true knowledge and conceptual error has not been clearly demonstrated. Scientific knowledge is known to be correct but incomplete. Students understood the misconception sentence correctly. The correct information was not found at the end of the texts. The rebuttal text of the students is not convincing, accurate and understandable.

6.2. Findings related to science teachers' difficulties in preparing RTs

In Tables 4 and 5, the opinions of teacher candidates about the issues they had difficulty in writing the RTs are given.

Table 4. Percentage of the candidates' answers to the first question on the interview form

Answers	Number of Individuals (*N* = 35)	Percentage
1. I had a hard time writing rebuttal text.	8	22.85
2. I had difficulty writing interpretive text.	4	11.42
3. I could not understand the sentence structure.	7	20
4. I do not know what kind of sentences I should use.	6	17.14
5. I have a lack of information on the subject.	12	34.28
6. I do not know the difference between rebuttal and interpretive text.	4	11.42
7. I had no difficulty writing the texts.	1	2.85
8. I could not convince the reader.	3	8.57

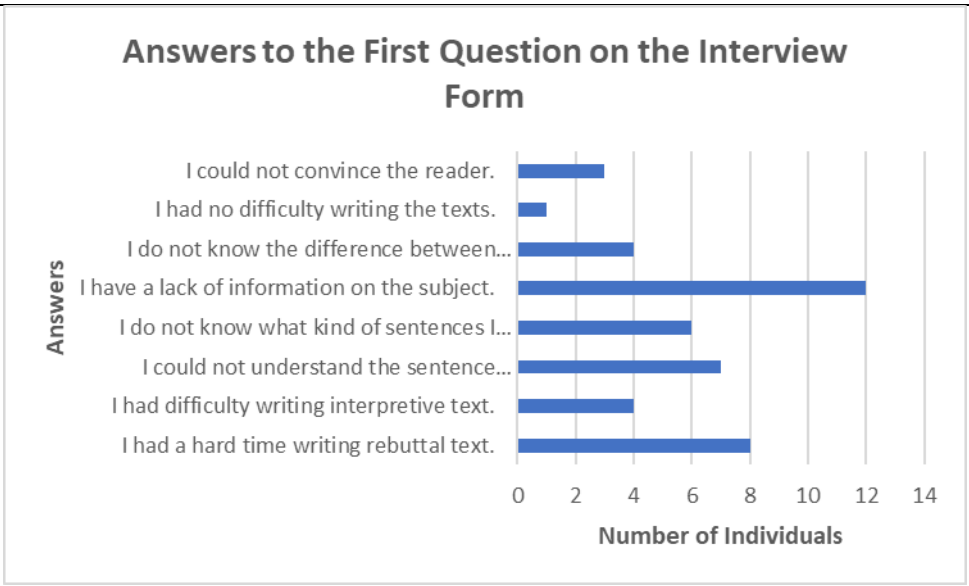

Figure 3. Teacher candidates' answers to the first question

It is seen in the answers of the teacher candidates that there was a lack of information in the teacher candidates who had difficulty in writing the texts (Figure 3). It was determined that one of the

important reasons that pre-service teachers had difficulty in writing the RT was the lack of knowledge.

Table 5. Percentages of teacher candidates' answers to the second question in the interview form

Answers	Number of Individuals (*N* = 35)	Percentage
1. Defining and interpreting text should be defined.	9	25.71
2. Examples from daily life should be given.	11	31.42
3. The misconception should be stated, why it should be explained and theoretical (scientific) information should be given.	10	28.57
4. It must be convincing.	4	11.42
5. The text should be clear and understandable.	4	11.42

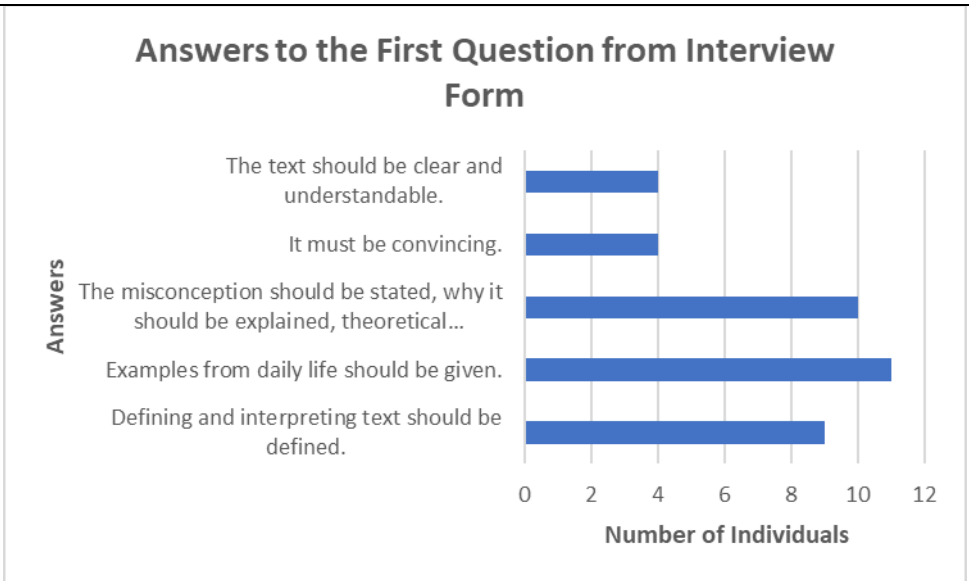

Figure 4. Answers to the second question on the interview form

The teacher candidates who answered the second question stated that the presentation of examples from daily life also had persuasiveness of the text. According to Figure 4, it is seen that prospective teachers find it important to give examples from daily life in RTs.

