

LOWER SECONDARY SCIENCE STUDENTS’ MISCONCEPTIONS OF OZONE DEPLETION AND GLOBAL WARMING

Rawatee Maharaj-Sharma

This study focused on students’ misconceptions related to ozone depletion and global warming. Six open-ended diagnostic questions were administered to 103 randomly selected lower secondary school science students in Trinidad and Tobago. A subsample of 15 students was purposively selected and interviewed to clarify their written responses and to further probe their understandings based on their responses to the six questions. The findings revealed that students have a number of misconceptions about ozone depletion and global warming. The results have implications for the teaching of these concepts at the lower secondary science level and for a review of the teaching resources and teaching strategies used.

Introduction and Literature Review

The international science education literature provides extensive coverage of a number of misconceptions held by students at different levels of the education system on a variety of science topics. Many of these reports show that students’ conceptions are often times inconsistent with the scientific concepts they are expected to learn. Some of these have been identified and labelled by different researchers as alternative conceptions and/or naïve conceptions (Garnett, Garnett, & Hackling, 1995; Vosniadou, 2002). In the local context, lower secondary science students exhibit an array of misconceptions about the processes involved in global warming and ozone depletion. Such misconceptions are also a concern in the international context (Boyes & Stainsstreet, 1997; Fisher, 1998a).

Krishnan and Howe (1994) and Mortimer (1995) have articulated that learning takes place when the learner is able to move successfully from the domain of the known into the domain of the unknown through metacognitive negotiation and reconciliation of the unknown with the known. In this regard, science teachers have placed increasing emphasis on students’ prior knowledge before new instruction. When these prior conceptions are misconceptions, they prove to have severe negative impact on students’ learning (Toby, 1997). The result is that students do

not construct appropriate understandings of the concepts being taught. This is the case with respect to the concepts of global warming and ozone depletion. Further research has shown that those students' ideas are resistant to change, so that simply alerting them to the errors does not transform their misconceptions (Swan & Spiro, 1995). With this in mind, Kerr and Walz (2007) suggest that teachers need to be aware of some of the possible prior misconceptions that their students might have, so that they can craft appropriate teaching strategies using relevant stimulus material to accommodate and reform these misconceptions. Some effective teaching/learning strategies for such conceptual reform have also been suggested by Chi and Roscoe (2002), which include the use of credible and current video clips, simulations, and factual reports and papers that highlight common misconceptions but which also provide convincing and scientific explanations aimed at addressing the identified misconceptions. The caution here is that any strategy/teaching aid used in the classroom must be age-appropriate and experientially relevant for the students involved.

There is evidence in the literature that not just students, but some teachers as well have misconceptions about global warming and ozone depletion. Khalid (2001) suggests that, in some instances, teachers transfer their misconceptions to students when teaching these topics. In a survey of 113 pre-service science teachers regarding greenhouse effect, ozone depletion, and acid precipitation, Khalid found that 65% of the teachers interviewed were of the view that ozone depletion causes global warming. Even though this work focuses on students' misconceptions, mention of teachers' misconceptions is being made since this will be the focus of a future study.

The concepts of global warming and ozone depletion are included in the local curricula of primary schools, through lower secondary, to upper secondary science education. Christidou and Koulaidis (1996) conducted a written test and interviews with elementary school students to elicit their mental models of the ozone layer and their understandings of ozone depletion, and found that elementary school students had a variety of ideas, models, and explanations for these two concepts. In a later study done by Boyes and Stainsstreet (1997), with a similar sample, in regard to the ozone layer and greenhouse effect it was again revealed that students had several models in their mind that were not scientifically correct—one of the more frequent misconceptions being that ozone depletion is responsible for global warming. Fisher (1998b) found that students interpreted the word *hole* literally and perceived the statement “a hole in the ozone” as an actual opening in the ozone layer through which “more heat gets to the earth.”

Lower Secondary Science Students' Misconceptions

Research at the high school and university levels reveals that many high school students, and even university students, experience difficulties with fundamental ideas in science even after exiting introductory science courses (Sozbilir, 2002). In a study of fourth year secondary science majors in the United States, it was found that 56% of the majors held the idea that holes in the stratospheric ozone layer would increase the greenhouse effect (Khalid, 2003). In another study, Cordero (2002) found that 40% of first year science students at an Australian university believed that the ozone hole causes global warming.

