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The effect of conceptual change texts on eliminating the misconceptions of K5 students' alternative views about the birds

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Abstract

The purpose of the study is to examine effect of conceptual change texts used by the 5th grade students in science and technology courses on eliminating misconception about class of vertebrate birds. Data for the study of which its sample was composed of 26 students from the 5th grade were compiled from a two tier test question and semi-structured interviews conducted with 9 students. It has been experienced that the rate of %69.21 wrong explanation obtained from the pre-test was decreased to rate of %26.91 at the last test.

Keywords: Misconceptions, conceptual change texts, science education, primary education.

1. Introduction

As it is known, the approach based on the preparation of a Science and Technology course education program is the constructivist approach. Structuralists claim that learning takes place as a result of the students’ active interaction within their surrounding and that it is not independent from the individual (Baki & Bell, 1997) and that leaning is a mental formation (Köseoğlu & Kavak, 2001; Özmen, 2004). However, concepts do not form in minds of individuals only in the learning environment, through the information provided by the teacher. They may also form depending on the interpretation of students regarding the events occurring around them and related to the interaction with other individuals before entering the learning environment (Sevim, 2007; Ünal, 2007). Such types of student perceptions that result different to those being accepted by scientific communities are named as misconceptions (Aydın & Uşak, 2003). Misconceptions have an adverse effect on the students’ later learning and in developing new and correct concepts in their minds (Griffiths & Preston, 1992). Therefore, determining the preliminary information and if any, the misconceptions of students takes an important place in realizing an effective concept teaching. However, it is not enough to determine the preliminary information and misconceptions of students in order to realize an effective concept teaching. The teaching process should also be arranged by taking student errors into account (Nakiboğlu & Özkal, 2006). Conceptual change texts are one of the different teaching strategies to remove the misconceptions of students (Guzzetti, 2000; Köse, 2004; Ünal, 2007). Despite that many researches in the literature are available in the direction that these texts create a conceptual change on students, that they provide meaningful learning and that they are used in removing misconceptions (Wang & Andre, 1991;
The purpose of this study is to examine the effect of conceptual change texts used in 5th grade students’ science and technology course on removing students’ misconceptions related to birds.

2. Method

This study was carried out by using the case study method. With this method, it is possible to approach one direction of the researched problem for an in-depth study and to use different data collection methods in order to reach the goal (Çepni, 2005). Therefore, special case studies can be based on the mix of qualitative and quantitative data. In studies where this method is used, an experimental subject can be researched by following a predetermined procedure like in other research methods (Yin, 1994). Also in this study, a “simple experimental” way was followed (Creswell, 2003). In this study, the evaluation regarding the intervention to a single sample was carried out within itself.

2.1. Participants

This study was carried out with 26 students, attending the 5th class of a primary school located in the Akçaabat district of the province Trabzon, during the spring term of the academic year 2008-2009.

2.2. Data Collection and Analysis

Within the scope of the study, it was primarily determined which misconceptions of students related to the bird concept are under the scope of the 5th class curriculum by scanning the relevant literature. Then, studies carried out abroad and in the country related to conceptual change texts were examined. A conceptual change text was prepared based on the bird concept and on animals involved in the bird classes of vertebrates by taking the determined misconceptions into consideration. The test prepared before and after the application was applied to the students as a two-stage test consisting of a pre-test and final test and this text prepared in relation with the subject was distributed to the students in the class. The study was carried out as utilizing from the prepared conceptual change text and executing a class discussion based on the questions in the text during the study of the relevant subject in line with the course book. The data of the study was collected through a pre-test and final test implementation of a two-stage test, which was prepared by taking student misconceptions related to birds into consideration, and by semi-structured interviews carried out with 9 students. The first part of the test article used in relation with the subject in the study was including 4 confounding multiple-choices including the correct answer and the second part was designed in an open ended structure containing the reason of the response given in the first part (Chen et al.,...
2002; Karataş et al., 2003; Saka, 2006). The options other than the correct answer in the prepared multiple-choice section have been formed from the misconceptions derived from previous studies. In this way, the possibility of finding the correct answer by turning the wheel was minimized.(Chen et al., 2002; Karataş et al., 2003). The aim of preparing the test in two stages is the demand to investigate the specified misconceptions in-depth. The prepared test article has been examined by experts in their fields and necessary fields were corrected. Regarding the pilot study carried out the discrimination strength of this test article was determined as 0.3. That the discrimination strength for the test article according to the Kalaycı et al., is between 0.4 – 0.3, suggests that this article is good (Kalaycı et al., 2005). In addition to this, the responses given by students were also supported by interviews. The students to be interviewed under the scope of the study were determined by the teacher by taking their status in the class into account (lower-middle-upper). The interviews were carried out as a pre—final interview by taking into consideration the responses of the determined students given to the relevant question before the application and after the application.

