

## Gender differences in achieved process skills of grade VIII in general science: Perspective of Bangladesh

Alam Rezwanul\*, Khan Md. Abdul Awal\*\*, Raihan Jahir\*\*\* and Ozaki Koji\*\*\*\*

\* BRAC Education Programme (BEP), BRAC, Bangladesh

\*\*Institute of Education and Research (IER), University of Dhaka, Bangladesh

\*\*\*Lab. of Biodiversity Conservation, United Graduate School of Agricultural Science, Gifu University

\*\*\*\*Faculty of Education, Gifu University

**Abstract :** The purpose of this study was to find out a comparative picture of the achieved process skills between male and female students of Grade VIII in General Science. Data were collected by administering a test to the students of Grade IX as they had completed Grade VIII. 5 practical items were included in the test, which examine the eight process skills proposed by Tannenbaum. 24 secondary schools of 6 administrative divisional cities were selected for administering the test. 10 students of grade IX were selected from each school. So, the total sample size was 240. Both male and female students were equal in number (120 & 120). Allotted time for the test was 45 minutes. The results were as follows: moderate success rate in classifying (54.2%), experimenting (64.2%) and formulating hypothesis (62.5%) skills; good success rate in predicting (71.7%), inferring (68.3%) and comparing (73.8%) skills; satisfactory success rate in observing (82.5%) and measuring (75.0%) skills. Success rate was not poor in any process skills. The study further indicated that the success rate was highest in observing skill (82.5%) whereas it was lowest in classifying skill (54.2%). It was also summarized that, among the eight process skills, male students did better than female students in 5 process skills. Those skills were comparing (male 78.3% and female 69.2%), classifying (male 58.3% and female 50.0%), experimenting (male 68.3% and female 60.0%), measuring (male 77.5% and female 72.5%) and predicting (male 75.0% and female 68.3%). On the other hand, female students did better than male students in observing (female 83.3% and male 81.6%), formulating hypothesis (female 64.1% and male 60.8%) and inferring (female 70.8% and male 65.8%). There was significant difference between those male and female respondents who performed accurately in comparing (male 78.3% and female 69.2%), classifying (male 58.3% and female 50.0%) and experimenting (male 68.3% and female 60.0%) skills.

### 1. Background

The underrepresentation of women in the sciences is a significant and well documented societal concern (Miller et al. 2006; Stake 2006). So, Gender differences in science have received serious attention in the science education research. Boys and girls have been compared on variables such as achievement, attitude, motivation and performance behaviors (e.g., Eccles & Blumenfield, 1985; Erickson & Erickson, 1984; Greenfield, 1997; Jovanovich & King, 1998; Kahle, Parker, Rennie, & Riley, 1993; Morrell & Lederman, 1998; Simpson & Oliver, 1985). But as our knowledge, there was few comparative studies on achieved science process skills between male and female students.

Bangladesh is in the region of the world in which gender disparities are noticeably the worst (Deon Filmer et al. 1998) and as a result, there are thought to exist huge gender

gaps in various sectors including education sector. But recent study on enrollment rate shows that gender gap has disappeared by an increased commitment of the government, non-governmental organizations (NGOs), and donors to primary education (A. Mushtaque R. Chowdhury et al, 2002). There were still no studies on the quality of education; i.e. achieved learning outcomes of the students of primary or secondary level in Bangladesh.

Junior Secondary Level (Grade VI to Grade VIII) is an important level of education in Bangladesh. After completing primary education, students enter into this level where science is a compulsory subject in all Grades of Junior secondary level. Grade VIII is the last grade of this level. In this level, science education cannot be fulfilled without giving proper importance to develop the process skills of the students. Without developing process skills, they will not be able to use in practical life. So, Science education should develop the basic process skills.

After studying a number of research reports, science texts and relevant literature, Tannenbaum (1970) found the following eight (8) process skills which are most appropriate for science teaching and learning (Bhatt, 1988).

1. Observing
2. Comparing
3. Classifying
4. Quantifying
5. Measuring
6. Experimenting
7. Inferring
8. Predicting

Arrangement of processes from observation to prediction forms an hierarchical pattern and is cumulative. Each process category is included in the next succeeding category i.e., Observing follows Comparing; Observing and Comparing follow Classifying; Observing; Comparing and Classifying follow Quantifying; Observing, Comparing, Classifying and Quantifying follow Measuring; Observing, Comparing, Classifying, Quantifying and Measuring follow Experimenting; Observing, Comparing, Classifying, Quantifying, Measuring and Experimenting follow Inferring. Observing, Comparing, Classifying, Quantifying, Measuring, Experimenting and Inferring follows Predicting.

