2016-09-01

Grade VIII Students' Views about Nature of Science (NOS)

Afrin, Sadia

Center for Pedagogy (CP) Established under the Sub-project Titled "Pedagogical Development at Undergraduate and Master's Level" (CP3357), Independent Univeristy, Bangladesh (IUB)

Grade VIII Students' Views about Nature of Science (NOS)

Sadia Afrin[9]
University of Dhaka

Nature of science (NOS) is the values and attitude which is showed to the development of scientific knowledge. The knowledge and understanding about different aspects of Nature of science (NOS) are important for both students and teachers. However, the students' conception about NOS has not been explored yet in the context of Bangladeshi. The results of this study will help teachers find out the ways in which they can help students have informed understanding about NOS and gain necessary skills for being scientific literate. The purpose of this study was to explore grade VIII students' views about Nature of Science (NOS). A quantitative approach was followed for this study. The result showed that students' have a medium level of understanding about different aspects of NOS.

Keywords: *Nature of science, grade VIII, science education.*

Introduction

The phrase "nature of science" typically refers to the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge (Lederman, 1992, 2007). Since 1960 the concept of the Nature of Science (NOS) had a prominent role in the scientific community and curriculum reform (Rudolph, 2000). Science educators have recognized NOS as a central component in achieving scientific literacy (Muslu & Akgul, 2006). Since the understanding of NOS remains a key dimension by which students' scientific literacy can be enhanced (Preczewski et al., 2009), it is very important for students to understand the NOS. It helps students to enhance their understanding of science, learn the science content successfully and take part in socio-scientific decision making (Driver, Leach, Millar, & Scott, 1996; McComas, Clough, & Almazroa, 1998).

There are some research about the teacher's conceptions about NOS and its practice in the classroom in Bangladesh. These studies mainly focused on teachers' view about their conceptions of nature of science in the context of Bangladesh. It has been found that science teachers in Bangladesh held uninformed conceptions of the NOS aspects (Sarkar, 2010). Teachers teach students with their uninformed conceptions or understanding of the NOS aspects.

Prospective Science teachers' and educators' views and understanding of ideas about science had also been explored through a different study (Siddique, Rahman & Gomes, 2009). We therefore focused on students' views about nature of science and for the first time we studied on grade VIII students' views about NOS.

Conception of NOS

NOS is an approach of knowing science or the values and beliefs which are essential to develop scientific understanding. It deals with the knowledge of science according to the philosophy and science itself

[9] Correspondence should be addressed to Sadia Afrin, E-mail: rezwanasadia@yahoo.com

(Lederman, 2007). Scientific knowledge and its development are also included with it. It describes the characteristics of scientific knowledge which are the results of scientific approaches (Lederman & Lederman, 2004). There is always a lack of agreement among the philosophers of science, historians of science, sociologists of science, scientists and science educators about a specific conception of NOS (Abd-El-Khalick& Lederman, 2000). Everyone has their different opinion about it. So it is a vast area where different social studies of science are included like the history, sociology, philosophy and cognitive sciences such as psychology. We can see that, these four disciplines (the philosophy, history, sociology and psychology of science) guide us to understand the science and its functions. In science not only philosophy and history help us to develop our understanding about NOS but also sociology and psychology give us important aspects to understand this. It is understandable that, NOS is not only the philosophy of science, but also informed by the study of those different disciplines. From different research works it is identified that in cognitive sciences there is a description about science, working process, scientists role in the society and society`s action and reaction on scientific activities (M. F. William, C. P. Michael &A.Hiya,2002). So nature of science is a mix of different disciplines (McComas & Olson, 2002).

