Dear Editor,

We would like to thank you and your reviewers for your constructive feedbacks. We have revised the paper and highlighted any change in the text to facilitate the revision procedure. We highlighted our responses to Reviewer A with yellow color, Reviewer B with green color and Reviewer C with turquoise color. Further, we have proofread the paper again and tidies typographical errors up. Unfortunately, the journal new page length policy (15 typesetting pages with all tables, figures and references) did not allow us to depict some of them in the text instead of the supplementary material. Indeed, the revised version of the paper has exceeded the new page length. We wish the editors will provide enough allowance for us. Otherwise, we have to move some part of the text to supplementary materials even though Reviewers A and B criticized this issue. If you or your reviewers request any further revision, we are willing to focus on them. Our responses to the reviewer comments are outlined as follows:

Our responses to Reviewer A (highlighted with yellow color in the text):  
  
INTRODUCTION  
  
**1. Page 2, line 35: The graphical skills cannot be learned, but they can be  
acquired or developed.**

We changed “learning” with the “developing” in the introduction section on pages 2.  
  
**2. Page 2, line 54-61: „Even though conceptual change methods used in the  
aforementioned studies were somewhat effective in overcoming the pre-service  
science teachers’ alternative conceptions related to gases and gas  
laws...“ The authors should more clearly explain the differences between  
this current study and previous ones which also examined the conceptual  
change instructions within pre-service science teachers. What conceptual  
change instructions were applied in that studies? Henceforth, the  
contribution of the present study would be highlighted.**

We had already handled this issue within the introduction section in page 2: “These include problem-based learning13, research-based approach11,14, research-based computer simulations15, conceptual change-oriented instruction9,12, hands-on laboratory activities accompanied with computer modeling16, argumentation-based pedagogy17, augmented virtual science laboratories3,18 and case-based instruction.7 Of these studies, only three concentrated on teacher preparation programs and studied with pre-service teachers.11,13,17 Pabuccu and Erduran19 called for more studies related to facilitating pre-service science teachers’ understanding of the gases and gas laws. The current study, therefore, was undertaken in response to this call.” However, we inserted the following explanation to respond the Reviewer A’s comment: “Previous studies have used only one or two conceptual change methods/techniques ,3,7,12,14,15,16,17 instead of combining various conceptual change methods/techniques within the 5Es learning model. By doing this, the current study illustrated an alternative pedagogical approach for gases and gas laws and enriched the learning environment with different conceptual change methods/techniques.”

**3. Also, as I could  
see, for example, cited study [ref. 20] included students (11th grade  
students) and not pre-service teachers as higlighted on page 2, line 58.**

You are right. We removed it from on page 2, line 58.

**4. -       Theoretical framework of 5Es learning model should be elaborated: each  
„E“ as a part of the learning model should be explained, then how this  
model is connected with constructivist theory of learning, etc.**

Indeed, earlier draft version of the paper included all inquiries aroused by the Reviewer A. However, the journal new page length (15 pages with all tables and references) forced us to eliminate some points of the paper. We have just added the 5Es learning model and its relation to constructivism on page 4-5 with the subsequent statements: “Any educational paradigm change (e.g., constructivist learning theory) promotes national educational systems to update their needs of new trends (i.e., economic development, manpower). For example; the most recent versions of the Turkish science curricula emphasize student engagement, creative thinking, innovative thinking, constructivist learning theory, and varied teaching methods/strategies to stimulate students’ interests in science/chemistry30. That is, the Turkish science curriculahave challenged traditional or teacher-centered instruction and fostered any innovative view for science learning and teaching. Even though various learning models of constructivism have been launched, e.g., 3Es (Explore-Explain-Elaborate) (called Learning Cycle), 4Es (Engage-Explore-Explain-Evaluate), 5Es (Engage-Explore-Explain-Elaborate-Evaluate) and 7Es (Excite-Explore-Explain-Expand-Extend-Exchange-Examine,39 the most recent versions of the Turkish science curricula have especially suggested the 5Es learning model.21,34 Since each “E” represents a particular part of the learning process and calls for varied conceptual change methods/techniques (i.e., computer animation, worksheet, analogy and experiment), the 5Es learning model purposes to actively assist students in linking their prior knowledge with new concepts.”. But, we have unfortunately exceeded the page length again.

