Primary science teaching in Bangladesh: A critical analysis of the role of the DPEd program to improve the quality of learning in science teaching

Md. Mustafizur Rahman Talukder a, Colin Green b,*, Md. Mamun-ur-Rashid c

a Primary Teachers' Training Institute, Bhola, Bangladesh
b University of South Wales, UK
c Department of Agricultural Extension and Rural Development, Patuakhali Science and Technology University, Dumki, Patuakhali, 8602, Bangladesh

ARTICLE INFO

Keywords:
Current practice
Learning and teaching
Primary level
Professional preparation
Quality
Triangulation
Teacher-centered
Pupil participation
Inquiry oriented
Scientific literacy

ABSTRACT

This study investigated the current practice of learning, teaching and assessment in science, particularly in classrooms at primary level in a division of Bangladesh. In addition, this study also focused on the role of DPEd program in the development of the professional preparation of teachers' for improving their quality of science teaching. For the purpose of this study, a mixed method research design which used both quantitative and qualitative method to gather and analyse data. A random stratified sampling process was used to select 150 primary science teachers and 60 students in grade 5 (10 + years) students for collecting quantitative data while a purposeful sampling process was used for qualitative inquiry. Qualitative data was obtained through analysis of the national documents and the interviews of Head teachers of primary schools, Assistant Upazila (Sub-district) Education Officers and Instructors of Primary Training Institutes (PTI) and Upazila Resource Centers. Quantitative data was analysed by using descriptive statistics and qualitative data was transcribed and labelled into emerging themes. A triangulation technique was used to establish the findings of this study. The findings of this study revealed that the present practice of learning and teaching science is mostly teacher centred with little active pupil participation, limited opportunity for hands on activity and discussion. The major barriers for teachers' to teach science effectively were large class sizes, insufficient materials, lack of teacher's knowledge and skills, absence of assessment for learning strategies, inadequate opportunities for professional development and poor quality of support from the stakeholders. The current DPEd program has consist of limited focus on hands of activities, insufficient learning assessment capacity of the PTI instructors, and a lack of teacher monitoring in placement schools during training. The basic recommendation suggested by this research is to enhance the use of an inquiry oriented science learning and teaching approach with associated assessment for learning strategies for ensuring the quality of science learning and teaching. For preparing a better quality teacher, ensuring subject based training and to review the current teacher training program is further suggested. The result of this study can be used for future development of science learning and teaching practice at elementary level in Bangladesh and similar other developing countries.

1. Introduction

Education is inevitable for future growth, development and survival of a nation. To ensure a good education for its citizens Bangladesh divided her entire education system into three major stages-primary, secondary and higher education. Primary education is a 5-year cycle whilst secondary education is a 7-year one with three sub-stages: 3 years of junior secondary, 2 years of secondary and 2 years of higher secondary. The entry age for primary is 6 years. The junior, secondary and higher stages are designed for age groups 11–13, 14–15 and 16–17 years. Higher secondary is followed by graduate level education in general, technical, engineering, agriculture, business studies, and medical streams requiring 5–6 years to obtain a Master's degree (MoE, 2020). Among these stages of education primary level deserves particular attention as it lays foundation for the other levels of education. Hence, every country is active in their own way in preparing their children as a skilled human resource, so that they can fully participate and contribute to their nations' growth and development. Bangladesh being a progressive country also recognizes primary education as a crucial base for our future generations to acquire quality, modern and updated knowledge of science and
technology and to evolve as a skilled human resource so that they may contribute to eradicate poverty, illiteracy, corruption, communalism and backwardness and build up a developed and prosperous Bangladesh (MoE, 2010).

Over the decades, significant progress has been made at primary level education in Bangladesh on the access to and participation with elementary education, such as pupils' enrollment (97.9%), primary cycle completion and gender equity (DPE, 2015; Unicef, 2020; Ahmed, 2011). Lamentably, the achievement in relation to the students' attainment in primary education was comparatively less than expected (Nath et al., 2015). Unicef (2020) described the quality of primary education in Bangladesh as poor leading to low-learning outcomes. This situation is further supported in the Annual Sector Performance Report (ASPR) 2017 which claimed that 66% of grade 3 students and 67% of the grade 5 students failed to achieve expected level of competence in mathematics in their respective grades (Alamgir, 2019; MoPME, 2019).

The outcomes of children's competency attainment level testify to the delivery of poor quality education (Ahmed, 2007). This argument is further supported by Alam (2009) that the quality of the country's science learning and teaching in schools is far from a satisfactory level. Moreover, in a report prepared for Bangladesh Government Advisory Group on Primary Education Austin et al. (2008) claimed that although Bangladesh has made great strides in the access to education over the past decades but education quality remain low. In fact, most schools tend to embark on memorizing fact accompanied by traditional teaching and put minimal effort in developing analytical, practical and vocational skills (Unicef, 2009). Therefore, the quality of science is an important issue that needs to be addressed urgently.