In Trinidad and Tobago, the situation is not very different. At all levels of the education system, educators are discovering that students do not have a clear understanding of these two fundamental concepts. Students are also unclear about the causes of the phenomena and their impact on the physical and biological environment. In fact, many students, especially at the lower secondary levels, cannot explain the phenomena, and many collectively share the misconception that ozone depletion is a major factor responsible for global warming.

It is against this background that the motivation for this work emerged. The researcher wanted to determine, in a very general sense, what were lower secondary science students' understandings of the terms *global warming*, *ozone depletion*, and *greenhouse effect*. Additionally, the researcher sought to find out the students' beliefs about the causes and effects of global warming and ozone depletion. Finally, the researcher wanted to elicit from the students if they thought there was a relationship between both phenomena.

Ozone depletion and global warming, though not difficult ideas individually, often tend to be misconceived because in many science classrooms both phenomena are taught simultaneously, suggesting that perhaps one is linked to or even responsible for the other. Studies in this area in the local and regional contexts are few and do not necessarily focus on the students' ideas, interpretations, and misconceptions in great detail. The findings and educational implications derived from this research are expected to provide useful references for science teacher preparation and training as well as for curriculum design. In addition, the recent increased focus on global environmental problems, particularly climate change, makes this work topical and timely. Both these occurrences—ozone depletion and global warming—are the result of activities of, and choices made, by human beings either because of ignorance or blatant disregard. On both accounts (ignorance and disregard), it is imperative that the urgency of these global environmental problems be addressed head-on and among those who will inherit the existing environmental crisis—the current pool of students, who will be

Rawatee Maharaj-Sharma

the decision makers of the future and for whom environmentally friendly decisions and actions can be taken when misconceptions are eliminated. In a more general sense, this work will add to the body of knowledge on the conceptions and misconceptions about global warming and ozone depletion that is already in the literature.

The key research question in this study was:

What are lower secondary science students' misconceptions regarding ozone depletion and global warming?

Methodology

The Sample

The sample for the present study was composed of lower secondary science students pursuing Integrated Science in Forms 1, 2, and 3. All the students would have been exposed to some degree of science at primary school and therefore would have met the terms *global warming*, *greenhouse effect*, and *ozone depletion* at some point in their primary school science experience.

Lower secondary science students were chosen because it is at this level that the misconceptions are detected when students are called upon to relate and apply their understandings of these concepts to the impact of man's activities on the environment. At this level, science teaching is guided by the Secondary Education Modernization Programme (SEMP) syllabus, which has as one of its stated goals that students should demonstrate appreciation for the environment.

A random selection of 103 lower secondary science students were asked to participate in the research. They all agreed and, under normal classroom conditions, the open-ended questionnaire was administered to them. The students were guaranteed that their responses would be kept confidential and would be used only for research purposes. A subsample of 15 students was purposively selected (McMillan & Schumacher, 2001), with the aim of seeking maximum diversity with respect to the misconceptions presented in their written responses. These 15 students were each subsequently invited for an interview. Through the interviews, the students' written responses were not only clarified and confirmed, but their conceptual understandings and misconceptions were further probed. The interview time ranged between 10–15 minutes. All interviews were tape-recorded after first obtaining the interviewees' consent. The interviews were subsequently transcribed, coded, categorized, labelled, and analysed using the constant comparative

Lower Secondary Science Students' Misconceptions

method for qualitative data analysis (Boeije, 2002), in which comparison is the main intellectual tool.

Data Collection

A diagnostic test composed of six open-ended questions was specifically developed for this study (see Appendix). Question 1 aimed to elicit students' understandings of the terms *global warming*, *ozone depletion*, and *greenhouse effect*. Questions 2 and 3 aimed to reveal students' knowledge of the causes of global warming and ozone depletion, while Questions 4 and 5 asked students to state what they knew were some of the effects of global warming and ozone depletion. The final question (Question 6) explicitly asked students to state whether or not there was a relationship between global warming and ozone depletion, and to explain their responses. All six questions were piloted prior to the administration of the questionnaire. The content validity of the test questions was assessed by two chemistry lecturers, a physics lecturer, and an environmental science lecturer.

