

Babu R. (2016). Teaching Science in Bangladesh: Expectation versus Reality. *Journal of Education and Learning*. Vol. 10 (3) pp. 244-254.

Teaching Science in Bangladesh: Expectation versus Reality

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Abstract

A mixed methodological approach was used to explore to what extent the *ideal teaching learning strategies of science* were being *followed* in *Bangladeshi rural classrooms*. 160 *rural* students were randomly selected and 10 science teachers were purposively selected as study respondents. Fifteen science lessons were observed. Data were collected via student questionnaires, teacher interviews, and classroom observation checklists. Grade VIII science teaching-learning activities were not conducted according to the instructions of the science curriculum. Most teachers did not adhere to the curriculum and teacher's guide. Teachers mainly depended on lecture methods for delivering lessons. Learning by doing, demonstrating experiments, scientific inquiry, rational thinking, and analysing cause-effect relationships were noticeably absent. Teachers reported huge workloads and a lack of reagents as reasons for not practising these activities. Teachers did not use teaching aids properly. Science teaching-learning was fully classroom centred, and students were never involved in any creative activities.

Keywords: *science teaching, science curriculum, grade eight, mixed method, Bangladesh*

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Introduction

Science is a major contributor to cultural development and our understanding of the world (Mathews, 1994). School curricula quite rightly consider science an important subject (Yadav, 1992), and it is increasingly viewed as a subject of lifelong utility to students whether or not they enter science-related careers (Ware, 1992). Science education originated in Western countries in the nineteenth century (Layton, 1981). In Bangladesh, the National Curriculum Committee prepared detailed curricula and syllabi for primary and secondary schools in 1974 (MoE, 1974). At present, the curriculum provided by the National Curriculum and Textbook Board (NCTB) in 2012 is followed to teach science. Effective science education is true to child, true to life, and true to science (NCERT, 2006). Effective science teaching practice in school is a must to ensure good science education. Gomes (2007) argued that school science provides a gateway to young learners to meet various scientific ideas, principles, and to develop attitudes that promote rational thinking. The Science and Technology Committee (2006) reported that science teaching ensures scientific literacy in society and equips the next generation of scientists and engineers to progress to higher education. Therefore, school-level science teaching and learning is very important.

Becoming a science teacher is a creative process as it involves the selection of appropriate teaching methods, itself a creative process (Hassard and Dias, 2011). A number of science teaching strategies have been suggested. For example, MoE (1977), Church (2000), Carin, Bass & Contant (2005), and Hoisington, Sableski & DeCosta (2010) suggested inquiry-based teaching. McCrea (2006), Braund & Reiss (2006), and Chandler & Swartzentruber (2011) recommended teaching science through experience by promoting hands-on activities and informal learning environments. Krajcik & Sutherland (2010) and Hackling, Smith & Murica (2010) suggested that science teachers link new ideas to students' prior knowledge and experiences. McDonald & Dominguez (2009) postulated teaching science through reflection as an effective science teaching method. The National Science Curriculum suggests the same teaching strategies for science teaching in Bangladesh.

There is, however, increasing concern among educationalists about the practical aspects of teaching effectiveness. The "how" of teaching is now being given greater prominence (Dhand, 1990). We therefore sought to establish exactly what is happening in school science classes in Bangladesh in practice and whether teachers deliver lessons traditionally or by following the curricular instructions.

The science teaching-learning status of Bangladeshi schools is unknown, so it is difficult to identify areas of science education requiring improvement. The outcomes of this study are likely to benefit curriculum developers, textbook writers, teachers, trainers, and the researchers in this field and provide a new platform for all science education professionals to reshape and revise their practice. Moreover, these data provide a research foundation for science education researchers in Bangladesh.

The study aimed to explore science teaching methods at grade eight and compare actual classroom teaching-learning of science with the teaching-learning strategies suggested in the National Science Curriculum.