Based on the two-tier test used in the study, the options marked by the students and their responses related to the options were analyzed by using the approaches of full response determination and classifying the responses within certain categories (Küçüközer, 2004; Saka, 2006). In the first step obtained from the two-tier test applied in this context, the options marked for each question by the students and the explanations they made based on these options were divided into categories according to seven conceptual understanding levels. The scores achieved by the students from the pre-test and final test were calculated by giving 6 points to the most correct answer and 0 points to unanswered questions regarding the levels. In order to enable a better understanding related to the data obtained from the study, the conceptual change levels in which students were involved in relation to the subject before and after the application are shown with the help of a table. The findings obtained from the applied test on the other hand, were analyzed by using the Wilcoxon Signed Ranks Test (within a group) and the results are presented in tables. Below, the levels are indicated that were developed to calculate the scores of students to be achieved from the two-tier test that was prepared in relation to birds.

Table 1- Levels developed to calculate the scores of students to be achieved from the conceptual understanding test

| Levels                      | Score |
|-----------------------------|-------|
| A- Exactly Correct: Explanations that are scientifically accurate and which can be accepted as exactly correct are addressed within this group | 6     |
| B- Partially Correct: If explanations are correct but are missing according to the exactly correct answer, then they are addressed within this group | 5     |
| C-Wrong (1): Explanations that can be both accepted as partially correct and that also contain wrong expressions are addressed within this group | 4     |
| D-Wrong (2): This is the level containing completely wrong answers | 3     |
| E-Wrong (3): Expressions unrelated to the subject | 2     |
| F-Non-Coding: Contains explanations not understood and which are not exactly related to the subject are addressed within this level | 1     |
| G-Unanswered: Those who have not answered and those who write the same of the option they have marked into the explanation field are addressed within this level | 0     |

While analyzing the data obtained from the preliminary and final interviews made with nine students within the scope of the study, the responses that students gave to the question were asked again to the student and the responses were tried to be researched in-depth. The carried out interviews were recorded on tapes which were analyzed and made written after the application. The analyzed student interviews were brought together under the asked questions and were classified according their same or opposite questions. The responses in findings were arranged without a meaning distortion and were presented to the reader. Different, interesting and attractive expressions that at the same time contain misconceptions were also presented to the reader without changing.

3. Findings

The two-tier test question prepared according to common student misconceptions and the responses that students gave to this question are presented below.
4) Penguin, Butterfly, Bat, Pigeon
Which of the above animal is or are birds?

a) The penguin and the pigeon are birds.
b) All of them are birds
c) The bat and the pigeon are birds
d) The bat, the pigeon and the butterfly are birds
Because;

The percentages of responses that students gave to the multiple-choice section of the test are indicated in Table 2.

Table 2- The preliminary and final test percentages of student responses related to the multiple-choice section of the test.

| Responses | Frequency (%) |
|-----------|---------------|
| a) The penguin and the pigeon are birds. | 15,38 65,38 |
| b) All are birds | 11,54 7,69 |
| c) The bat and the pigeon are birds | 26,92 11,54 |
| d) The bat, the pigeon and the butterfly are birds | 42,31 15,38 |
| No answer | 3,84 ------- |
| Total | 99,99 99,99 |

As shown in the table 26, %15,38 of the experimental group students have correctly answered the 4 questions about birds during the preliminary test. The option “The bat, the pigeon and the butterfly are birds” took the first place among the wrong answers (%42,31), “The bat and the pigeon are birds” took the second place (%26,92) and the option “All are birds” took the third place (%11,54). This test article was not answered by %3,84 of the students during the preliminary test. In the final test on the other hand, %65,38 of the students gave correct answers. Like in the preliminary test, the option “The bat, the pigeon and the butterfly are birds” took again the first place among the wrong answers (%15,38), The bat and the pigeon are birds” took the second place (%11,54) and the option “All are birds” took the third place (%7,69). The percentages of the answer categories created for the explanations that students made regarding the question are given in Table 3.

