IJEEL
Peer-Reviewed International Journal

International Journal of English Language, Education and Literature Studies (IJEEL)

ISSN: 2583-3812
Vol-3, Issue-3, May-Jun 2024

Journal Home Page: https://ijeel.org/
Journal CrossRef DOI: 10.22161/ijeel

Misconception in Air Pressure and Use of Conceptual Change Model to Eliminate Misconception

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Article Detail:

Received: 15 Sep 2023;

Received in revised form: 04 Jun 2024;

Accepted: 14 Jun 2024;

Available online: 26 Jun 2024

Keywords*— *Conceptual Change Model (CCM), misconception, Air pressure.

Abstract

Determine the common misconceptions about air pressure's dependence on altitude and boiling point's dependence on air pressure and use the Conceptual Change Model to eliminate misconceptions. A quantitative case study was administered to gather information from 25 students of Tang Central School. The three-tier model was used to identify the misconceptions in participants. The conceptual Change model focused on four steps (awareness, exposure, confrontation, and resolving) were incorporated to address the misconception. In the process, YouTube tutorials were used as learning materials. Misconceptions are allayed using an effective teaching strategy (Conceptual Change Model) and outsourcing external resources such as tutorials.

I. INTRODUCTION

Science is the subject that explains all natural, chemical, and biological phenomena taking place in and around us. It encompasses the study of all aspects from micro to macro levels. It is the subjects that evaporate all sorts of orthodox and misinterpretations of phenomena. It gave a new outlook to our mind to explain with valid proof of everything. Analogously, an empty room is no longer considered empty for the fact that air as a matter occupies it.

It makes sense to state school as a place where learners learn and unlearn. To make sense of new concepts, it is always important for teachers to be aware of clear misconceptions students bring in. Simply teaching from the text or the teacher's perspective would no longer enhance effective learning. There must be an understanding that students come with their prior knowledge.

Misconception is a misguided belief or a naïve idea that learners bring into the classroom. It creates confusion in making sense of concepts taught in the classroom and students become reluctant to accept them from the perspective of how they should learn. As long as students come with their understanding inherited from their experience and their social interactions, misconceptions will exist.

The Bhutanese curriculum (Physics) being spiral in structure, students progressively confront with deepening of concepts in air pressure (Physics) standard by standard. Therefore, the knowledge acquired at lower levels does not adequately express enough ideas to address the misconceptions. In the process, misconception would be carried throughout their lives or it becomes difficult to induce understanding at the later stage.

1.1 Background of the Study

Misconceptions, also called alternative conceptions, refer to ideas that are inconsistent with scientific conceptions. By the time learners reach the high school, they have well established misconceptions

that are resistant to change despite teaching (Merwe & Gaigher, 1994).

In Bhutan, students are introduced to the formal science curriculum only when they take up science subjects in class IV. However, simple concepts about the air are learned in another subject called social studies. At this lower level, students learn about the air in the form of drawings to represent the weather and find the direction of the air. With this naïve concept taught and from the interaction of students with their surroundings, then the misconception is almost rooted in the minds of young people when they start to learn about deeper concepts like the kinetic theory of matter. Students mostly then believe air and gas to be two different entities. Therefore, this paper aims to determine the misconceptions on the properties of air pressure.

1.2 Problem statement

The air is all around us and is an essential part of our everyday environment. Children have a lot of experiences with air before they are taught about it in schools. However, since air is invisible, its properties are taken for granted or not consciously considered by children before they are taught about air in school. The nature of air is very difficult to understand for children because it is colorless, odorless, and tasteless (Bulunuz, M., Jarrett, O. S., & Bulunuz, N., 2009).

As a case study, the gap in understanding the of properties air pressure (as a property of air) identified by Bulunuz, M., Jarrett, O. S., & Bulunuz, N. (2009) as the air all around us and is an essential part of our everyday environment. Children have a lot of experiences with air before they are taught about it in schools; they live in the air, feel wind and drafts and they inhale and exhale and use devices operating with air, for example, tyre pumps, balls, electric fans, air conditioners, vacuum cleaners, sprayers, etc. However, since air is invisible, its properties are taken for granted or not consciously considered by children before they are taught about air in school.