Method

This was a qualitative and quantitative study based on primary data. Eight secondary schools from the Narsingdi district, Bangladesh were selected by simple random sampling (SRS). Twenty grade VIII students from each school were selected by SRS (n=160 in total). Ten science teachers were selected purposively from these schools (n=170 total respondents). Students were administered a questionnaire and an interview schedule was used to collect data from science teachers. Fifteen science classes were observed using a five point Likert scale observation checklist. Data were organised, themes developed, and data interpreted as in Marshall & Rossman (1999).

Data Analysis

The curriculum developed by the National Curriculum and Textbook Board (NCTB) was used during the study period, which provided specific and clear strategies for science teaching-learning. The suggested teaching-learning strategies of science education are explained below.

Critically Looking into the Teaching-Learning Strategies in the Science Curriculum

The grade VIII general science textbook has 14 chapters (NCTB, 2012). Realizing the overburden of theory and lack of emphasis on scientific process and scientific attitude in the curriculum of 1996 the new curriculum had been offered which intended to cover these gaps. Ideal teaching-learning methods of science state that, students are expected to think rationally and solve simple problems in their daily life through science education. The curriculum mentions that science cannot be learnt solely

by reading books; therefore, science teaching through ‘learning by doing’ is strongly emphasised. The curriculum instructs that opportunities should be given to learners to learn by doing according to the school facilities and environment. Observation and experimentation are defined as key tools to develop scientific skills. The curriculum also explains that if learners observe things properly, questions will naturally arise and consequently they will seek the answers with the help of their teacher. In this case, the teacher will inspire learners to derive a hypothesis about the problem and collect data to test that hypothesis. These aspects of teaching science are directly related to the scientific process skills which had been mentioned by Harlen and Jelly in 1997. They mentioned that science teaching-learning strategies should include observing, questioning, hypothesizing, predicting, investigation, interpretation and communication.

The curriculum states that teachers should prepare lesson plans and collect necessary teaching aids. The teachers should conduct lessons using the question-answer technique. To explain the mechanism of any instrument being used, the class could be divided into groups; where there are insufficient numbers of instruments, the demonstration method can be used. The curriculum also suggests that the teacher should try to be diverse when teaching-learning. The teacher will ask relevant questions, judge the prior knowledge of the learners, and then announce the lesson. Emphasis is given to student participation and didactic teaching should be avoided where possible. The curriculum further states that experiments should be demonstrated to solve problems. Students' observation of the experiments and results should be assured, and the teacher should try to assess student understanding of the observed results and experiments. The students will foster a relationship between the actual problem and observed outcome. Finally, the teacher will summarise important points on the board. One important instruction in the curriculum is that the teacher will discuss, demonstrate experiments, and ask questions in the classroom and, via these processes, students' knowledge, comprehension, and skills will be evaluated (NCTB, 1996 & 2012). The expected teaching-learning strategies are summarised in Figure 1.