Aspects of Nature of Science (NOS)

There are many different aspects of scientific knowledge which establish from the conventional approach (i. e. scientific inquiry) and used by the scientist to develop knowledge (Lederman & Lederman, 2004).Lederman (2004) categorize seven aspects of NOS and these are easy to get by secondary students which are signified by empirical research. Some other aspects also included in Next Generation Science Standards (2013) and in the American Association for the Advancement of Science [AAAS].In 'ideas-about-science' Osborne et al. (2003) also stated some aspects of science which are also similar with the aspects of NOS. These aspects are important for all citizens to know. There are three principle aspects: a) nature of scientific knowledge, (b) nature of scientific inquiry and (c) nature of scientific enterprise. From this study I want to see the students understanding level in different aspects of NOS. Here quantitative strategy was used to find out the students understanding level in different aspects of NOS.

Nature of scientific knowledge

Observation and inference

For the Students it is very important to know the key differences between observation and inference (Lederman & Lederman, 2004). Scientists monitor different natural facts and then explain it with logic. In observation, observers monitor natural facts and describe it with what they experienced by observing. But in inference the natural facts are not only depend on the experience but also on its accessibility or measurement of its demonstration or outcome (Lederman & Lederman, 2004). So inference is the logical conclusion of observation (Sarkar, 2010).

Laws and theories

In science, law is a brief description of the correlation or outlines about the natural phenomena which is every time observed in nature. We can also say that Laws are described the natural phenomena by using mathematical term (Bell, 2008). A scientific theory is an authentic justification of some characteristic of the natural world, based on the records which are repetitively established by observing and testing the same fact. Theories are never established into laws and also laws are never established into theories. They are not similar but both of these are important for science and scientific knowledge.

Tentativeness of scientific knowledge

Although we believe that scientific knowledge is trustworthy and robust but it is also found that it is by no means absolute or definite (Lederman & Lederman, 2004). However, scientific knowledge or explanation can change based on the new evidence (NGSS, 2013). New evidence can be found from the development of science and technology, advanced theory, changing cultural and social area (Abd-El-Khalick et al., 2003). So tentativeness of scientific knowledge is viewed for the reason that it is inferential, subjective, creative and culturally embedded in nature (Sarkar, 2010).

Nature of Scientific Inquiry

Empirical Basis of Scientific Knowledge

Most of the scientific knowledge is based on and/or derived from observations of the natural world. Scientist must be verified all of the theories and laws in natural environment for developing science and scientific knowledge day by day. If the empirical observations are not consistent with the predictions which derived from our theories and laws, scientists begin to search for alternative descriptions and explanations (Lederman & Lederman, 2004).

Science Demands Evidence

Science relies on testing ideas with evidence which can be found from the natural world. Evidence makes the scientific claim more trustworthy. For establishing any scientific claim scientist need to get accurate evidence. The evidence can be obtained from observation or by doing scientific experiment. Both types of evidences are useful and valuable in science (Peterson, 2011). By the use of evidence any one can check the findings of other groups or investigators (AAAS, 1990).

Human Inference, Imagination and Creativity

Most of us believe that scientific knowledge means only practical based or based on investigation, but some of the science knowledge are not practical based. For example: atoms, black holes and species are the scientific concepts which are functional theoretical model not an authentic copy of reality (Lederman & Lederman, 2004). Scientists also have some human qualities for example persistence, precision, reasoning, logic, imagination and creativity which direct them to do new investigation and to discover the cause and theory behind the science knowledge (Lederman, Abd-El-Khalick, Bell & Schwartz, 2001; Bell, 2009; NGSS, 2013).

Science is Not Authoritarian

There are no scientists in the world that they can say that they are always right. People who are specialized in related disciplines are the knowledgeable source of information and opinion. In the history of science, many times well-regarded authorities were also wrong. Scientist is not authorized to take decisions about other scientist whether they are wrong or right. Scientific knowledge and theories are judged by their evidence (AAAS, 1990).

Nature of Scientific Enterprise

Socially and culturally embedded

Science is not a matter outside of society. It is surrounded by society and culture ((Lederman & Lederman, 2004). Scientists collect data from scientific investigation and then infer the same data sets differently by the use of their different life experiences and different ways of thinking. So the culture and different factors (like social values, power structures, politics, socioeconomic factors, philosophy and religion) influence science and scientific knowledge where it is practiced.