The nature of air is very difficult to understand for children because it is colorless, odorless, and tasteless. Although children are familiar with the word "air," stationary air has little reality for them (Bulunuz, M., Jarrett, O. S., & Bulunuz, N., 2009). Furthermore, many individuals believe that increasing altitude naturally leads to decreased atmospheric pressure without considering other influential factors such as temperature variations and weather systems. To this, Thompson (2019), discusses altitude as just one factor influencing atmospheric pressure, shedding light on how temperature variations and weather patterns also play a crucial role.

1.3 Research question

1.3.1 Primary Question: How can the conceptual change model help students overcome misconceptions about two properties of air pressure?

1.3.2 Secondary questions:

Do students have misconceptions about the dependence of air pressure on altitude and how can conceptual change help them overcome it?

Do students have misconceptions about the dependence of boiling point on air pressure and how can conceptual change help them overcome it?

1.4 Aim

This case study looks forward to the following extremely important traits related to air pressure:

1. Determine the misconceptions related to air pressure.
2. Suggest strategies to overcome misconceptions.

1.5 Significance

This study is carried out to firstly identify the common misconceptions on properties of air pressure then the identification it sought to help students to overcome their misconception through the use of conceptual change method.

II. METHODOLOGY

2.1 Research Approach

Research approach used by the researcher depends on numerous factors such as worldview of the researcher, research design, research methods, and research problem (Creswell, 2014). The qualitative approach is used as it fits the intended research questions and tools for data collection to obtain answers to the research questions. Moreover, qualitative approach has had a rich history and effectively adopted in the education and the social sciences.

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2.2 Research method

The method employed to collect data is survey questionnaire. Questions are developed based on the common misconceptions already identified and adopted with modification. The sample of questionnaire is reflected in Annexure I.

The more effective method to study on misconception would be the three tier system. In this system the first tier detects the misconception through multiple choice question. The second tier explores the reason for choosing the particular answer from first tier and the last tier checks the validity of the reason

Stepans, (2006) suggested the resulting implications for teaching that the teacher should identify misconceptions about prior knowledge or concepts prior to teaching the basics, identify reference book learning, and facilitate effective communication so that information received by the student is complete and correct. Similarly (Alexopoulou & Driver, 1996) have seen that students' naïve conceptions can be improved through active participation in hands-on activities and demonstrations and collaboration with teachers and peers.

The conceptual change model as suggested by Stepans, (2006) places students in an environment that encourages them to confront their own preconceptions and those of class mates, then work toward resolution and conceptual change. The stages of this model includes

1) Awareness: students become aware of their own preconceptions and make predictons.
2) Exposure: students expose their beliefs by sharing to the class.
3) Confrontation: students confront their beliefs by testing and discussing
4) Resolving: students work to resolve conflicts (if any) between their ideas and observations to accommodate new concept.

Therefore the conceptual framework for this particular study is developed in-cooperating three tier system as used by (Taslidere, 2016) and the conceptual change model developed by (Stepans, 2006).

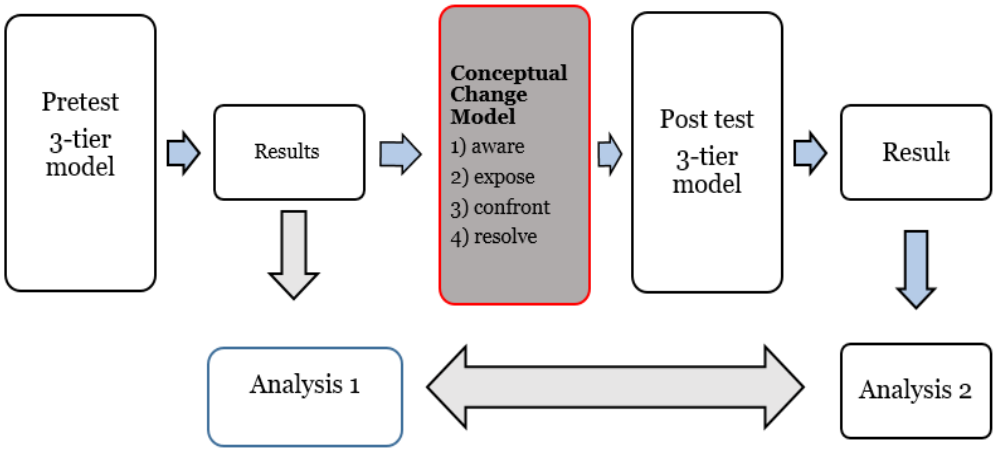

Fig 1: Conceptual Frame Work

III. SAMPLING

The samples of the study were class X students of Tang Central School, Bumthang. 25 students (11 males & 14 females) were randomly selected to answer the questionnaire. The Simple Randomization of sample is administered to provide impartial opportunity to students to participate in the questionnaire with the hope that these participants would be able to represent the whole population of students across in terms of understanding the misconception under study.