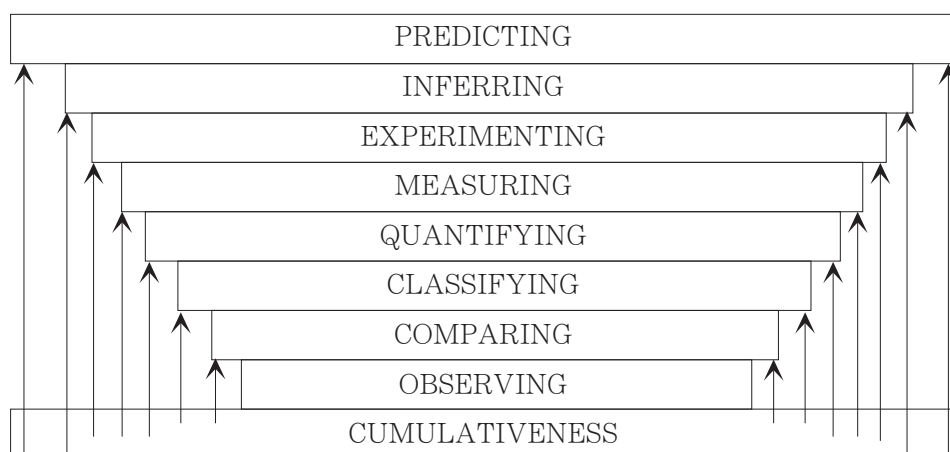


Fig.1 Cumulative Structure of Science Processes

The eight process skills proposed by Tannenbaum (1970) are most accepted and used by the science teachers of Bangladesh. But it is wonder that these skills were acquired effectively in Bangladesh.

## **2. Objectives**

The main objective of this study was to assess the process skills of the students of Grade VIII in General Science with respect to the eight basic process skills and to find out a comparative picture of the achieved process skills between the male and female students.

## **3. Methods and Materials**

Data were collected by administering a test to the students of grade IX as they had completed grade VIII. The test included 5 practical items. After piloting to 40 students (both male and female) in 4 co-education schools in Dhaka and Chittagong cities, the test was finalized. Allotted time for the test was 45 minutes.

### **3.1 Development of Test Instruments**

There are 26 chapters (NCTB, 2003) in the General Science textbook of Grade VIII. Every chapter does not contain practical items, but process skills are mainly assessed through practical items at the junior secondary level in our schools. So, the researcher had to identify those practical items of General Science textbook of Grade VIII which are mainly practiced to assess the process skills of the students. After discussing with the General Science teachers of 4 co-education schools in Dhaka and Chittagong cities and consulting with relevant personnel, the researcher identified 47 practical items by which the science teachers usually assess the process skills of the students of Grade VIII. The identified items are given in table (Appendix 3).

The test of 5 practical items was developed after verbal consultation with some education experts. Firstly, the primary basis of the items was the learning outcomes adopted by the National Curriculum and Textbook Board (NCTB) and was expected to be achieved by the students completing grade VIII. Thus, the items may be validated with respect to the National Learning Outcomes. Secondly, some teachers who are nationally recognized as education specialists helped in the development of those items. Thirdly, the specialists re-validated the items against the respective learning outcomes before piloting and again during the final selection of the items. Before piloting, 8 practical items were included in the test. Then the items were piloted to 40 students (20 male and 20 female) of grade IX (as they had completed grade VIII) in 4 co-education schools in Dhaka and Chittagong cities. After piloting, 3 items were excluded from the test. The test was finalized consisting 5 practical items and administered to the students of grade IX as they had completed grade VIII. Allotted time for the practical items consisted 45 minutes. From those 5 items the researcher assessed 8 process skills (comparing, classifying, observing, experimenting, formulating hypothesis, measuring, predicting and inferring). Those 5 practical items are described (Appendix 2).