Table 3- Percentages of response categories created for the explanations that students made regarding the question

| Level | Categories (N=26) | Pre test | Final test |
|-------|-------------------|----------|------------|
| A | The penguin and the pigeon are birds. Because they are oviparous and they have wings and feathers. The bat is a mammal as it is giving birth. The butterfly on the other hand cannot be a bird as it is involved within the class of invertebrates. | 3.84 | 3.84 |
| A | The penguin and the pigeon are birds. Because both the penguin and the pigeon have beaks and they lay eggs while the bat gives birth. The butterfly on the other hand cannot be a bird as it is an insect which was a larva before. | 3.84 | 3.84 |
| A | The penguin and the pigeon are birds. Because the penguin and the pigeon do not give birth as they lay eggs but the bat gives birth and is not therefore a bird. These animals are involved in the vertebrates group. The butterfly cannot be a bird as it is an invertebrate. | - | 11,54 |
As shown in Table 3, %11.52 of the students who were asked a question in the preliminary test in order to learn their thoughts about birds, have made explanations to the question that can be accepted as scientifically correct. A total of %69.21 of the students on the other hand, made wrong explanations that cannot be accepted as scientifically true as also seen from the table. The explanations similar to; “the bat, the pigeon and the butterfly are birds as they all are flying. However, the penguin is not flying and therefore it is not a bird”, is the explanation with the highest percentage of %38.46 among the wrong answers. Due to the reason that the butterfly was once a larva despite that it is flying, some students correctly did not include the butterfly to the classification of birds as also seen from Table 27 (%11.54). In addition, it was determined that %15.58 of the experimental group students did not make any explanation in the preliminary test or that they wrote the same of the option they have marked as the explanation. If the explanations in the final test are examined, it is observed that %65.37 of the students made explanations that can be accepted as scientifically correct while %26.91 of the students answered the questions with wrong statements that cannot be accepted as scientifically correct. The statement with the highest percentage among these wrong statements is “the bat, the pigeon and the butterfly are birds as they all are flying. However, the penguin is not flying and therefore it is not a bird” with a percentage of %11.54. In order to determine the view about birds of prior education students, the findings obtained from the executed interviews are presented below.

**R:** Penguin, Butterfly, Bat, Pigeon. Which of these animals is a bird or are birds? Why?

**S1:** The bat, the pigeon and the butterfly are birds. Because, these animals have wings and they fly.

**Do all birds fly?** Flying is a common characteristic of birds.

**Is the Penguin a bird?** It is not as it cannot fly

**If it is not a bird, what is it?** It is a fish.
S2: The bat and the pigeon are birds. Because they both can fly; Penguins cannot fly and therefore cannot be birds. The butterfly is also not a bird. It exists in the summer but not in the winter. The birds have a longer life. In addition butterflies are very small.

So, what is the penguin if it is not a bird? They might be fish as they swim very well. However, they stay too much out of water; they cannot be fish as well.

Do all birds fly in your opinion? Yes, they fly.

S3: In my opinion, only the penguin is not a bird. The others are birds, because the penguin cannot fly. However, the others fly.

What is a penguin according to you? I do not know. It might be a fish, I am not sure.

Do all birds fly? Yes, they fly. Birds have wings and they fly with these wings. For this reason the penguin is not a bird. It is a fish. It swims in water and eats other fish.

Why did you call the bat a bird? The bat is flying, it has wings. All animals that fly are birds.

Why is the butterfly a bird? It is also flying, it is a bird, and it has wings.

So, a fly, a bee, can these living beings also be birds? They might be, in my opinion. As they fly, they should be birds.

S4: The bat and the pigeon are birds. The butterfly is not a bird as it cannot fly high and it is very small.

Can bees be birds? The bees are not as big as birds as well.

Why can penguins not be birds? The penguins cannot be birds as they cannot fly. Those cannot fly be cannot birds.

If it is not a bird, what can it be you think? (Fish, reptile, mammals)

They might be involved in the fish group as they are swimming very well and as they eat fish.