IV. PRE DATA: FINDINGS AND ANALYSIS

The respondents' answers to the questions were analyzed using Microsoft Excel. For the three tier system, each tier is analyzed to provide distinct aspect each tier and to avoid ambiguity among each tier.

4.1 Misconception on of air pressure with altitude.

To identify the misconception on relation of air

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pressure with altitude, the multiple choice question was asked as first tier to understand students' response:

Question: *suppose you drive quickly down a high mountain to a valley. Your ears will be clog up. What is the reason for it?*

Secondly, another round of multiple choice question was asked to know the reason of choosing a particular answer in first step.

Lastly, another round of options are laid to students to really confirm whether the topic under the study is a misconception, no conception or no misconception.

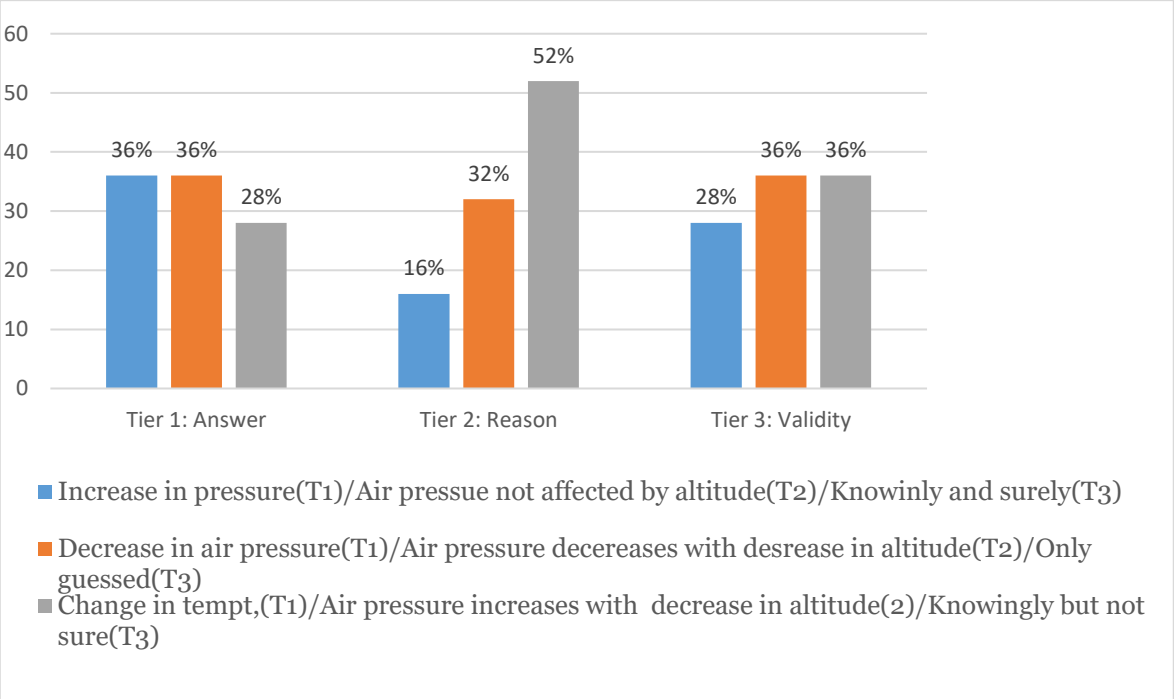

Fig.2: Response graph to the first part of the misconception (pre-test)

First tier: From the response graph, it is evident that 36% of participants were able to answer correctly, another 36% took the concept oppositely while 28% could not connect the concept of air pressure with change in altitude. So we cannot assure if it is a misconception or not.

Second tier: In crosschecking of participants' reason for opting for or selecting a particular answer in the first tier, interestingly 52% responded correctly. 32% of the respondents have mistaken the relation whereas only 16% thought that there is no relation between air pressure and altitude.

In the third tier to validate if the respondents had misconceptions or not 36% guessed the answer and reason whereas another 36% knew the response but weren't sure. Only 28% were sure of their response.