### **3.2 Sampling Procedures**

Bangladesh has 6 administrative divisions. These divisions are Dhaka, Chittagong, Rajshahi, Khulna, Barisal and Sylhet. 24 secondary schools from 6 administrative divisional

cities were selected purposively for administering the test. 4 schools from each city were selected. Among them, 12 were government and the others were non government schools. Boys', Girls' and Co-education schools were 9, 9 and 6 in number respectively in order to ensure equal representation of male and female students. 10 students of Grade IX (as they had completed Grade VIII) were selected from each school where good, moderate and poor marked students were 5, 4 & 3 in number respectively. 5 male and 5 female students were selected from each co-education school. So, the total sample size was 240. Male and female students were equal in number (120 & 120).

### 3.3 A Comprehensive Analysis

The results obtained by administering a test of 5 practical items to 240 students are categorized as poor/moderate/good/satisfactory for a particular skill as table 1. It was decided by the consultation with relevant education specialists and science teachers of some secondary schools.

Table1. Decided categories of evaluation according to success rate (%)

Category	Success rate (%) of respondents
Poor	<50%
Moderate	50%~64.9%
Good	65%~74.9%
Satisfactory	>74.9%

## 4. Results and Discussions

Percentage distribution of the respondents who performed accurately in 8 process skills by sex is shown in Table 2.

Table 2. Percentage distribution of those respondents who performed accurately in 8 Process skills by sex

Process Skill	Number of Practical Item	Sex				Total N=240	Percentage (%)
		Male N = 120		Female N = 120			
		N	%	N	%		
Observing	1	98	81.6	100	83.3	198	82.5
Comparing	1	94	78.3	83	69.2	177	73.8
Classifying	1	70	58.3	60	50.0	130	54.2
Inferring	1	79	65.8	85	70.8	164	68.3
Predicting	1	90	75.0	82	68.3	172	71.7
Experimenting	1	82	68.3	72	60.0	154	64.2
Measuring	1	93	77.5	87	72.5	180	75.0
Formulating Hypothesis	1	73	60.8	77	64.1	150	62.5

Table 2 shows the followings. The highest success rate belonged to observing skill (82.5%) followed by measuring skill (75.0%) and both success rate were satisfactory. In case of other skills, success rate was good in comparing (73.8%), predicting (71.7%) and inferring (68.3%) skills; moderate in classifying (54.2%), experimenting (64.2%) and formulating hypothesis (62.5%) skills. Success rate was not poor in any of those 8 process skills. Among these process skills, the percentage of those respondents who performed accurately was lowest in classifying skill (54.2%). The success rate of both male and female students was highest in observing skill (male 81.6% and female 83.3%) and lowest in classifying skill (male 58.3% and female 50%).

The study summarized the following findings:

- I. The percentage of those respondents who performed accurately was highest in observing skill (82.5%), whereas it was lowest in classifying skill (54.2%).
- II. The success rate of both male and female students was highest in observing skill (male 81.6% and female 83.3%) than other skills.
- III. The success rate of both male and female students was lowest in classifying skill (male 58.3% and female 50.0%) than other skills.
- IV. Percentage of those respondents who performed accurately was satisfactory in 2 process skills. Those skills were observing (82.5%) and measuring (75.0%).
- V. Success rate was good in predicting (71.7%), inferring (68.3%) and comparing (73.8%) skills.
- VI. Percentage of those respondents who performed accurately was moderate in classifying (54.2%), experimenting (64.2%) and formulating hypothesis (62.5%) skills.
- VII. Success rate was not poor in any of those 8 process skills.
- VIII. Among the 8 process skills, the success rate of male students was higher than that of the female students in 5 process skills. Those skills were comparing (male 78.3% and female 69.2%), classifying (male 58.3% and female 50.0%), experimenting (male 68.3% and female 60.0%), measuring (male 77.5% and female 72.5%) and predicting (male 75.0% and female 68.3%).
- IX. Percentage of those female respondents who performed accurately was higher than that of the male in 3 process skills. Those skills were observing (female 83.3% and male 81.6%), formulating hypothesis (female 64.1% and male 60.8%) and inferring (female 70.8% and male 65.8%).
- X. There was significant difference between those male and female respondents who performed accurately in comparing (male 78.3% and female 69.2%), classifying (male 58.3% and female 50.0%), and experimenting (male 68.3% and female 60.0%) skills.
- XI. There was no notable difference between those male and female respondents who performed accurately in observing skill (female 83.3% and male 81.6%).
- XII. The success rate of female respondents who performed accurately was higher than that of the male students in such 3 process skills (observing, formulating hypothesis and inferring) which are not very much related to practical activities.