Data Analysis

Students' written responses to the diagnostic questions were qualitatively analysed to identify the different misconceptions students held. The interviews were used to further probe, explore, and exemplify the misconceptions determined. The interviews were transcribed, and the transcriptions were reviewed and cross-checked several times to ensure that there was no misrepresentation of the interviewees' responses. The responses were subsequently coded and grouped in respect of each misconception that emerged, and based on the number of students interviewed the percentage of students with each particular misconception was calculated.

Results and Findings

Analysis of students' responses revealed several misconceptions, as presented in Table 1.

Written responses obtained from students for Question 6 on the questionnaire showed that 87% of the students believed that ozone depletion causes global warming. The students holding this view stated that because the protective ozone layer is being destroyed, more light and heat can enter the atmosphere and that the increased light and heat caused global warming. In other words, they viewed the ozone layer as a shield against heat. In fact, during the interview phase, many of them stated that a hole allows objects to pass through it and that the "ozone

hole” simply allows more heat from the sun to pass through it and into the earth’s atmosphere. They did not seem to know that the ozone layer specifically protects the earth from the ultraviolet rays/radiation emanating from the sun. The following quotation from a student’s written response encapsulates the perception that ozone depletion is the cause of global warming:

“the ozone hole lets in more heat...this makes the earth hotter...when the hole gets bigger more heat will come in and the earth will get more hot...which will cause global warming...”

Table 1. Range of Misconceptions Among Students

Misconceptions	Students (%)
Ozone depletion causes global warming	87
The ozone hole means more heat enters the earth and that is the cause of the warming up of the earth	91
Use of aerosols is responsible for global warming	64
Air pollution causes global warming	92
Increased levels of CO ₂ cause the ozone hole	24
Ozone depletion causes climate change	60

Another student said that the ozone hole is an actual physical “hole” which needs to be “covered” to control global warming. The following excerpt from this student’s interview exemplifies this notion:

Researcher: Can you describe for me exactly what we mean when we say there is a hole in the ozone layer?

Student: It is like a hole in a covering...like your shirt if it gets a rip...you have a hole in your shirt and things can pass through....

Researcher: Is this the kind of hole you think is in the ozone layer?

Student: Yes, because if there was no hole, not so much heat will come to the earth...the opening makes more heat come in....

Comments of this kind may suggest that the students lacked an understanding of the concept of ozone depletion, and that perhaps the use of the term *ozone hole* may have been the more frequent expression they were exposed to rather than the term *ozone depletion*. Furthermore, it may be that students are unfamiliar with the stratification of the layers of

Lower Secondary Science Students' Misconceptions

the atmosphere and, further, that they may not have a conceptualization of what an atmospheric layer is.

This misconception was shared and explicitly expressed by 91% of the students: the “ozone hole” means more heat enters the earth and that is the cause of the warming up of the earth (responses given to Question 2). They thought that the size of the hole was directly related to the amount of heat that reaches the earth’s surface. Again, there was no indication that students were aware of concepts such as “thinning of the ozone layer” or “depletion” to mean that molecules of ozone are gradually being broken down, thus reducing the protective capacity of the ozone layer. The following excerpt indicates students’ views:

Researcher: OK. Do you remember this question [showing Question 2 on the questionnaire]? Are you saying that the hole in the ozone layer is the cause of global warming?

Student 1: Yes, I think so....because with a hole up there more heat from the sun can come down to earth.

Student 2: Global warming is related to ozone depletion...more ozone depletion means more global warming.

In further response to Question 2, 64% of the students surveyed said that the use of aerosols is responsible for global warming—only one student wrote that aerosol usage causes ozone depletion. When probed further during the interview, this particular student revealed that he had seen a “documentary on television that explained the harmful effects of aerosols on the ozone layer.” He suggested further that he knew of “other substances” that cause ozone depletion “such as refrigerants and CFCs.” When asked about the causes of global warming, this student said that the “bush fires and industrial wastes” are the causes of global warming. Except for this student, none of the other students were able to suggest what might be causes of global warming other than their misconceived notion of the “ozone hole.” Responses to Question 2 obtained from about 8% of the students were vague and were not used in the analysis.

Responses obtained for Question 3 revealed that most students did not know what the causes of ozone depletion were: 92% of the sample suggested [in their written responses] that ozone depletion was due to air pollution. Even when probed during the follow-up interview they maintained this view. Written responses obtained from a few students were vague and efforts to clarify these during the follow-up interview proved futile. The following are some of the vague responses obtained for Question 3:

Rawatee Maharaj-Sharma

Student 1: ...the gases in the air cause ozone depletion....