Methodology

Sample and Sampling

In this study I studied on grade VIII students' views about NOS. I had chosen five secondary schools through convenience sampling. I had chosen 100 students for this survey through simple random sampling.

Instrument

To find out students' understanding about different aspects of NOS I have selected nine statements from Chen and Tanner (2006) ideas about science and one from Siddique, Rahman and Gomes (2009) work for this survey. This was a 5 point Likert scale type instrument.

Data analysis

The NOS survey is scored by assigning point values to each of the statements. Point values are assigned as shown in Table 1. Scores of the 10 statements are determined by adding the scores for the statements. There is a total for positive items, a total for negative statements and a total for the NOS survey. The range of scores for each statement is 1-5 (1-5 points × 1 item). The range of scores for entire NOS survey is 10-50 (1-5 point × 10 items).

Table-1

Point Values for Positive Items and for Negative Items

	Positive items	Negative items
Strongly agree	5	1
Agree	4	2
I don't know	3	3
Disagree	2	4
Strongly disagree	1	5

We have counted the frequencies and mean of analyzing student's response. Microsoft office excel was used for calculating the result of the survey.

Result & Discussion

From this study it has found that the grade VIII students are having a medium level of understanding about the aspects of NOS. But the students have a low level of understanding about science is not authoritarian, everyone has the capability to be a scientist and science is socially and culturally embedded. Students had a high level of understanding about the statement scientist use evidence to support their ideas; science is a process of discovery through observation and scientist use imagination and creativity in their work. The mean score for each statement is given below:

Table-2

Mean Score for Each Statement

Statement	Mean score
1. Scientists use evidence to support their ideas.	4.72
2. Scientists are always right.	3.28
3. Scientist will make new discoveries that change the ideas written in our textbook.	4.02
4. Scientist never changes their ideas about how the world works.	3.39

5. Science is a process of discovery through observation.	4.57
6. Scientists believe in things they cannot see.	3.23
7. Scientists use imagination and creativity in their work.	4.46
8. Scientists only use observations to explain how world works.	2.58
9. Science is affected by social, economic and cultural factors such as social or religious values/ethics, power, structures, economic benefits and politics.	2.12
10. Everyone can't be a scientist.	2.04