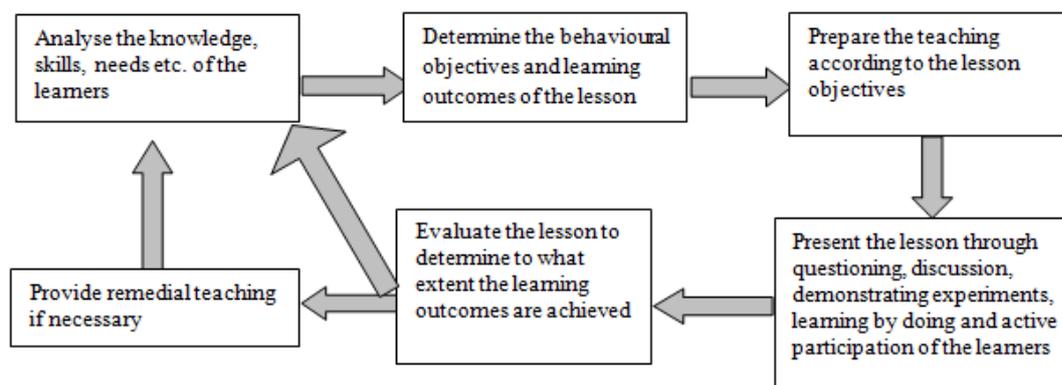


Figure 1. Science Teaching-Learning Strategies

Teachers' Preparation for Conducting Science Classes

Theoretical Preparation

The science curriculum instructs that science teachers need to study the subject matter given in the curriculum and teacher's guide (TG) carefully prior to conducting the lesson. In reality, almost every teacher was unaware of the curriculum and did not follow the TG. Half of the teachers sampled reported not preparing for classes. They mentioned that they prepared for class by reading science books and collecting materials.

Preparing Lesson Plans

The science curriculum suggests that science teachers prepare lesson plans to address the objective(s) of the lesson. A lesson plan was only used in one class. Some teachers mentioned that they used lesson notes but could not demonstrate this.

Using Teaching Aids

The curriculum mentions that teacher should only enter the classroom after collecting the necessary teaching aids and equipment. In practice, it was found that teachers used teaching aids 8 out of 15 classes (Figure 2).

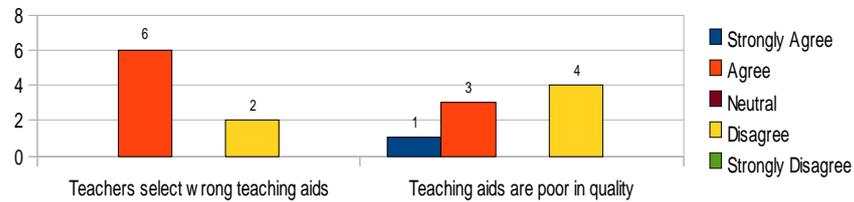


Figure 2. Use of teaching aids

Teachers selected the wrong teaching aids for most of the classes. For example, one teacher showed a piece of soil as an element, while another teacher showed a poster in which the formula of carbon di oxide was written as Co_2 instead of CO_2 . Sometimes, teachers used unclear posters that students found difficult to read.

Teachers' Opinions about Lesson Preparation Issues

Although half of the teachers questioned reported that they prepared for science classes, there was no reflection of their opinions. The teachers raised several issues regarding lesson preparation. Almost every teacher reported having to conduct 6-7 classes per day. Although they were science teachers, they also had to take other classes. Some teachers expressed their feelings as follows: "*If our burden of excess classes and other official tasks could be reduced then we would be able properly prepare for science classes. At the moment, we take our classes based on our prior experiences only*". Some teachers mentioned that they had no teacher's guide in their school, and in one school the science textbook had yet to be supplied, which were regarded as barriers to preparation for science classes. In their opinion, they could better prepare if their academic pressures could be reduced. They regarded 3-4 classes per day as sufficient to allow for adequate preparation.

Science Classroom Practice

Announcement of the Lesson

The curriculum states that before announcing the lesson, the teacher should instruct the students to close their books while relevant questions are asked on their knowledge, skills, experiences, capacity, and needs related to the lesson. Of 15 observed science classes, teachers investigated prior knowledge of the learners in 13 classes but did not motivate the students in 12 classes. 26.3% of students reported that teachers asked question about themselves and then announced the lesson, 38.8% reported that teachers checked their homework and then announced the lesson, and 33.8% students agreed that teachers generated their interest first then announced the lesson.

Lesson Progress

NCTB (1996 & 2012) suggests that science teachers should progress the lesson through precise questioning and answering. In reality, teachers did not progress the lesson in this way. Teachers sometimes asked questions, but the questioning procedure was inappropriate and teachers did not instruct the students as to whether they should respond individually or in groups. The teachers did not create scope for students to ask questions, and students did not ask the maximum amount of questions in science classes. Teachers did not arrange creative activities in classrooms and only asked creative questions in 2 classes:

Is fire a matter?