From the above findings maximum number of respondents gave the correct answer and even more right reasons for their answer. Meaning the respondents knew the concept of the relation of air pressure to altitude. Although the first and the second tier inform about how well the respondents informed could be on the concept many opted knowingly but not surely. This indicates that there is a misconception in understanding the concept of air pressure being dependent on altitude. Similarly, more numbers of respondents seemed to have a limited concept of air pressure changing about changing altitude as more guess options were shown.

4.2 Misconception on the dependence of boiling point on air pressure.

To identify the misconception on the relation of air pressure and boiling point, the multiple choice question was asked as the first tier to understand students' responses:

Question: Compared to Samtse (lower altitude), the boiling point of water as Dochula (higher altitude) will be _____.

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Secondly, another round of multiple choice question was asked to know the reason of choosing a particular answer in first step and lastly, another round of options are laid to students to really confirm whether the topic under the study is a misconception, no conception or no misconception.

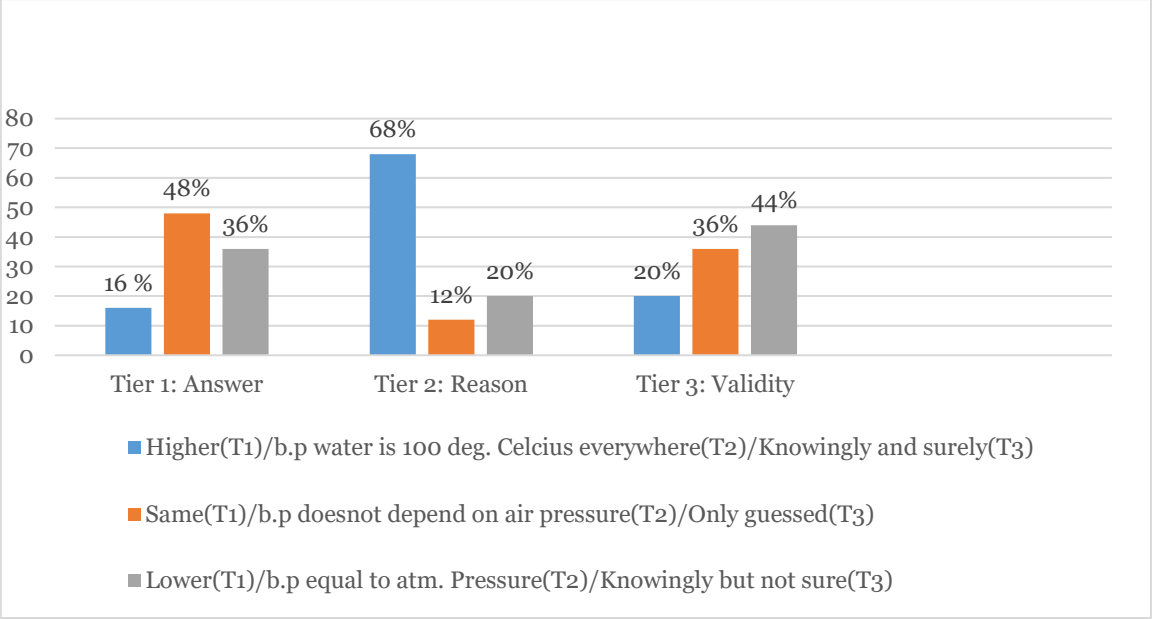

Figure 3: Response graph to the second part of the misconception (pre-test)

First tier: From the response graph, it was evident that 36% of participants were able to answer correctly but 16% of respondents thought the boiling point at Dochula would be higher and 48% thought that the boiling point at Samtse and Doclula is the same. So, from here we can sense the misconception.

Second tier: In crosschecking of participants' reason for opting for or selecting a particular answer in the first tier, interestingly 68% responded that the boiling point of water is 100 ^{o}C everywhere. However a good number of respondents, 20% gave the correct reason and the remaining 12% thought that there is no relation between air pressure and boiling point. Therefore the findings here might prove that respondents do not have the concept.

In the third tier to validate if the respondents had a misconception or not, it shows that a maximum number of respondents have the misconception. It is because 44% of the respondents seemed to have the concept but they were not sure of whether the boiling point depended on atmospheric pressure. The remaining 36% guessed the answer showing that they did not have the concept and only 20% were sure of their response.