Student 2: ...ozone depletes...by...things that happen in the sky...

Student 3:nuclear reactions destroy the ozone....

Student 4: ...the heat from the sun destroys the ozone...

Student 5: ...smoke makes the hole in the ozone layer...

In the responses given by Students 1 and 5 there is the implicit suggestion that pollution (“gases,” “smoke”) causes ozone depletion, but their use of the terms *gases* and *smoke* to mean pollution could not be explicitly verified during the interviews.

Analysis of students’ written responses to Question 5 revealed a significant misconception: ozone depletion leads to climate change (60%). This was identified from students’ detailed explanations in their written responses to Question 5. All the students holding this misconception were part of the larger group of students (92%) who believed that air pollution causes global warming. It was clear from the analysis of their written responses, as well as their interview transcripts, that the terms *air pollution* and *climate change* were familiar to these students. They were using the terms in context and with ease and comfort in their explanations.

What emerged, however, as some of them articulated in responses given during the interview, was that air pollution led to/caused ozone depletion, which in turn led to/caused global warming, which in turn led to/caused climate change. In addition, most of the students interpreted global warming to mean higher (“hotter”) temperatures. The following excerpts from two students (in response to Question 5) capture this stated understanding:

Student 1

Researcher: You wrote on your questionnaire that an effect of ozone depletion is climate change. Can you explain further what exactly you mean by this?

Student 1: Well, with the ozone hole...I mean ozone depletion, a lot more heat from the sun comes into the earth.... And this causes the climate to get hotter...

Researcher: Are you saying then that climate change means higher [hotter] temperatures?

Student 1: Yes, because more heat is getting to the earth.

Student 2

Researcher: Could you explain to me why you say that ozone depletion leads to climate change?

Student 2: Ozone depletion means a hole in the ozone layer...which means more heat comes in...which mean that the temperature will be higher...and so the climate will be hotter....

Researcher: Are you saying then that climate change means higher temperatures?

Student 2: Yes.

Responses obtained for Question 4 were in large part a duplication of those given to Question 5. The reason for this was obvious: many of the students believed that there was a cause-effect relationship between ozone depletion and global warming, and, further, that there was also a cause-effect relationship between global warming and climate change. Their perception, however, of global warming and climate change was only in relation to higher temperatures. Students were unfamiliar with the concept of, and the role of, the [enhanced] greenhouse effect in global warming and, ultimately, its impact on climate change. Instead, their understanding was a simplistic one—ozone depletion causes global warming which leads to climate change. Furthermore, it was clear after the analysis of students' responses obtained from Questions 4 and 5, that the single major misconception in their minds was that ozone depletion, or in their terms the “ozone hole” [which in their view was caused by air pollution], is responsible for more heat getting to the earth, thus causing global warming, which eventually leads to climate change. Additionally, it was evident that most of the students interpreted climate change to mean higher temperatures or in their words “hotter weather.”

To a lesser extent, students responded that the use of aerosols [sprays] caused global warming which also led to climate change. To an even lesser extent, some students were of the view that increased levels of carbon dioxide [which they suggested came from industries and car exhausts] is responsible for the ozone hole, which causes global warming and ultimately leads to climate change. None of the students surveyed suggested explicitly that increased levels of carbon dioxide in the atmosphere caused global warming. It was also clear that the students did not have an understanding of the [enhanced] greenhouse effect and the role of carbon dioxide in this process and ultimately in global warming. In fact, most of the students seemed to believe that the terms “greenhouse effect” and “global warming” meant the same thing.

Rawatee Maharaj-Sharma

Summary of Students' Written Responses From the Questionnaire

Question 1: Explain what you understand by the terms: global warming, greenhouse effect and ozone depletion.

Students' responses to this question were varied, suggesting that they had a range of understanding of these three phenomena. Some of these are presented below.

Global Warming:	The earth gets hotter (68%) More heat on the earth (12%) Higher temperatures on earth (10%) More light and heat in the atmosphere (7%)
Ozone Depletion:	A hole in the ozone layer (92%) Less ozone (7%)
Greenhouse Effect:	The warming up of the earth (12%) More heat trapped on earth (15%) Higher temperatures (29%)

Question 2: What causes global warming?