What type of germination occurs in paddy?

In those two classes, teachers taught topics related to these questions, but the questions were absent in textbooks and students answered using creative thinking. With respect to question-answer

practice, 154 students (96.25%) said their teachers asked question and 6 students (3.75%) reported that their teachers did not ask questions (Figure 3).

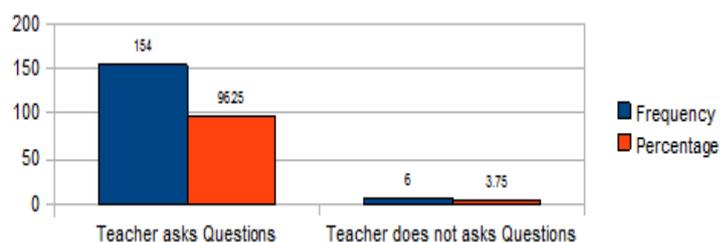


Figure 3. Students' responses with respect to teacher questioning

When asked whether they could answer questions easily or they had to think a lot to answer, 110 students (71.42%) reported that they could answer easily, 31 students (20.14%) reported that they had to think a lot to answer, and 13 students (8.44%) said that they sometimes had to think to answer and sometimes they could answer easily. When the students were asked to give examples of questions for which they had to think critically, answer they could not provide examples.

Use of Methods in Teaching Science

Most of the science teachers did not select appropriate teaching methods. For example, teachers delivered the lesson "body parts of a plant" through direct lecturing, but demonstration or a practical might have been more appropriate in this case. The methods used to teach science are explored in detail below.

Lecture Method

NCTB (1996 & 2012) recommends avoiding traditional lecture (didactic) methods as much as possible. In practice, the lecture method was the most commonly used method even though teachers had the scope to deliver lessons using different interactive methods. Every teacher reported using lecture methods most commonly. Sometimes teachers used other methods, but lecturing was used simultaneously.

Demonstration Method

The curriculum advises that if the equipment and materials are available then teachers should divide students into small groups and create opportunities for the groups to conduct experiments. Where only a single set of equipment is available, the curriculum suggests demonstration of the experiment with student help. In practice, teachers had the scope to use demonstrations in 12 out of 15 observed classes, but teachers arranged demonstrations in only 4 classes.

Although half of the sample teachers reported using demonstrations to teach, most could not mention the name of an experiment that they had demonstrated. The curriculum did not appear to be followed for demonstration purposes. Teachers explained a lack of demonstrations through a lack of materials and poor infrastructure of science laboratories, large syllabi, and limited time. With respect to teaching experimental methods, teachers reported teaching these topics by verbal description, while some teachers reported drawing experiments on the board and then explaining the mechanism via verbal discussion. Some teachers said, "In class eight these experimental topics are not given enough importance, we demonstrate experiments in class nine and ten. Sometimes we call a few students into the laboratory and instruct them to observe the experiment performed by their seniors". This comment is encouraging and suggests that at least some teachers attempted to use demonstrations in classrooms in spite of limitations.

Learning by Doing Method

The curriculum instructs that opportunities should be created for students to learn science by gaining practical experience. Science learning should not be confined to the textbook alone. According to the available school facilities and environment, teachers should involve the students in activities. We found that teachers never involved learners in accomplishing tasks even though they had scope to "teach by doing" in every class. Teachers reported being limited by short classes, a lack of materials, and the

pressure of huge syllabus. Teachers who claimed that they engaged students in tasks could not provide examples. 80.6% students claimed that they performed doing tasks in science classes but could not name any of the activities.