V. INTERVENTION

As an intervention conceptual change model as used by Stepans, (2006) was incorporated to design the following lesson

5.1 Intervention 1: To address the misconception on the relationship between air pressure and altitude

Question: why do our ears clog up when we travel down to lower altitudes?

Conceptual Change Elements	Activity
1. Awareness: students become aware of their preconceptions and make predictions.	Students individually share their perceptions and understanding in a small group of three.
2. Exposure: students expose their beliefs by sharing with the class.	Then share their understanding with the whole class

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3. Confrontation: students confront their beliefs by testing and discussing	Students then watch a video clip(clogging and puffing of ears of pilots) along with an explanation from the teacher/researcher
4. Resolving: students work to resolve conflicts (if any) between their ideas and observations to accommodate new concept.	Students then again discuss in their group of three and share their consensus idea with modification.

Fig.4: Intervention table for first part of misconception

5.2 Intervention 2: To address the misconception on the relation between air pressure and boiling point.

Question: 1. Explain the working of the pressure cooker. 2. Is it easier to cook at a lower altitude or higher altitude?

Conceptual Change Elements	Activity
1. Awareness: students become aware of their preconceptions and make predictions.	Students individually share their perceptions and understanding in a small group of three.
2. Exposure: students expose their beliefs by sharing them with the class.	Then share their understanding with the whole class
3. Confrontation: students confront their beliefs by testing and discussing	Students then watch a video clip (working of pressure cooker and atmospheric pressure and boiling) along with an explanation from the teacher/researcher
4. Resolving: students work to resolve conflicts (if any) between their ideas and observations to accommodate new concepts.	Students then again discuss in their group of three and share their consensus idea with modification.

Fig. 5: Intervention table for the second part of the misconception

VI. POST DATA ANALYSIS

After the intervention same questions were again floated to participants. Respondents' answers to the questions were analyzed using Microsoft Excel. For the three-tier system, each tier is analyzed to provide distinct aspects of each tier and to avoid ambiguity among each tier as done in the pre-test.

6.1 Misconception on the dependence of air pressure on altitude.

Now to test the misconception on the relation of air pressure with altitude, the multiple choice question was asked as the first tier to understand students' responses:

Question: *suppose you drive quickly down a high mountain to a valley. Your ears will be clogged up. What is the reason for it?*

Another round of multiple choice questions was asked to know the reason for choosing a particular answer in the first step. Lastly, a round of options is laid out to students to confirm whether the topic under study is a misconception, no conception, or no misconception.

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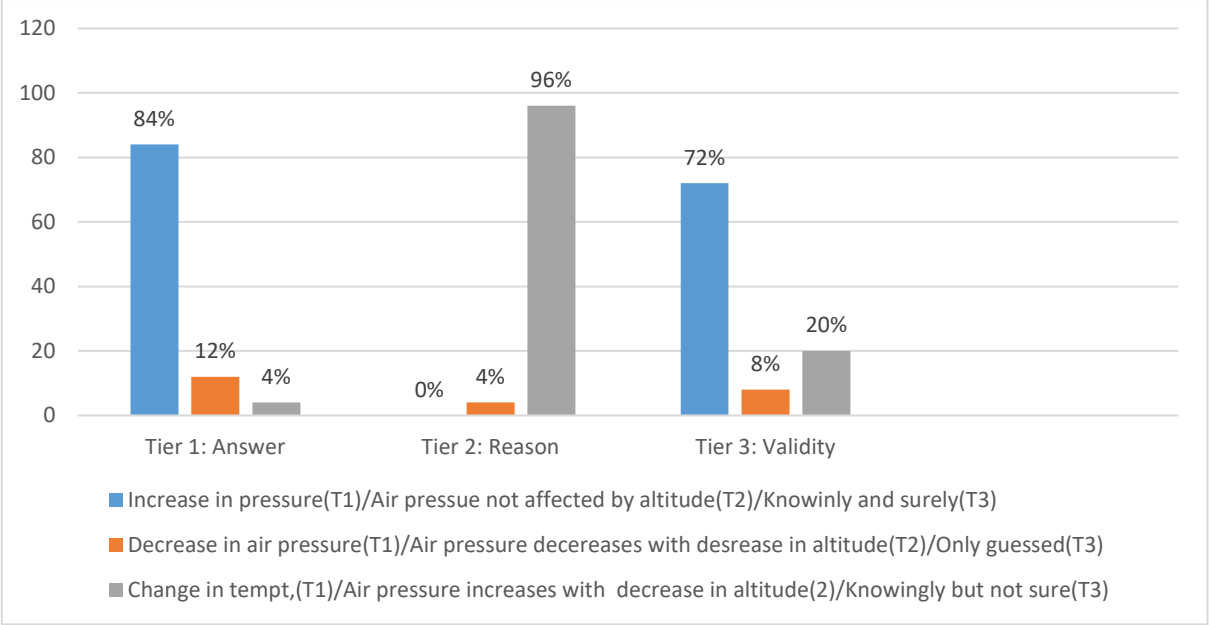