7. Discussion

Considering the findings, it was determined that three pre-service teachers did not write RT as desired, but they had scientific knowledge about misconceptions. It was seen that the teacher candidate did not have the skills to correct misconceptions. The RTs were written under two titles (1, Rebuttal text and 2, Interpretative text). They are written together without leaving the teacher candidates, and the rebuttal and interpretative text cannot be distinguished. It has been determined that the RTs written by prospective teachers do not comply with the rubric criteria.

Considering the findings, pre-service teachers were found to be more successful in writing the rebuttal text than the rubric. The teacher candidates' writing skills in the rebuttal texts are higher than the interpretive texts. The majority of students scored 'very good' in the rebuttal text rubric for almost all items. Conceptual error RTs, which were examined (18), were subjected to descriptive analysis separately as interpreters and rebuttals. At the end of the rubrics, the 'RT is persuasive, understandable and correct'. The expression was examined separately for each misconception, and the three RTs of each misconception were averaged for this expression.

- *The new species will be replaced by evolutionary species.* According to the three interpretive and three rebuttal texts examined in the misconception, the interpretative texts and the rebuttal texts were found to be convincing, understandable and correct.
- *The loss of one type will not affect people.* According to three misleading and three interpretive texts of misconception, the texts of both types are not convincing, understandable and correct.
- *All genres have been discovered.* According to the three rebuttal and three interpretive texts examined in the misconception, the persuasive, understandable and correct values of the interpretive texts are good; in the rebuttal texts, persuasiveness, accuracy and understandable are very good.
- *The species coexist in the ecosystem due to similar needs.* According to the three interpreters and three rebuttal examined in the misconception, both types of texts were not found convincing, understandable and accurate.
- *The species has always been exhausted, so we do not have to worry about a few lost animals or plants.* The interpretive texts according to the three interpretive and three rebuttal texts examined in the misconception are not convincing, understandable and accurate; however, rebuttal texts are persuasive, understandable and accurate.
- *There is nothing I can do to preserve the biodiversity of the Earth; the loss of habitat is the number one reason for extinction.* According to the three interpreters and three rebuttal texts examined in the misconception, both types of texts were not found convincing, understandable and accurate.

The answers given by the pre-service teachers to the interview form consisting of two questions are as follows:

- It has been determined that, for *what you had difficulty in writing the RT,* the most common answer in the question is that *I have a lack of knowledge about the subject.* The inference we have obtained here is that a teacher candidate who wants to explain the known misconception about a topic may contradict himself. This situation arising from the lack of subject brings with it the inability to explain the elements that should be included in the texts. In some of the teacher candidates' answers, there are situations that argue that the misconception is not an error and even a correct sentence. The reason why the teacher candidate perceives the misconception as a correct expression is also an indication that the individual does not have a good command of the subject.
- In the question, *what should be in the text of a refutational,* pre-service teachers mostly answered, *examples from daily life.* Pre-service teachers advocate explaining a subject by

> connecting to daily life and progressing by giving examples. Pre-service teachers argue that when a misconception is associated with daily life, the misconception will disappear in the student. The part that is taught in science class – deepening with daily life – (elaboration) can be determined as the part where students' misconception disappears completely. Giving examples from daily life can be shown as a way for pre-service teachers to explain a concept in the most beautiful and non-complex way.

Kendeou and van den Broek (2007), Kendeou and O'Brien (2014) and Kendeou, Butterfuss, Kim, and Van Boekel (2018), Rapp and Kendeou (2007, 2009) and Van Boekel, Lassonde, O'Brien, and Kendeou (2017) have shown that RTs are effective in correcting misconceptions. In the literature study, classification of living things (Ural Keleş, 2009); photosynthesis (Köse, Kaya, Gezer, & Kara, 2011); recognition of celestial objects (Şahin, Durukan, & Bülbül, 2015); the phases of matters and heat (Sarı Ay & Aydoğdu, 2015); the nature of science (Çepni & Çil, 2016); physical and chemical change (Ayas & Birinci Konur, 2017); work, power and energy (Cerit Berber & Sarı, 2009); tissues (Çaycı, 2007); electric (Başer & Geban, 2007); and reproduction, growth and development in plants and animals (Sinanoğlu, 2017) are some of the misconceptions in Turkey, and we are working to ensure the use of conceptual change to RT.

Pabuçcu and Geban (2006) have shown that RT education supports better learning of chemical bonding concepts and elimination of students' misunderstandings than traditionally designed teaching. Tekin, Kolomuç, and Ayas (2004), after teaching RTs, measured the comprehension level of the students. Uyanık and Dindar (2016) found that the difference between the experimental and the control group was significant, in favour of the experimental group, when they looked at the post-test scores (in the fourth grades, the teaching group applied the RTs). From the results of fourth-grade science course, it is suggested to apply RTs for misconception removal.