Use of Inquiry Approach

The curriculum states that teachers should create opportunities for students to observe objects and events in their surrounding environment. If they properly observe the environment, questions are likely to be asked. With help from the teachers, students will form hypotheses to these questions, which can then be tested by data collection and performing experiments. During experiments, students will observe the results. Teachers will then examine the results to help create a relationship between the actual problem and the experimental results and will write a summary on the board. In practice, these activities were totally absent. Although teachers had ample opportunity to use the inquiry approach to involve learners in observational activities, they did not. Students never went outside the classroom to observe and did not formulate hypotheses, collect data, or perform experiments to test a hypothesis. Teachers failed to relate the problem with experimental result and did not present a summary of the lesson. In this way, the science curriculum was absent in science teaching.

Rational Thinking

The curriculum expects students to be capable of thinking rationally and solve simple problems of daily life. In reality, teachers did not involve students in rational thinking. Teachers did not create scope for students to analyse any cause-effect relationships.

Student Participation in Teaching Learning

The curriculum emphasises ensuring student participation in class activities. Teachers were not conscious about learners with learning difficulties. Learners were not attentive and did not participate in class activities (Figure 5).

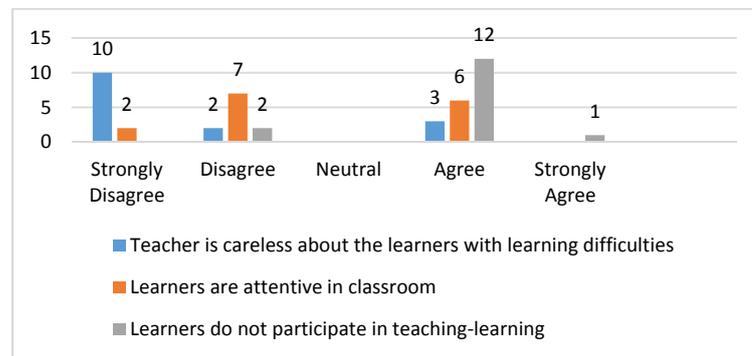


Figure 5. Student participation in class activities

All teachers reported that they took steps to ensure active participation of students in class activities, but no teachers could explain the steps they took.

Assessment of Achievement

Teacher should evaluate learning outcomes to judge to what extent the learners have achieved these outcomes. It is suggested that teachers should ask questions and judge students' knowledge, comprehension, and skills. We found that teachers assessed students' learning achievements in most classes. Teachers mainly assessed students' recall capability, which is regarded the lowest level learning domain according to Bloom taxonomy (Bloom, 1956). All assessment devices were knowledge-based questions, with other cognitive sub-domains left unexplored and items from affective and psychomotor domains totally absent. The classroom observation data showed that in most classes, teachers did not identify the learners who could not achieve a day's competencies. The overall observed result revealed that the process of assessment of achievement did not follow the curriculum instruction.

Remedial Teaching

Remedial teaching is suggested in the curriculum for those students who cannot achieve the day's competencies. In reality, teachers were unaware of students with learning difficulties. No teacher identified learners who could not achieve the day's competencies and remedial teaching was never seen.

Discussion of Findings and Recommendations

Here we discuss and compare the study result with published findings and make some recommendations to improve science teaching in Bangladesh.

Ensuring Availability of Curriculum and Teachers' Guide

This study identified that the curriculum and teachers' guide were generally unavailable in schools, similar to the results reported by Nina (1992) and Sadat (2001). The lack of the curriculum and teachers' guide appears to be common in Bangladesh, but they are required for better teaching. Hatton (2008) reported on pre-service science teachers who were concerned about the pedagogy of science teaching and they had good command of the curriculum, content, and scientific attitude. Their performance in classrooms was satisfactory. Therefore, steps should be taken to ensure the availability of the science curriculum, teachers' guide, and other necessary materials.

Reducing Teachers' Workloads

Large workloads were one of the major problems for teachers since it stopped them from preparing and delivering quality science classes. Hossain's (2000) study also identified that teachers' workloads were beyond tolerable levels. School authorities need to consider workloads of science teachers and try to find alternatives such as employing para-teachers or teaching assistants.