Fig.6: response graph for first part of misconception (post- test)

After the intervention, 84% of the respondents could answer correctly to the answer whereby still 12% seemed to have little confusion and 4% yet not convinced by the intervention. However, 96% have the correct reason for their answer, and only 4% with the confusion. In line with the correct answer and the reason in the first and second tier, and third part which shows the validity of participants' answers and responses shows that the participants are now clear with the concept in which 72% opted to show that they knew the answer and reason for sure. Only 8% guessed the answer and 20% weren't sure. From this data obtained it clearly shows the conceptual change model indeed has helped students clarify their misconceptions.

6.2 Misconception on the dependence of boiling point on air pressure.

To check whether the misconception on the relation of air pressure and boiling point, the multiple choice question was asked as the first tier to understand students' responses:

Question: Compared to Samtse, the boiling point of water as Dochula will be _____.

Secondly, another round of multiple choice questions was asked to know the reason for choosing a particular answer in the first step and lastly, another round of options was laid to students to confirm whether the topic under the study is a misconception, no conception or no misconception as in the pre-test.

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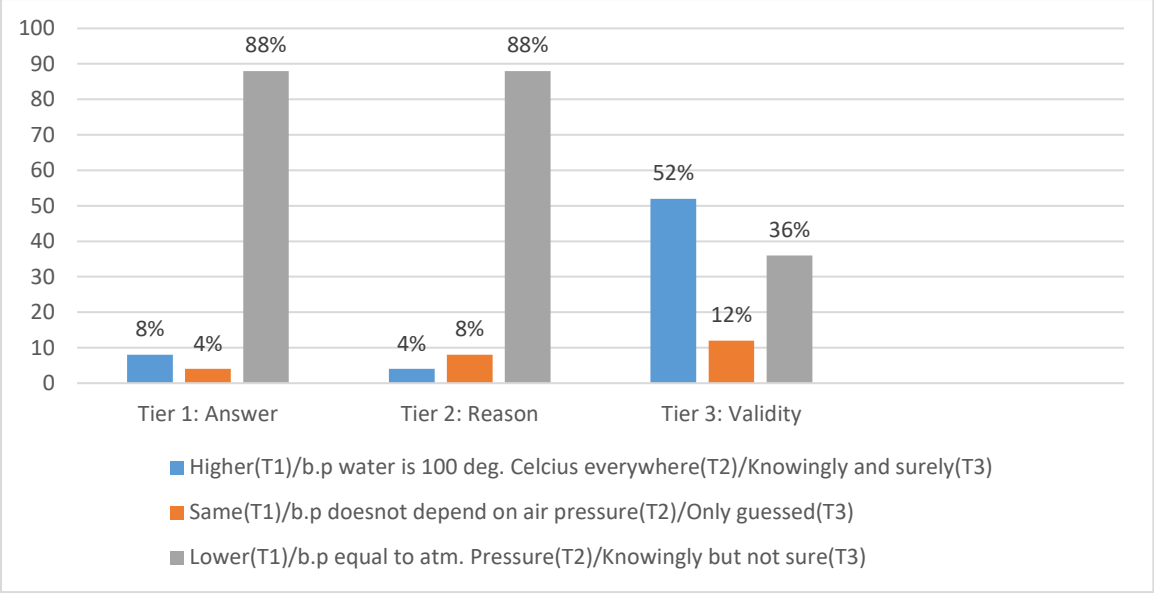

Fig.7: response graph for second part of misconception (post-test)

After the intervention 88% of the respondents could answer correctly to the answer whereas 12% seems to have confusion. However 88% have the correct reason for their answer and only 12% unsure sure of the reason. In line to the correct answer and the reason in first and second tier, and third part which shows the validity of participants' answer and response show that the participants are now clear with the concept in which 52% clearly opted to show that they knew the answer and reason for sure. Only 12% guessed the answer and 36% wasn't sure. From this data obtained it clearly shows the conceptual change model indeed have helped students clarify their misconception.