The responses to this question suggest that many students did not have a clear understanding of what activities and behaviours lead to the global warming phenomenon. The following were put forward by students as being responsible for global warming:

- The ozone hole (91%)
- Pollution (92%) – Students giving this response believed that pollution was responsible for the “ozone hole”
- Aerosols (64%)
- Carbon dioxide (5%)
- Nuclear power stations (2%)

Question 3: What causes ozone depletion?

The following were students' ideas/beliefs about the causes of ozone depletion:

- Air pollution (92%)
- Gases in the air/Smoke (4%)
- Nuclear reactions (1%)
- Heat from the sun (1%)

Question 4: What are some of the effects of global warming?

Two major ideas emerged from the responses given to this question:

1. Increased temperatures
2. Climate change

Question 5: What are some of the effects of ozone depletion?

Three ideas—all implicitly suggesting that students believed there was a direct relationship between ozone depletion and global warming—emerged from the responses students gave to this question:

1. Global warming (87%)
2. Higher temperatures (82%)
3. Climate change (60%)

Question 6: Is there a relationship between global warming and ozone depletion?

The general consensus among the students surveyed was that there is a relationship between both phenomena, summarized simply as “ozone depletion causes global warming.”

Discussion, Conclusions, and Implications for Teaching

It is obvious from what is reported in this work that students have many “confused” understandings about the meanings of *global warming* and *ozone depletion*. Furthermore, they were unclear as to the scientific explanations of both phenomena and were even more unclear about their effects on the environment and on their lives. What was obvious, however, was that many students believed that the two phenomena were related—specifically that ozone depletion causes global warming—which they ultimately interpreted to mean that ozone depletion is responsible for climatic changes.

What is disappointing from the findings of this work is that none of the students seemed to have known that ozone depletion has severe effects on their personal lives in terms of its effects on their bodies and on plant and animal life. None of the students suggested that ozone depletion puts human beings at increased risk for skin cancers and eye diseases, or that it could have an effect on crop yields and on animal tissues. None of the students suggested, even implicitly, that there is need for humans to monitor and control their activities by the choices they

make so as to minimize activities that could lead to further depletion of the ozone layer. No one indicated that there was a need to revisit certain kinds of human activities which have resulted in increased consequences of global warming. In all instances, written and oral responses revealed that the students were unaware of the implications and importance of the phenomena on human beings and on the environment. Teaching approaches seemingly did not focus on the risk/harm to society that ozone depletion and global warming can cause.

The empirical findings of this research—similar to that obtained by Christidou and Koulaidis (1996) and Boyes and Stainsstreet (1997)—revealed very clearly that students had several misconceptions about the concepts of ozone depletion and global warming and, further, that some misconceptions were common to a significant extent. These misconceptions could be summarized as follows: ozone depletion causes global warming (87%); the ozone hole allows more heat into the earth which results in the earth warming up (91%); aerosols are responsible for global warming (64%); air pollution causes global warming (92%); increased levels of carbon dioxide are responsible for ozone depletion (24%); and ozone depletion causes climate change (60%).

These misconceptions held by students, particularly the perception that ozone depletion causes global warming, are very worrying to the researcher. It seems obvious that students would have developed these misconceptions as a result of their prior learning experiences, either within a classroom setting or from experiences outside the classroom. The alarming concern that arises here, as presented by Toby (1997), is to what extent are the understandings of the general public—and particularly teachers, more so science teachers—scientifically accurate. It would seem, as suggested by Vosniadou (2002) and Khalid (2001), that perhaps teachers themselves have similar misconceptions which they naturally transfer to students during the teaching/learning interface.

Questions arise about the resource material that teachers use when preparing for their class. How credible are these resources? Do teachers question these sources? Do they interrogate their own knowledge and understandings and the resources (such as textbooks and websites) as they prepare for classroom delivery? What level of research (of subject/content material) do teachers engage in? Is there knowledge sharing and discussion of ideas among teachers or members of departments in relation to teaching these topics?

These and many similar questions of concern seem to be what needs to be addressed in detail, at the causal level, to find ways of dealing with students' misconceptions, which seem to be a manifestation of a deeper issue. If perhaps, as Fisher (1998b) and Khalid (2001) suggest, students'

Lower Secondary Science Students' Misconceptions

misconceptions are as a result of knowledge transfer from teacher to students, then it is at the levels of teacher content capacity and teacher pedagogical content knowledge that the issue must be treated. The exploration of this perception, in the local context, is a valid topic for future research.