Using Lesson Plans

Lesson plans are necessary for effective teaching and better management of large classes (UNESCO, 2006). The curriculum also suggests using lesson plans. Teachers did not use lesson plans, similar to in Sadat's (2001) study. This is also related to teachers' workloads. However, teachers should be encouraged to prepare lesson plans and proper supervision systems should be in place to ensure compliance.

Training for Applying Proper Methods of Teaching

A number of studies, including the present one, have reported that lecture method is most commonly used to teach science. Other interactive teaching methods like group discussion, demonstrations, and learning by doing are not applied for teaching science in practice (ADB, 1998; Hossain, 2000; Sadat, 2001; Huq, 2004; Gomes, 2007 & Orhan, 2009). Teachers reported that short time periods, large syllabi, etc. were the main causes for not practising these methods, similar to Nina (1992), Krishna (1997), & Sadat (2001), who reported that lack of time, unavailability of materials, and lack of laboratory facilities and ingredients were the core reasons for not using demonstration, experimentation, or learning by doing methods. Another alarming result of our study was that teachers did not use the inquiry approach at all, similar to Wang & Lin (2009) and Anne & Coll (2010). The inquiry approach is particularly important for science teaching (Joseph, Munro, Prebble & White, 1976). We also found that teachers did not involve students in creative activities. Longo (2010) found that the inquiry approach of teaching made students creative. According to Jale, Erdinc & William (2005), using teacher-centric methods such as lecturing or reading from textbooks were characteristic of low-efficacy teachers. Teachers need to be trained properly so that they can use different interactive methods effectively.

Ensuring Student Participation in Teaching-Learning

Students did not participate in teaching-learning and the teachers were not attentive to those learners who could not achieve a day's competencies. Students were also inattentive to the lesson. Ahsan (2009) also found less participation of students in science classes. However, teaching aids facilitate student learning by attracting their attention (Adeyanju, 2003). Using teaching aids can ensure student participation and can also help promote higher achievement of the students (Agun, 1986; Agun and Imogie, 1988; Adeanja, 1988; Akanbi, 1988; Akinola, 1988 and Adeyanju, 2003). Although the curriculum suggests that teachers collect teaching aids and then enter science class, teachers did not do so. Teacher should try to collect the proper teaching aids and should also be attentive to all the learners to ensure student participation in the classroom.

Fostering Effective Classroom Assessment and Feedback

Assessment is also an important aspect of the teaching-learning process (Stiggins, 1991). Assessing students is a very important part of teaching (Nitko, 1996), and is ideally an integrated process that determines the nature and extent of student learning and achievement (Linn & Gronland, 2005). The curriculum suggests the teachers assess students' knowledge, comprehension, and skills, but it practice only the recall power of students was assessed. Higher-order questions, creative questions, or affective and psycho-motor domain tests were totally absent. MacNeil (2010) and Sternberg (1985) argued that higher-order questioning helped students to learn better. Questioning was also one sided. Students did not ask any questions, but students' questions are important in the assessment and feedback process (Aguiar, Mortimer & Scott, 2010). The teacher should try to ask higher-order questions and at the same time involve students in questioning. Remedial teaching should be practised. Sanalan & Shirley (2009) found that using technology in science classes was helpful for assessment and technology might therefore be useful in science teaching.

Conclusion

The study revealed that science teaching in sample schools in Bangladesh was not practised as instructed in the science curriculum. There was a big difference between the prescribed curriculum and what is being practised in the classroom. Learning science is not only learning information and facts, but also acquiring process skills and higher-order thinking. Given the importance of science education, due emphasis should be given to on-time delivery of curriculum materials to teachers, proper training, and curriculum dissemination for teachers. Teachers should be encouraged to plan and prepare before going into class. Optimum learning environments also need to be ensured in schools so that teachers and students can undertake science experiments and activities. Most importantly, the issue of teachers' workloads needs to be taken seriously. Further studies are needed in these areas to overcome these problems so that school science education can be improved in Bangladesh.

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