**5. Also, the  
authors noted that this is the first study that has tested the effects of  
5Es learning model on pre-service science teachers’ understanding of the  
subject of gas and gas laws (page 5, lines 134-136). However, there are  
other studies which examined the same question before, within different  
chemistry topic (e.g. electrochemistry), and this should be noted in the  
manuscript.**

We inserted the following statement into the text: “Even though some studies have investigated the effect(s) of the 5Es learning model with varied conceptual change on the pre-service science teachers’ understanding of other science/chemistry subjects (e.g., electrochemistry),21…”. We think this statement emerge the significance and originality of the current study within “the effects of  
5Es learning model on pre-service science teachers’ understanding of the  
subject of “gas and gas laws” and SPS” on page 5.

**6. -       Page 5, lines 136-139: „Therefore, the 5Es learning model directly  
influences their conceptual understanding and science process skills...“  
Is this statement comes from the results of some study?   
-       After defining the aim of the study, the research questions or tasks  
should be derived.**

The Reviewer A is right. We added related references for the statement and our research questions at the end of the introduction

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**EXPERIMENTAL  
  
7. -       Observing the applied research design – a quasi-experimental research  
design with a non-equivalent pretest-posttest control group, it is unusual  
to have groups in which participants were randomly assigned. Namely, in the  
literature it is noted that in the  non-equivalent  pretest-posttest   
control group design  subjects  are not  randomly  (NR)  assigned  to   
groups (e.g. Sousa  VD,  Driessnack  M,  Mendes  IAC.  Rev  Latino-am   
Enfermagem,  2007,  15(3):502-7.). If the authors have an adequate  
literature to confirm that this research design can be followed by randomly  
assigned groups, such reference should be added.**

Indeed, earlier draft version of the paper included how we selected and assigned the groups. However, the journal new page length (15 pages with all tables and references) forced us to eliminate this assignment procedure, we have just added the subsequent statements: “The department of science education under investigation possessed two regular cohorts (Classes A and B) for the third-year of the four-year teacher preparation program. Hence, the experimental (15 females and 9 males) and control (15 females and 10 males) groups were randomly assigned to these two cohorts instead of randomly devoting them to the groups.” Also, we have added related references we had already used.

**8. -       Additional information about science teachers study programme in the  
public university in Turkey is missing (the groups of courses, etc.).**

We copied this information from the first draft of the paper we had removed due to page length : “A-four-year-science teacher education program, which is an integrated framework of physics, chemistry, biology, earth science and astronomy, covers a total of 240 European Credit Transfer System (ECTS)—180 ECTS for compulsory courses and 60 ECTS for elective courses. All Turkish science teacher education programs have to track the same syllabus of any compulsory course offered by Higher Education Council (Yüksek Öğretim Kurumu). These courses are labeled under four categories: subject matter knowledge (i.e., General Chemistry I-II, Science Laboratory Applications I-II, Special Topics in Chemistry), pedagogical content knowledge courses (e.g., Science Teaching Methods I-II), general pedagogy knowledge (i.e., philosophy of education, sociology, guidance and counseling) and general cultural knowledge (e.g., foreign language—English, German, French).

**9. -       In the present form of the manuscript, it is unclear how worksheets,  
analogy, computer animations were related to the 5Es learning model  
(engagement, explanation, exploration, elaboration, evaluation), because it  
is not convenient to put everything in the Supplementary Material. The  
readers should be familiar with the applied instructions (in both  
experimental and control groups) from the basic text of the paper. Some  
materials as worksheets can be placed in the Supplementary Material,  
however, the teaching and learning design must be explained directly in the  
text.**

We absolutely agree with the Reviewer A’s comment. However, the journal new page length policy did not allow us to depict them in the text instead of the supplementary material. For this reason, we have not moved these designs into the text. If associate editor permits us to extend the page length of the paper, we can do this. Otherwise, they will remain as the supplementary materials.

**10. -       Also, one example of the two-tier item should be provided in the  
manuscript, and the whole gas laws questionnaire should be presented in the  
Supplementary Material.**

We absolutely agree with the Reviewer A’s comment. However, the journal new page length policy did not allow us to depict them in the text instead of the supplementary material. For this reason, we have not moved same questions into the text. If associate editor permits us to extend the page length of the paper, we can do this. Otherwise, they will remain as the supplementary materials. For the whole gas laws questionnaire, unfortunately we preferred only presenting sample questions to translating all questions from Turkish into English. If anyone requests its full text via e-mail from the correspondence author, we are willing to share it with him/her. We wish the Reviewer A will understand our preference.