Can the fly be a bird? It cannot. It cannot fly much. Those that fly much and high become birds.

Can those that do not fly be birds? No. They cannot. All birds fly.

S5: The bat, the pigeon and the butterfly are birds. The bat flies. The pigeon is a bird as well. It also flies. The butterfly is also a bird.

Can a bee, a fly be birds? These are also birds, they fly.

Do all birds fly? Yes, they fly.

Why is the penguin not a bird?

It is not a bird as it cannot fly. It is a sea fish. It lives in ice and the sea.

S7: The penguin and the pigeon are birds. I saw it in a documentary. The penguin is a bird species that cannot fly. They have lugs like wings.

Do you know how birds reproduce? Through egg.

Is the pigeon a bird? The pigeon is a bird, I am sure. It can fly and it reproduces through eggs.

Well, is the bat a bird? The bat can fly. Therefore, it might be a bird. Now, I see that the bat, the pigeon and the penguin might be birds. However, the butterfly cannot be a bird. It was a larva before.

S8: The penguin and the pigeon are birds. I think that the bat is not a bird as it gives birth. However, birds do not give a birth. I saw in a film on TV that the penguin is a bird, they laid eggs.

Why is the butterfly not a bird? It is an insect. It was already a larva before. Then, it turned into a butterfly. Therefore, the butterfly is not a bird. I think that it is too small to be a bird and it has not a beak. Birds have beaks. The penguin for instance has a different beak.

S9: The bat, the pigeon and the butterfly are birds. The pigeon and the bat are birds as they fly and they have wings. The butterfly is also a bird it is also flying.

The penguin, why is it not a bird? It can never fly, it is not a bird. It swims and therefore it is a fish.

Regarding the pre-interview, It is observed that a large part of the students have a strong misconception that “all birds fly”. The students S1, S2, S3, S5, S9, considered the butterfly as a bird as it was flying while students S7 and S8 have expressed that the butterfly cannot be a bird as it was a larva before. Additionally, the student S8 expressed that the butterfly was an insect and that it was different from birds in this direction. Some of the students who participated in the interview expressed that the butterfly was not a bird because of the reason that it had a short life (S2), its size, and that it was not able to fly high. Related to the penguin on the other hand, only S7 among the participant students specified that the penguin was a bird that cannot fly and which was reproducing by laying eggs, while S8 indicated that the penguin was a bird as it was reproducing by laying eggs and that it had a beak-like mouth structure. Students S3 and S5 among the participant students stated that the penguins were swimming very well and they were fish and as they eating fish. Only the student S8 used a statement that “the bat was not a bird as
it was giving birth” while the student S7, who answered the question in the direction that the bat was not a bird but stated in the interview that the bat also could be a bird. The other students who participated in the interview stated wrong ideas in the direction that the bat could also be a bird as it was flying. The findings from the interviews carried out with the students after the application about birds are presented below.

*R*: The penguin, the butterfly, the bat, the pigeon, which of these animals is or are birds? Why?  
**Ö1**: The bat and the pigeon are birds. The butterfly is not a bird. Though it is flying, I think it cannot be a bird.  
*Why can it not be a bird?* It seems to me that it is not a bird. We stated in the class that it was not a bird.  
*Why is it not a bird?* May be as it is not flying that much  
*Why is the penguin not a bird in your opinion?* It is also not a bird. The penguin cannot fly at all. It is different than birds. It is usually walking and swimming.  
*Is the bat a bird?* Yes, it is a bird. It is flying and it looks like a bird.  

**S2**: The bat, the pigeon are birds. The butterfly can only fly but this does not indicate that it is a bird. In addition, butterflies do not exist in every season. However, the pigeon is a bird and the bat is a bird as well.  
*Why is the bat a bird?* Because it is also like birds, it looks like a bird. It has wings and it is flying  
*The penguin, why did you call him not a bird?* Because it cannot be a bird in my opinion as it cannot fly.  