Figure-1
Mean Score of Individual Statement

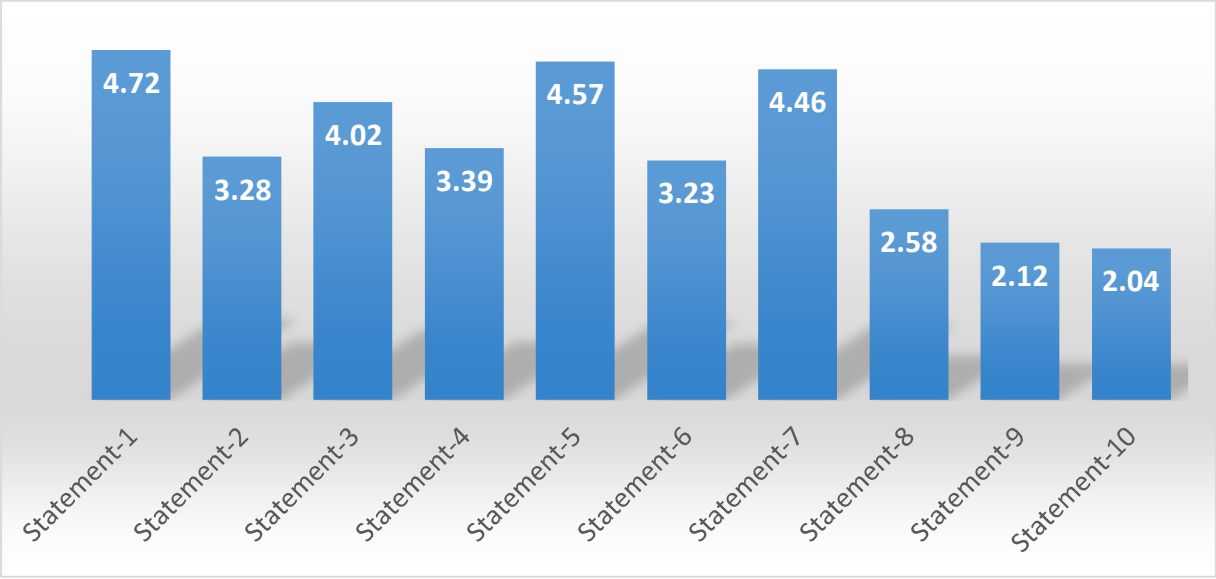

Figure 1 shows the result of this study. From the figure we can see that the grade VIII students are having a medium level of understanding about the aspects of NOS and they have a low level of understanding about science is not authoritarian, everyone has the capability to be a scientist and science is socially and culturally embedded. In the study of Sangsa-ard, et al. (2014) it has found that the majority of grade 9 students had poor understanding and held unexperienced views about the aspects of NOS. Abdulla, et al. (2007) in their research found that fourth grade students had a low level of understanding of the NOS. In the study of Kang, et al. (2004) showed that the majority of Korean 6^{th}, 8^{th} and 10^{th} graders' students possessed a realist view about the NOS and there were no difference among the different grades students. Samara (2015) studied on the understanding of NOS among the undergraduate students of Mutah University of Jordan and found that their understanding about NOS is moderate with a medium level understanding in the role of scientist and scientific methods and low level understanding in scientific theories and scientific laws. From the study of Chan & Tanner (2006) they studied on 7^{th} grade students and found that a majority of the students showed characteristics which was associated with existing scientific epistemologies but students was unable to have informed NOS views. In the study of Kakaras (2008) it has found that students hold present-day views about some aspect and traditional views about some other aspects. On the different side Liu and Lederman (2002) studied on talented students of 7^{th} grade of Taiwan and found that most of the students had basic understanding about the tentative, subjective, empirical and socially and culturally embedded aspects of NOS. Mahatoo (2012) studied on

11-12 years boys' conception about NOS and found that before intervention they had moderate understanding of NOS and after intervention students' views of NOS enhanced.

Conclusion

This study has shown that grade VIII students have a medium level of understanding about the different aspects of NOS. They have a poor level of understanding about many other different scientific methods. They have no idea about the social and cultural influence on science. They also have a poor knowledge about being a scientist. This result will help our teachers to plan their teaching activities and become focused on the assessment strategy for students' better understanding about NOS. It also helps the curriculum committee to include inquiry based activities in the textbook which can help teachers and learners for better teaching and learning about different aspects of NOS. Moreover, it may help textbook authors to include the aspects of NOS in science content. In this study only 100 students from 5 schools were selected to give their opinions. Therefore, the result from this study cannot be generalized for the whole nation. We only used a 5 point Likert scale questionnaire for this study but other instruments like open-ended survey and interview methods could be used to get the students' in-depth idea about the different aspects of NOS.

References

Abd-El-Khalick, F., & Lederman N. G. (2000). The influence of history of science courses on students' views of nature of science. *Journal of Research in Science Teaching,37,* 1057-1095. Retrieved from http://www.bu.edu/hps-scied/files/2012/10/Abd-El-Khalick-HPS-Influence-of-History-of-Science-Courses-on-Students-Views-of-NoS.pdf.

Abd-el-Khalick, F., & Boujaoude, S. (2003). Labanese students' views of the nature of science*., Mediterranean Journal of Educational Studies*, *8,* 61-79*.* Retrieved from: https://secure.um.edu.mt/__data/assets/pdf_file/0004/39388/15_MJES_812003.pdf#page=61.