**11.-       Page 8, lines 256-257: „After the teaching intervention, the same instruments were re-administrated as post-tests.“ I wonder if the form of the gas laws questionnaire was exactly the same in the pre-test and post-test? If yes, how it was ensured that pre-service science teachers do not discuss each other about the correct test solutions before the final testing?**

Let us explain our preference again. First of all, researchers generally use the same instruments as pre- and post-tests to eliminate another variable stemming from instrumental differences in re-test and post-test. A few researchers also claim to use different questions in pre-test and post-test. However, the latter is generally criticized since finding similar questions is very difficult. For this reason, we preferred the former one and added the following explanation for the Reviewer A’s other comment: ” Further, the researchers did not give any information about the data collection tools and their possible responses. For this reason, they did know that the data collection tools would be employed as post-tests after the treatment. . However, they may have wondered their responses and argued them with their peers. This may be seen as the effect(s) of the teaching intervention on building their own knowledge and facilitating their science learning.”

**12. -       Please provide one example of the multiple-choice question of the Science  
Process Skills test also.**

We added one example of the multiple-choice question of the Science  
Process Skills test in the supplementary material.

**13. -       Page 8, line 258, Data analysis: It must be highlighted that the authors  
had made changes in scoring rubric in comparison with cited literature [ref.  
21, 22]. For example, in original ref. 22, correct answer with sound  
understanding was scored with 5 points, and in this manuscript correct  
answer was scored with 4 points and then sound understanding within the  
second-tier with 8 points more. The authors should explain why such changes  
were made.**   
  
We explained these comments under data analysis section.

**RESULTS AND DISCUSSION  
  
14. -       The authors should represent the basic statistical parameters for the  
pre-service science teachers’ performances on the gas laws questionnaire  
and science process skills test (average scores, SD, min, max, etc.). Such  
information can be beneficial to observe the real difference between the two  
groups. These Tables could be placed in the Supplementary Material.**

We created and added Table S-V for the descriptive parameters.

**15. -       The authors should be more careful in interpreting the results about  
conceptual changes (Page 10, lines 318-319; Page 11, lines 332-334).  
Firstly, it should be highlighted how many misconceptions were identified in  
total. According to the Table S-IV there were 11 identified misconceptions  
in total. Then to calculate the number of misconceptions in which no  
conceptual change was observed in each group; the number of misconceptions  
in which positive conceptual change occurred in each group; the number of  
misconceptions in which negative conceptual change occurred in each group.**

We would like to thank Review A for his invaluable comments. We added the following statement to respond his comment: “pre-gas laws questionnaire drew out 9 alternative conceptions for the control group and 6 alternative conceptions for the experimental group. After the treatments in both groups, the control and experimental groups accomplished positive conceptual change for 8 and 6 alternative conceptions respectively. Further, the control group showed one negative conceptual change for the ninth alternative conception and one neutral conceptual change for the fourth alternative conception. This means that…”

**16. -       Page 11, lines 348-349: the sixth and eleventh misconceptions were not even  
identified within experimental group. Also, page 11, line 355, eight, ninth  
and tenth misconception were not identified within experimental group.**

 The Reviewer A is right. We had miswritten their numbers. Given the Reviewer A’s comment, we corrected them.  
  
**CONCLUSION  
  
17. -       In this study the learning styles were not observed as independent  
variable, so this should be deleted from the conclusion (Page 13, line 403).**

We deleted it from the conclusion section.

**18. -       Page 13, lines 404-405: „There were alternative conceptions that were  
resistant to change in both groups.“ This sentence needs explanation. How  
this was concluded? Which alternative conceptions were resistant to change  
in both groups?**

We explained these issues in the ‘results and discussion’ section under the results from the gas laws questionnaire. We did not replicate them in the conclusion section and only addressed our inferences from the results and discussion.

**19.-       Also, it should be noted if some new misconception was found in this study  
as original contribution of the research (i.e. misconception which was not  
previously presented in the literature).**

We added the following statement by taking the Reviewer A’s comment into consideration: ” Even though the pre-service science teachers held some common alternative conceptions reported by the related literature (see Table S-I), the current study elicited several new alternative conceptions (i.e., the first, fourth, sixth and tenth alternative conceptions—see Table S-IV). This may stem from their pre-existing experiences or learning/class cultures or contextual differences in various countries.”  
  