**S3**: The bat and the pigeon are birds. Because, the butterfly cannot be a bird, it is an invertebrate. If the butterfly would be a bird, then bees and flies should also be birds but they cannot be birds. Only their flying is like a bird.  
*The penguin, can it be a bird?* The penguin is not a bird. It cannot fly; it is a very good swimmer. However, the bat and the pigeon are flying. They are birds in my opinion. After all they are vertebrates but the butterfly is invertebrate.  
*S4*: The penguin and the pigeons are birds as the penguins and pigeons reproduce through eggs like all birds and they care after, protect and feed their offspring.  
*Is the butterfly a bird?* No, the butterfly cannot be a bird as the body of birds is covered with feathers but the butterfly does not have feathers. In addition, it is too small and it does not have a vertebra.  
*Is the bat a bird?* The bat is also not a bird. It looks like a bird, it can fly but the bat is a mammal. They reproduce by giving birth and feed their offspring with their milk.  
*S5*: The penguin and the pigeon is a bird. The penguin is among the birds that cannot fly. The pigeon is a bird that can fly.  
*How did you decide that these animals are birds?* They reproduce through eggs and care after their offspring. I saw on TV in a film related with penguin that they care after and feed their offspring between their legs.  
*What features have other birds?* Their bodies are covered with feathers and they breathe through their lungs.  
*The butterfly, why is it not a bird?* The butterfly is invertebrate. It cannot be a bird.  
*Well, is the bat a bird?* The bat is involved in the mammal group of animals. They give birth and give milk.  
*S6*: The penguin and the pigeon are birds. They are vertebrate.  
*Are the other invertebrate?* The butterfly is invertebrate. It does not have a skeleton  
*On what other characteristics did you decide that the penguin and the pigeon was a bird?* They reproduce through egg laying and they have beaks. The penguin has wings but it is not flying. They both have feathers on their bodies. They protect their offspring and find food and feed them.  
*Is the butterfly a bird?* No, it is not a vertebrate animal, birds are vertebrate.  
*Well, is the bat a bird?* The bat is not a bird. It is within the mammals group. The bat does not lay eggs, it gives birth.  
*S7*: The penguin and the pigeon are birds. The penguin is not flying but it is a bird. They reproduce through eggs and care after their offspring.  
*Can all birds fly?* No, there are birds as well that cannot fly. For instance, the chicken, the turkey, they are also birds but they do not fly. The ostrich and the penguin they never fly but they are birds as well.  
*The bat, is it not a bird?* No, it is a mammal. They reproduce through giving birth. Birds on the other hand reproduce through eggs.  
*The butterfly?* It cannot be a bird at all. Birds have a vertebra but the butterfly is not vertebrate. Moreover, the butterfly was a larva before. A living being that was once a larva cannot become afterwards a bird.  
*Ö8*: The penguin and the pigeon are birds. The others are not birds.  
*Why they are not birds?* The bat does not possess the characteristics of the penguin and the pigeon.
What are these characteristics? For instance, as the penguin and pigeon are birds they have beaks, they do not give birth for their offspring as they reproduce through eggs. However, the bat is a flying mammal but it has not a beak like birds and it gives birth and feeds its offspring with milk. Therefore, it is different than birds.

Can the butterfly be a bird? The butterfly can fly but it is not a bird. Not all birds do fly; the penguin is a bird but it does not fly. The butterfly is an insect and it is not a vertebrate animal. However, birds are vertebrate. Therefore, the butterfly cannot be a bird.

What are these characteristics? They reproduce through eggs, they care after their offspring, and they have feathers and beaks.

Why did you call the butterfly not a bird? The butterfly is not a vertebrate. Therefore it cannot be a bird. It does not show the characteristics of a bird. It only flies but not all those fly are birds.

The bat, why is it not a bird? I already stated that not all those fly are birds. The bat is one of those. The bat flies but it is a mammal. It gives birth and feeds its offspring with its milk.

When the interviews carried out with students after the application are examined, it can be observed that except the students S1, S2, S3, have escaped from their misconceptions that were seen prior to education and that they showed a conceptual change. The students S1, S2 and S3, who accepted that the butterfly was not a bird showed that their misconception related to the bat and the penguin are remaining based on their answers that “The bat and the pigeon were birds as the bat was flying whereas the penguin could not”. In addition, if the answers given during the interview of the students S1 and S2 are examined; their statement that butterflies do not exist in every season and that they do not fly that much and that they therefore could not be birds, shows that the misconception of these students related to butterflies is continuing. Although, the student et al.,S3 who participated in the interview and who gave the same wrong answer corrected his/her pre-education misconception that “the butterfly was a bird” by specifying that butterflies were invertebrate animals and that they could not be birds. All students who participated in the interview have escaped after the application from their misconception of all birds and opined that there could also be birds that could not fly.