Among the 8 process skills, the success rate of male students was higher than the female students in 5 process skills. Those skills were comparing, classifying, experimenting, measuring and predicting. On the other hand, the success rate of female students was higher than the male students in 3 process skills. Those skills were observing, formulating

hypothesis and inferring. One of the main reasons for the results might be, these 3 process skills are not very much related to practical works and female students were not so interested and skilled in practical work. They also might not get enough scope to do practical works in a comparison with the male students both in the school and outside the school and thus, their participation is very much poor in practical works.

There were some limitations in this study. This study was conducted only in 24 schools in 6 administrative divisional cities of Bangladesh. All the schools were located in the urban area. There was no rural school. More schools couldn't be taken owing to shortage of time and financial constraint. The total number of the students to whom the practical items were administered was only 240. The scope of this study was very narrow and making generalizing is definitely not possible except throwing some light on the prevailing situation.

The study revealed that there are gender differences in achieved process skills in General Science and achieved process skills was not in satisfactory level except a few. The degree of participation in practical works may be a main reason for differing in achieved process skills between male and female students. But further detail studies are needed to find out the reasons behind this condition. In order to improve the present condition, this study feels the necessities to modify the curriculum as well as proper implementation of the curriculum equally to the male and female students.

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## 6. Appendix

### 1) Definition of Related Terms

- 1. Process skills:** Process skills are some special scientific skills of the students by which they can realize and be skilled in scientific arena.
- 2. Respondents:** In this study, respondents mean the total number of students (both male and female) to whom the practical items were administered.
- 3. Experimenting:** Experiment effectively designed to test hypothesis. It is logically organized and easy to understand.
- 4. Formulating hypothesis:** Hypothesis is directly related to problem/purpose and stated as a relationship between variables.
- 5. Measuring:** Measuring means selecting the most appropriate and accurate merit unit and instruments for measuring properties of an object; compares and orders objects by

length, area, weight, volume etc.

- 6. Classifying:** Classifying identifies properties the system is based and groups objects by those properties and reclassifies and regroups objects as needed.
- 7. Predicting:** Prediction distinguishes between the observations, inferences and predictions. Constructs prediction and supports prediction based on observed patterns, related research evidences, and inferences.
- 8. Inferring:** Inference suggests specific/detailed inferences based on observations, prior knowledge, and experiences.
- 9. Comparing:** Comparing can tell how things are alike and different based on highly obvious characteristics.
- 10. Observing:** Observing means observe objects/events in a variety of ways using all appropriate senses

## 2) Description of 5 Practical Items

1. 8 different items (HCl, NaOH, lemon juice, liquid antacid, detergent, H<sub>2</sub>SO<sub>4</sub>, vinegar and liquid soap) were set on a piece of glass. Then the students were asked to identify the items which were either acid or alkali by observing the colour change by using the given red and blue litmus papers. Thus their observing skill was assessed. Again they were asked to compare the acidic and alkali items by the litmus papers according to their strengths. Thus their skill of comparing was assessed.
2. A test-tube, three-fourth full of water was individually given to all the students. The researcher asked them individually what would happen if the test tube was heated by a burner below 100°C temperature (70°C- 80°C). The students answered the question. Thus their skill of formulating hypothesis was assessed. Again they were asked to complete the experiment individually according to the instruction of the researcher by the given instruments (test tube, burner etc.). They did it. Thus their skill of experimenting was assessed.
3. A stone piece was given to the students and they were asked to measure the weight of that stone piece individually by the given weight measuring tool. They measured the weight of the stone piece after measuring the mass. Thus their skill of measuring was assessed.
4. The researcher asked the students individually what would happen if a straight wood stick is put into a beaker, full of water. They answered the question. By that, their skill of predicting was assessed. Then they were asked to do the experiment and take the decision what was the reason for the polygonal view of the straight wood stick. Thus their inferring skill was assessed.



- Model of 3 fruits (mango, pineapple and custard apple) were given to the students. Then they were asked to classify those fruits as simple, compound and clustard fruits according to their structure. Thus their skill of classifying was assessed.

Among the above 5 descriptions, observing and comparing skills from the first practical items, formulating hypothesis and experimenting skills from the second practical items, measuring skill from the third practical item, predicting and inferring skills from the fourth practical item, and classifying skill from the fifth practical item were assessed.