Abdullah Y., Aboud A., & Al-Hamdani A. (2007). The extent of understanding of the nature of science among undergraduate students and its relationship to their thinking in the light of several variables, *Journal of Education and Science*, Iraq, 14(1), 186 – 203.

American Association for the Advancement of Science. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics and technology.* Washington, DC: AAAS. Retrieved from http://www.project2061.org/publications/sfaa/online/sfaatoc.htm.

Bell, R.L. (2008). Teaching the nature of science through process skills: Activities for grades 3-8. New York: Allyn & Bacon/Longman.

Bell, R.L. (2009). *Teaching the nature of science: Three critical questions* (Best Practices in Science Education Monograph). Carmel, CA: National Geographic School Publishing. Retrieved from http://www.ngspscience.com/profdev/monographs/scl22-0449a_sci_am_bell_lores.pdf.

Chan, J. M., & Tanner, K. D., (2006). *Understanding the Nature of Science: Science views from a seventh grade classroom. Science Education Partnership & Assessment Laboratory (SEPAL).* San Francisco, USA: San Francisco State University. pp.184-209. Retrieved from https://www.researchgate.net/profile/Kimberly_Tanner/publication/266864085_Understanding_the_Nature_of_Science_Science_Views_from_a_Seventh_Grade_Classroom/links/54bd6dae0cf218da9391b170.pdf.

Driver, R., Learch, J., Millar, R., & Scott, P. (1996). *Young people's images of science.* Buckingham, England: Open University Press. Retrieved from http://files.eric.ed.gov/fulltext/ED393679.pdf.

Kang, S., Scharmann, L. C., & Noh, T., (2005). Examining students' views on the nature of science: results from Korean 6th, 8th, and 10th graders. *Science Education, 89*, 314 – 334. doi: 10.1002/sce.20053.

Karakas M. (2008). A Study of undergraduate students' perceptions about nature of science**,** *Bulgarian Journal of Science and Education Policy, 2*(2), *2*33-249. Retrieved from http://bjsep.org/index.php?page=11&volume_id=1.

Lederman, N. G. (1992). Students' and teachers' conceptions about the nature of science: a review of the research. *J. Res. Science Teaching, 19,* 743–760. Retrieved from https://www.researchgate.net/profile/Norman_Lederman/publication/229588819_Students'_and_teachers'_conceptions_of_the_nature_of_science_A_review_of_the_research/links/540db87a0cf2df04e75651eb.pdf.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. S. (2001). "Views of nature of science questionnaire (VNOS): Toward valid and meaningful assessment of learners' conceptions of nature of science". *Journal of Research in Science Teaching*, *39*, 497-521. Retrieved from http://files.eric.ed.gov/fulltext/ED472901.pdf.

Lederman, N. G., & and Lederman, J. S. (2004). The nature of science and scientific inquiry in G.Venville & V. Dawson (Eds.), *The art of teaching science* (1st ed.,pp.1-16). Crows Nest: Allen & Unwin.

Lederman, N.G. (2007) Nature of science: Past, present, and future. In: Abell, S.K. and Lederman, N.G. (Eds.), *Handbook of Research on Science Education.*p. 831-880. Retrieved from http://tl.unlv.edu/sites/default/files/Lederman_2007.pdf.

Lederman, N.G., Lederman, J.S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. International Journal of Education in Mathematics, Science and Technology, 1(3), 138-147. Retrieved from http://files.eric.ed.gov/fulltext/ED543992.pdf.

Mahatoo, J. (2012). *Scientific Literacy and Nature of Science as it Impacts on Students' Achievement in South Trinidad*. The University of the West Indies, St. Augustine. Retrieved from http://uwispace.sta.uwi.edu/dspace/bitstream/handle/2139/12709/Judy%20Mahatoo.pdf?s.