4. Discussion and Result

Regarding the two-tier test question that was asked within the scope of the study; which of these animals is or are birds and why; the Penguin, the Pigeon, The Bat and the Butterfly?; the misconception in students that “the bat, pigeon and the butterfly was a bird” (Because birds fly but as the penguin is not flying it is not a bird) was the highest ratio (%38.45) before the application as also seen from Table 1. The statement that “the bat and the pigeon were birds” (Because they are flying, the pigeon is not a bird as it was not flying. The butterfly on the other hand flies a little or it cannot fly high) took the second place with a ratio of %11.54. The misconception that “the bat and the pigeon were birds” (because they are flying but the penguin is not a bird as it was not able to fly; as butterflies do not exist in every season they could not be birds), took the third place with a ratio of %7.69.

If the findings obtained from the study are examined, it can be stated that the reason for the misconceptions that students have related to birds are based on faulty generalizations (Çepni vd. 2005). Because, according to the Committee on Undergraduate Education (1996), students create their concepts through inexperienced opinions and daily life experiences (Yağbasan & Gülçięk, 2003). The students who saw that birds flying since their young ages, is it thought that they made an unnecessary generalization error by considering the bat and the butterfly as birds as well because they had a flying capability. It was observed that students with this misconception at the same time made a generalization error, less than necessary, as they did not consider the penguin as a bird as it was not flying. Although, flying is not a common feature for all animals that are included in the bird classification, a large part of the students, as seen from the interviews, consider flying as a basic feature for birds and that they do not consider the animals which do not carry this feature as birds, even if they show other features of a bird. It is specified in the literature that particularly the misconception in the direction that the penguin was a bird is observed in students at every age group (Dikmenli et al., 2002; Sivrikaya; 2005; Yen et al., 2007; Prokop et al.,2007). A similar situation applies to the bat and the butterfly. It is thought that although the bat is a flying mammal and the butterfly is included in the insect classification, they are considered as birds by some students as they are capable of flying. As seen from the explanations, some of the students who participated in the interview have accepted the bat, the
butterfly and even the bee and the fly as a bird like a pigeon only because they were capable of flying. Similar findings have also been reported in the studies carried out by Chen & Ku (1998) Dikmenli et al., (2002), Sivrikaya (2005).

The statistical analysis results (p=0.001) of students from the preliminary test and final test based on the study, show that there is a meaningful difference in favor of the final test. This finding indicates that the education carried out is directing students to make correct explanations and that it is effective on conceptual change at a certain amount. In this context, it can be stated that the conceptual change text prepared about birds help students to face their misconceptions related to the subject and to transform these misconception into scientific thoughts. It has been reported in the studies of Mikkilä-Erdmann (2001), Sivrikaya (2005), Yenilmez and Tekkaya (2006) that using conceptual change texts in learning environments provide opportunities for students to face their misconceptions and that they help to remove these misconceptions.

Although that the rate of %57.69 in the preliminary test of D level students dropped to %19.22 after the application, it is seen that it did not completely disappear after the application. It is specified in several studies (Bilgin & Geban, 2001; Şimşek & Tezcan, 2008) that particularly the thoughts of students formed in the direction of their experiences being different from scientific thoughts were not easy to develop in a positive direction, that they are very strong against new learning and resistant to changes. Therefore, it is obvious that some difficulties will be faced to change the bird concept of students who have gained this through their experiences and their daily life experiences. The findings obtained from the study carried out by Sivrikaya (2005) are in line with this study. It has been reported in the research that the misconceptions of the students continued also at the end of the application.

It has been determined that the conceptual change text, which was prepared by taking common student misconceptions into account, made important contributions in removing the misconceptions of students. Therefore, while teachers and students are developing course books, which are among those important sources they are applying, they should take the following into account; (a) considering the preliminary information and possible misconceptions of students they might have, (b) that they are in a structure enabling the student to built correct bindings between concepts. In this context, it is considered that placing conceptual change texts being prepared according to common misconceptions of students into Science and Technology books could make important contributions in removing the misconceptions of students and in internalizing the issues.

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