### Answer Key of 5 Practical Items

- There are 4 acidic items (HCl, lemon juice, H<sub>2</sub>SO<sub>4</sub>, vinegar) and 4 alkali items (NaOH, liquid antacid, detergent, liquid soap) on the piece of glass.  
The strongest acid is HCl and the strongest alkali is NaOH.
- At first, the water in the test-tube fell down a little bit. After 2/3 minutes the level of water goes up on the top of the test-tube.
- The mass of the stone piece is 2 kg. So the weight of the stone piece is (2kg × 9.8m/s<sup>2</sup>) or 19.6 kg • m/s<sup>2</sup> or 19.6 Newton.
- The wood stick looks polygonal if it is put into a beaker-full of water. Refraction is the reason for the polygonal view of the wood stick.
- Classification of fruits:
  - Mango - Simple fruit
  - Pineapple - Compound fruit
  - Custard apple - Clustered fruit

### 3) Distribution of chapter wise identified practical items in General Science Textbook of Grade VIII

Chapter No.	Content	Practical Items	Page No
1	Composition of Matter: Atom, Molecule	i. Experiment on existence of intermolecular force in the substances.	9
2	Symbol, Formula and Valance	No identified practical item	
3	Chemical Reaction and Chemical Equation	i. Experiment of not changing in mass of the substances due to physical change in it.	29
4	Acids, Bases and Salt	i. Containing acids in different foods. 43 ii. Experiment of finding the common element in all the acids. 43 iii. Process of preparing carbon dioxide. 44 iv. Experiment on colour change of different indicators in the solution of acids and bases. 46 v. Colour changing test of blue litmus paper. 46 vi. Colour changing test of red litmus paper. 49 vii. Process of producing salt and water. 50	

5	Hardness of Water	i. Preparing calcium-bi-carbonate solution (Hard Water). ii. Identifying normal and hard water. iii. Test for removal of temporary and permanent hardness of water.	60 60 63
6	Common Laboratory Process	i. Cutting of glass tube. ii. Bending of glass tube. iii. Making of jet tube. iv. Experiment of cork boring. v. Making of wash bottle. vi. Folding of filter-paper. vii. Proper completion of distillation process. viii. Proper completion of sublimation process.	71 72 73 74 75 76 77 78
7	Measurement	i. Measurement of length by vernier scale. ii. Measurement of the diameter of any sphere by slide calipers. iii. Measuring the weight of a body after measuring the weight.	84 85 93
8	Gravitation and Gravity	No identified practical item.	
9	Simple Machines	i. Using different types of lever. ii. Making work easier by using inclined plane. iii. Experiment of using pulleys. iv. Getting mechanical advantage by using the screw-driver.	99 101 102 105
10	Heat	i. Experiment on conduction of heat. ii. Experiment on convection of heat.	112 113
11	Sound	i. Experiment on production of sound by vibration.	124
12	Refraction of Light	i. Experiment on refraction of light through a rectangular glass-slab. ii. Looking a straight stick curvy due to refraction. iii. Looking an invisible coin in water due to refraction.	134 136 137
13	Electricity	i. Proper use of Ammeter and Voltmeter.	151
14	Science and Technology in Daily Life	i. Making work easier by using computer.	163

15	Plant Morphology: Fruits and seeds	i. Identifying different parts of a fruit. ii. Classification of fruits according to their structure. iii. Classification of seeds. iv. Experiment on germination of seeds.	169 170 173
16	A Flowering Plant: Chilly Plant	i. Experiment on identification of different parts of a chilly plant.	180
17	Living Organisms and Their Environment	i. Identifying different types of hydrophytes.	184- 187
18	Forest and Environment	i. Classification of the forests in Bangladesh.	194
19	Energy, Living Being and Natural Resources	i. Classification of different forms of energy.	202
20	Vertebrate Animal: Fowl	i. Classification of vertebrate animals. ii. External morphology of a fowl.	211 215
21	Cell Division	No identified practical item.	
22	Human Body	No identified practical item.	
23	Some General Diseases	i. Identifying the steps to prevent different types of diseases.	255- 267
24	Rotation of Earth: Time and Seasonal Change	i. Experiment on rotation of the earth with the help of a globe.	276
25	Natural Disaster: Cyclone and High Tidal Wave	No identified practical item.	
26	Population and Environment	No identified practical item.	