**Our responses to Reviewer B (highlighted with green color in the text):  
  
1. However, in some parts, it was quite complicated to follow the text of the  
manuscript. For example, in some reason, the Science Process Skills Test, outlined in  
Abstract, the following manuscript is the science process skills test (an  
abbreviation could help). In supplementary materials, there is an abbreviation SPS, but there is no explanation (science process skills, I suppose). Also, in supplementary materials, there are CA (computer animations, I suppose), but there is no explanation nor in the manuscript, nor the supplementary materials. Also, 5Es should be explained at the beginning, in Abstract. I suggest that each abbreviation should be explained  
at first guiding and consistently used through the manuscript and  
supplementary materials. The authors should consider it and apply in the  
manuscript.**

The reviewer B is right. We made these corrections given his comment.

**2. In the manuscript, authors rely heavily on supplementary materials. It is  
necessary that the essential parts of the application of the method are  
presented in the manuscript. Supplementary materials are supplementary  
materials. That is it. It is unusual to refer to supplementary materials for  
the key details of the applied intervention. That should be explained in the  
Teaching intervention.**

We absolutely agree with the Reviewer B’s comment. However, the journal new page length policy (15 typesetting pages with all tables, figures and references) did not allow us to depict them in the text instead of the supplementary material. For this reason, we have not moved them into the text. If associate editor permits us to extend the page length of the paper, we can do this. Otherwise, they will remain as the supplementary materials.

**3. I advise the authors to check the entire text of the manuscript, although  
I'm not a native speaker. For example:   
Line 246-249 Whilst multiple-choice questions focused on recalling the  
science process skills and could quickly be scored (time-efficient) by the  
participants. The open-ended questions, on the other hand, concentrated on  
their understanding of science process skills, and the use of scientific  
language (i.e., scientific terminology).   
I also had a dilemma whether the "gas laws questionnaire" was indeed a  
questionnaire. I think that the questionnaire, for this research, was also the test, as the  
Science Process Skills Test. It also deserves its full name and  
abbreviation, for easier reading of the manuscript.   
There are technical errors. Authors have to take care of. I give an example:  
Manuscript, Line 92. Font of references.   
Authors need to correct/reorganize manuscript.  
1. It refers to the explanations of all abbreviations that are in the  
manuscript and the supplementary materials  
2. It refers to the parts that are important to be in the manuscript, not in  
the supplementary materials. I suggest that more information on the teaching  
design for the experimental group/control group should be in the manuscript.**  
In line with the referee's comment, we corrected abbreviation and used their full names throughout the text. For the second comment, we absolutely agree with the Reviewer B’s comment. However, the journal new page length policy (15 typesetting pages with all tables, figures and references) did not allow us to depict them in the text instead of the supplementary material. For this reason, we have not moved same questions into the text. If associate editor permits us to extend the page length of the paper, we can do this. Otherwise, they will remain as the supplementary materials.

**Our responses to Reviewer C (highlighted with turquoise color in the text):**

**Reviewer C:  
  
Dear authors, this is well written paper and I suggest to be published. I recommend just  
few suggestions:    
1. - Supplementary material - Table S-I - No. 9 and 10 - Look like conclusions,  
not the concrete alternative conceptions**

Thank you for your positive feedback. We've checked Table S-I - No. 9 and 10. however, these are alternative conceptions reported in the literature. For this reason, we did not change them. We wish the Reviewer C will understand this special case.

**2. - Supplementary material - Is it possible to add tittles e.g. Appendix 1,  
Appendix 2,... and address them in the main paper respectively?**

We agree with the Reviewer C and added Numerical Appendix Order.

**3. - Line 39 - grades – age**

In line with the referee's comment, we added students’ grades.

**4. - Line 117 - explain the abbreviations only at the first mention (it is  
already done, line 112)**

We corrected it.

**5. - Line 260 - Please explain the assessment criterion, i.e. why is the point  
given for the wrong answer. Is the reason to force a response or something  
else?**

The related literature states that constructivism pays more attention to wrong answers as much as correct ones. We added the following explanation: “In analyzing the gas laws test, their responses were ranked from the most scientifically accepted ones to scientifically incorrect ones.”

**6. - Line 320 - the percentages of the experimental and control groups ... add  
(PrT, PoT)**

We added the percentages of the experimental and control groups.

**7. - Line 324 - positive conceptual change ... add (CC)**

We added “CC” for conceptual change on page 11 line 324.