McComas, W. F., & Olson, J. K. (2002). The nature of science in international science education standards documents. In W. F. McComas (Ed.), The nature of science in science education: Rationales and strategies. Dordrecht: Kluwer Academic Publishers. Retrieved from https://www.researchgate.net/profile/William_Mccomas/publication/226573879_The_role_and_character_of_the_nature_of_science_in_science_education/links/00b7d537c9fa6de966000000.pdf#page=64.

McComas, W.F., and Clough, M.P. & Almazroa, H. (2002). "The role and character of the nature of science in science education In W. F. McComas (Ed.), The nature of science in science education: Rationales and strategies. Dordrecht: Kluwer Academic Publishers. Retrieved from https://www.researchgate.net/profile/William_Mccomas/publication/226573879_The_role_and_character_of_the_nature_of_science_in_science_education/links/00b7d537c9fa6de966000000.pdf#page=64.

Muslu, G., & Akgul, E. (2006). Elementary school students' perceptions of science and scientific processes: A qualitative study. Educational Sciences:Theory and Practice 6(1), 225-229. Retrieved from https://www.questia.com/library/journal/1P3-1377453821/elementary-school-students-perceptions-of-science.

NGSS Lead States. (2013). Next Generation Science Standards: For states, by states. Washington, DC: The National Academies Press.

Osborne, J., Collins, S., Ratcliffe, M., Millar, R., & Duschl, R. (2003). What "ideas-aboutscience" should be taught in school science? A delphi study of the expert community. *Journal of Research in Science Teaching*, *40*(7), 692–720. Retrieved from

https://www.researchgate.net/profile/Robin_Millar/publication/227617874_What_'ideas-aboutscience'_should_be_taught_in_school_science_A_Delphi_Study_of_the_'Expert'_Community/links/09e41511243ba2ee1a000000.pdf.

Peterson, L. K., (2011). A Practical approach to teaching the nature of science. *Journal of Virginia Science Education, 4*(2), 41-48. Retrieved from http://www.vast.org/_docs/Peterson.pdf.

Preczewski, P. J., Mittler, A., & Tilltotson, J. W. (2009). Perspectives of German and US students as they make meaning of science in their everyday lives. *International Journal of Environmental & Science Education, 4*(3), 247-258. Retrieved from http://files.eric.ed.gov/fulltext/EJ884395.pdf.

Rudolph, J. L. (2000). Reconsidering the "nature of science" as a curriculum. *Journal of Curriculum Studies, (32)*3, 403-419. Retrieved from http://www.amscied.net/Publications_files/2000-Rudolph%20JCS.pdf.

Samara, N. A., (2015). Understanding of 'Nature of science' among undergraduate students at Mutah University in Jordan. *European Scientific Journal*, *11*, pp.290-302. Available from https://scholar.google.com/scholar?q=Samara%2C+N.+A.%2C+%282015%29.+Understanding+of+%E2%80%98Nature+of+science%E2%80%99+among+undergraduate+students+at+Mutah+University+in+Jordan.+European+Scientific+Journal%2C11%2C+pp.290-302.+&btnG=&hl=en&as_sdt=0%2C5.

Sangsa-ard, R., Thathong, K., & Chapoo, S. (2014). Examining grade 9 students' conceptions of the nature of science. *Procedia - Social and Behavioral Sciences. 116*, pp. 382-388. doi: 10.1016/j.sbspro.2014.01.226.

Sarkar, M. M. A. & Gomes, J. J.,(2010). Science teachers' conceptions of nature of science. *Asia-Pacific Forum on Science Learning and Teaching*, *11*. Retrieved from https://www.researchgate.net/profile/Judith_Gomes/publication/45459015_Science_teachers_conceptions_of_nature_of_science_The_case_of_Bangladesh/links/0c960538c050a9562d000000.pdf.

Siddique, M N.A.,Rahman,S.M.H.,& Gomes, J.J.(2009).Prospective science teachers' and educators' views and understanding of ideas about scienc. NAEM Journal, (p. 47-58).