VII. DISCUSSION AND RECOMMENDATION OF STRATEGIES TO IDENTIFY AND ADDRESS THE MISCONCEPTION ON PROPERTIES OF AIR PRESSURE

(Bulunuz, Jarrett & Bulunuz, 2009) and (Sere, 1986) found that there exist the misconception on the properties of air pressure among the students due to intangible form of physical nature of air. These researchers posits that the students believed that air is associated with motion. Aligning to the nature of misconception, it directly line up with preconceived notion and non-scientific knowledge that the students have gained from their interaction with their surroundings. Similarly, it seemed that misconception about the properties of air pressure also exists among Bhutanese students. In this study, the responses revealed that the students have misconceptions related to air pressure. Therefore, it is the role of the teachers to identify and address the misconceptions by using every possible strategy.

Humans construct their own knowledge using their existing knowledge. However, the construction process is influenced by a variety of social experiences, and the knowledge constructed by each individual is not normally completely personal and idiosyncratic (Hewson, 1992). Similarly (Stephan, 2006) posits that by identifying the source and type of misconception, teachers can use appropriate strategies mainly focused on students centered strategy, Conceptual Change method as follows: i) awareness of students' own thoughts ii) exposure of their thoughts 3) confronting their thoughts on the concept 4) resolving to accommodate to the new concept.

VIII. CONCLUSION

The main purpose of this study was to identify whether there were misconceptions about the two concepts of air pressure prevalent among the and thus accordingly design the instructional strategies that can confront and overcome the misconceptions. The study revealed that the students possess misconceptions about air pressure being affected by

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altitude and boiling point being dependent on air pressure as Bulunuz, Jarrett & Bulunuz (2009) found that students were not able to understand the relationship between altitude and air pressure and even the boiling point of water.

Misconceptions can be addressed if we can identify misconceptions. However, it becomes difficult to change the thinking of students. Therefore, it is also important to understand the cause of misconception and its origin so that we can use an appropriate method to address it. One can use the Conceptual Change Model in this regard. The idea of conceptual change entered education as an analogy drawn from the history and philosophy of science that helped understand the difficulties people experience in changing from one explanatory framework to another (Hewson, 1992).

If employed in the right sequence, the Conceptual Change Model helps in confronting and resolving misconceptions (Stephan, 2006). The use of CCM could also promote thoughtful reflection by introducing contradictions between erroneous conceptions and new information reinforcing engagement necessary for meaningful learning transformation (Fisher et al., 2018).

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Article DOI: https://dx.doi.org/10.22161/ijeel.3.3.12

Appendix A: Tools adapted from Bulunuz, Jarrett & Bulunuz (2009): *Air Properties Questionnaire*

Air pressure and Properties of air: Questionnaire

The following questions are related to two properties of air pressure. Thank you!

Survey Questionnaire

Section A: Demographic Profile

1. **Gender**
   a. Male ☐ b. Female ☐
2. **What is your age group?**
   a. 10-12 ☐ b. 13-15 ☐ c. 16-18 ☐ d. 18 & above ☐
3. **Class** ☐

Section B:

Direction: *The following questions are related to TWO properties of air pressure.*

1. Suppose you drive quickly down a high mountain to a valley. Your ears will be clog up. What is the reason for it?

a) Increase in air pressure b) Decrease in air pressure d) Change in temperature

Which one of the following is the main reason for your answer?

- ☐ Air pressure is not affected by altitude.
- ☐ Air pressure decreases with a decrease in altitude.
- ☐ Air pressure increases with a decrease in altitude.
- ☐ Air pressure is the same everywhere.

What do you think about your answer?

☐ Knowingly and surely ☐ Only guessed ☐ Knowingly but, not surely

2. Compared to Samtse, the boiling point of water at Dochula is

a) Higher b) The same c) Lower

Which one of the following is the main reason for your answer?

- ☐ The boiling point of water is always 100^{o}C.
- ☐ The boiling point does not depend on air pressure.
- ☐ The boiling point of liquids should be equal to the atmospheric pressure

What do you think about your answer?

☐ Knowingly and surely ☐ Only guessed ☐ Knowingly but, not surely

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