In this regard, it would mean that the local myth which portrays teachers as storehouses of knowledge must be dispelled. Indeed, curriculum design, both in content coverage and teaching strategies that specifically target students' misconceptions, is needed. Teacher guides and classroom aids (structured written documents) to assist teachers in identifying misconceptions and then systematically moving students from misconceptions to conceptions must form part of the curriculum redesign process.

It would seem, further, that there is urgent need to revisit the knowledge-dispensing image of teachers and perhaps to create a new image—one that is more research-based, collaborative, and dynamic—not simply of teachers but of the teaching profession in general. However, since the profession is shaped largely by the personalities, attitudes, conduct, and knowledge base of our teachers, the ultimate responsibility lies with the teachers.

References

- Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality & Quantity*, 36, 391–409.
- Boyes, E., & Stanisstreet, M. (1997). Children's models of understanding of two major global environmental issues (ozone layer and greenhouse effect). *Research in Science and Technological Education*, 15(1), 19–28.
- Fisher, B. W. (1998a). Australian students' appreciation of the greenhouse effect and the ozone hole. *Australian Science Teachers' Journal*, 44(3), 46–55.
- Fisher, B. W. (1998b). There's a hole in my greenhouse effect. *School Science Review*, 79(288), 93–99.
- Chi, M. T. H., & Roscoe. R. D. (2002). The process and challenges of conceptual change. In M. Limon & L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp. 3–27). Dordrecht: Kluwer.
- Christidou, V., & Koulaidis, V. (1996). Children's models of the ozone layer and ozone depletion. *Research in Science Education*, 26(4), 421–436.
- Cordero, E. C. (2002). Is the ozone hole over your classroom? *Australian Science Teachers Journal*, 48(1), 34–39.
- Garnett, P. J., Garnett, P. J., & Hackling, M. W. (1995). Students' alternative conceptions in chemistry: A review of research and implications for teaching and learning. *Studies in Science Education*, 25, 69–95.

Rawatee Maharaj-Sharma

- Kerr, S. C., & Walz, K. A. (2007). "Holes" in student understanding: Addressing prevalent misconceptions regarding atmospheric environmental chemistry. *Journal of Chemical Education*, 84(10): 1693–1696.
- Khalid, T. (2001). Pre-service teachers' misconceptions regarding three environmental issues. *Canadian Journal of Environmental Education*, 6, 102–120.
- Khalid, T. (2003). Pre-service high school teachers' perceptions of three environmental phenomena. *Environmental Education Research*, 9(1), 35–50.
- Krishnan, R. K., & Howe, A. C. (1994). The mole concept: Developing an instrument to assess conceptual understanding. *Journal of Chemical Education*, 71(8), 653–655.
- McMillan, J. H., & Schumacher, S. (2001). *Research in education: A conceptual understanding* (5th ed.). London: Longman.
- Mortimer, E. F. (1995). Conceptual change or conceptual profile change? *Science and Education*, 4(3), 267–285.
- Sozibilir, M. (2002). Turkish chemistry undergraduate students' misunderstandings of Gibbs free energy. *University Chemistry Education*, 6(2), 73–83.
- Swan, J. A., & Spiro, T. G. (1995). Context in chemistry: Integrating environmental chemistry with the chemistry curriculum. *Journal of Chemical Education*, 72(11), 967–970.
- Toby, S. (1997). Chemistry in the public domain: A plethora of information – or, don't believe everything you read in the newspapers. *Journal of Chemical Education*, 74(11), 1285–1287.
- Vosniadou, S. (2002). On the nature of naïve physics. In M. Limon & L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp. 61–76). Dordrecht: Kluwer.

Appendix

Dear Student,

The following is a questionnaire consisting of six (6) questions related to ozone depletion and global warming. Please answer the questions as honestly and as completely as you can in the spaces provided. Your responses will remain confidential.

Thank you,

..... Rawatee Maharaj-Sharma (Dr.).

Lower Secondary Science Students' Misconceptions

Question 1 – Explain what you understand by the terms: global warming, ozone depletion, greenhouse effect.

Question 2 – What causes global warming? Explain as fully as you can.

Question 3 – What cause ozone depletion? Explain as fully as you can.

Question 4 – What are some of the effects of global warming?

Question 5 – What are some of the effects of ozone depletion?

Question 6 – Is there a relationship between global warming and ozone depletion? Explain your answer.