Demirel and Anil (2017) worked with 10th-grade experiment and control groups. The course was taught with traditional lectures on gases to the control group and RTs prepared in the experimental group. As a result of the research, it was observed that the experimental group students were more willing to learn the lesson than the control group students. RTs appeared to give better results in terms of lesson activity and concept teaching than traditional teaching. Bilir and Özbaş (2017) examined the views of high school students (North Cyprus) on the problem perception and rejection of biodiversity loss. According to the results of the research, it was found that the students' perception of the problem regarding the loss of global and local biodiversity was higher than the rejection of the problem.

Young (2001) investigated the potential of developing sustainability education in the UK through biodiversity planning. In the research, the relationship between local biodiversity and national and international policies were examined. Although the importance of education in biodiversity is known, it is concluded that implementation policies are not sufficient in practice. Derman, Çakmak, Yaşar, Kızılaslan, and Gürbüz (2013) examined the importance of biodiversity in terms of sustainable development, the results of studies on biodiversity in our country and the place of biodiversity in the curriculum. As a result of the study, they determined that there is not enough study on biodiversity in our country, and students have little knowledge about biodiversity.

8. Conclusion

Considering the literature, forehead and research findings, prospective teachers were found to have deficiencies in writing RTs related to biodiversity. It is one of shortcomings that teacher candidates do not have knowledge about the misconception given and the subject content of the given misconception does not prevail. A pre-service teacher needs to master all the issues related to the field before embarking on the profession, and if there is a misconception, it should be corrected.

After the prospective teacher has finished his undergraduate life, he must be able to correct the misconception in his students who exist in his professional life. At the same time, the new graduate teacher should be able to print both types of RT for his students. With this method, students should be able to replace misconceptions with new and accurate information.

In order to develop RTs in prospective teachers, the nature and importance of biology, chemistry, physics and laboratory courses given in the undergraduate should be indicated to prospective teachers. These lessons provide elimination of misconceptions among students. Naturally, the more successful a prospective teacher is with these lessons, the more successful and freer of misconceptions they can train students.

Authors' contributions

In this research, the researchers played an equal role.

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Appendix 1: Examples of rebuttal and interpretive texts used in correcting misconceptions

Rebuttal Text

All species have been discovered. If this statement were true, biodiversity would be richer than it is now; our ecosystem would be more developed; and we could meet today's needs better and easier. For example, for a disease without treatment, if all plant species had been discovered, treatment would have been available and this could have contributed economically to magic. But when we investigate, three-quarters of the species live on land and many of them can be extinct without being identified. In addition, many species cannot be named in researches related to species. Scientist say that living species can reach 100 million, while only 8 million 700 of these species have been identified. So, not all species have been discovered.

Interpretive Text

If all species were discovered, wouldn't we be able to meet today's needs more easily? The genre includes all living creatures. And species constantly interact with air, water, soil and other living thing. This interaction enables us to meet our needs and offer a liveable life. The decomposers break down dead wastes to yield fertility to the soil; the nitrogen-binding bacteria are added to the cycles; the insects pollinate the plants. These interactions meet some of the thing we need and create the balance of the ecosystem. As species diversity increases, the ecosystem develops, grows and interactions increase. This enables development in areas such as health economics, but currently all needs that can be met by at least increasing species diversity can be met. In short, interactions between species provide a balance and some of the things we need are met with these interactions. However, some things we need are met. However, we cannot find solutions to everything we need.

Appendix 2: Rubrics evaluation of RTs

a. Rubric for evaluating interpreting texts

	Elements of RT	**Very good**	**good**	**bad**
1	While writing the text, he wrote the misconception.			
2	It started with the question about the misconception about the text.			
3	The student correctly understood the misconception sentence.			
4	He explained why the concept was wrong with reasons and examples.			
5	The difference between conceptual misconception and accurate information is based on a scientific cause.			
6	The contradiction between correct information and conceptual error is clearly shown.			
7	Scientific knowledge is known correctly by the student.			
8	With the misconception of the student, the correct concepts were replaced and the correct expression was given at the end of the text.			
9	The students' examples and rational are correct and straightforward.			
10	The student' text is persuasive, understandable and accurate.			
	Total Point			

a. Rubric for evaluating rebuttal texts

	Elements of RT	**Very good**	**good**	**bad**
1	While writing the text, he wrote the misconception.			
2	He started the text with the phrase 'if this statement was true …'.			
3	He explained why the concept was wrong with reasons and examples.			
4	The phrases of dissatisfaction about the conceptual error are included in the text.			
5	The difference between conceptual misconception and accurate information is based on a scientific cause.			
6	The contradiction between correct information and conceptual error is clearly shown.			
7	Scientific knowledge is known correctly by the student.			
8	The student correctly understood the misconception sentence.			
9	With the misconception of the student, the correct concepts were replaced and the correct expression was given at the end of the text.			
10	The student' text is persuasive, understandable and accurate.			
	Total point			