Quality education can be achieved by teachers, who possess a good range of learning and teaching techniques and are facilitated by a supportive learning environment (Ng, 2015). Research focusing diversified nations suggests that teachers are the most important driver of student learning (Azam and Kingdon, 2015; Bau and Das, 2017; Molina et al., 2020). Snilstveit et al. (2016) provide evidence which supports that most interventions targeted student's learning worked through teachers. Similarly, Sammons & Ko (2008) also provides evidence that effective teachers are more likely to demonstrate a supportive lesson climate, proactive lesson management, well-organized lessons with clear objectives, environment and teacher support. However, teacher effect is not stable and fluctuate over school years, implementation phases of education policy, different teaching periods and across lessons in which observation/assessment has taken place (Ko et al., 2013). Hence, changes teacher can implement to improve learning can vary across numerous factors and need evaluation to improve teacher's class performance.

Teacher education and teachers professional development are important to prepare better quality teacher, who are able to demonstrate their professional skills. In Bangladesh, Primary Training Institutes (PTI) are the sole agency to provide teachers education and therefore they play a pivotal role through initial teacher education Program (Directorate of Primary Education (DPE), 2019). At present in Bangladesh there are 67 PTIs scattered over almost all the districts of the country and train 46,975 primary teachers from the year 2016–2020 in 18 months long DPEd course (NAPE, 2020). Thus, any improvement initiative in primary science teaching in Bangladesh necessitates a better understanding of the learning and teaching process in DPEd program. Deplorably, till now there is limited research on the classroom practice of learning and teaching science in primary schools as well as in PTIs in order to identify the essential competencies required. Hence, a study related to classroom practice in science teaching is useful. This study has given an overview of the current learning and teaching practice particularly what strategies are used by science teachers; how they deliver their lessons; and the children's perceptions about their science learning; and the ways of current DPEd program improvement for enhancing the quality of science teachers. In addition, this study suggests a direction the changes needed to improve the quality of science teaching. This study should support stakeholders such as teachers, academic supervisors, teacher trainers, curriculum developers and researchers to provide an inquiry based elementary science.

1.1. Aims of the study

The main objective of this study is to examine the current practice of learning and teaching science, specifically classroom practice such as the teachers' delivery process, methods and techniques, practices of assessment for learning and children engagement at primary grade. Furthermore, the study places emphasis on developing the professional preparation of science teachers by identifying major issues and making appropriate recommendations.

1.2. Research questions

This study addresses the following research questions which are as follows:

- What is the current practice of science teaching at primary grade in Bangladesh?
- What changes can teacher's implement to improve the quality of science teaching?
- How should the current DPEd program change to improve the quality of teacher delivery within the class room?

1.3. Conceptual framework

The constructivist approach of learning and teaching has focused on the process of acquiring scientific knowledge (inquiry-based) and to encourage students to understand the nature of scientific inquiry rather than taught knowledge (Lederman et al., 2014). Basically, content based involvement has a minimal effect on children's learning process (Diamond et al., 2014). Fitzgerald and Smith (2016) noted that using a constructive approach supports elementary teachers to improve their learning and teaching techniques which enable children to develop their thinking skills and further their learning experience. Inquiry based teaching refers to the logical nature of learning and teaching which is known as constructivism that emerged from the works of Jean Piaget, Lev Vygotsky, and David Ausubel (Liang and Gabel, 2005). Ryan (2009) mentioned that inquiry based education is important to improve student's attainment and develop a positive interest in science that can support and develop children's curiosity.

Teacher quality is central in implementing the curriculum and obtaining better educational outcomes. Children's attainment depends on the quality of learning and teaching (The excellence of the teaching frame work, 2013; Tyler, 2007; Goodrum and Rennie, 2007). Therefore, teacher education is paramount in preparing a better quality of teachers with essential skills (Das and Ochiai, 2012; Ogunmade, 2005). However, there is a lack of consensus within the literature as to exactly what competences are needed for teachers to deliver elementary science teaching effectively (Kim and Tan, 2011).

Alake-Tuenter et al. (2012) considered twenty-three competencies for teachers, which they classified into three groups, such as subject matter knowledge (SMK), pedagogical content knowledge (PCK) and attitude components. Subject matter knowledge generally refers to the content knowledge which involves particular theories and concepts that is needed for learning and teaching (Shulman, 1986, 1991). Kim and Tan (2011) showed that the SMK of teachers has an impact of their classroom practice. Teachers with limited SMK teach basic science but more often use paper-pencil activities rather than choosing an inquiry based approach. Akerson (2005) suggested that teachers can develop their SMK through reading and discussions with colleagues. It should be noted that a strong SMK is needed, but in itself not enough to ensure effective teaching. They also have to have the capacity to transform subject knowledge into the pedagogical knowledge (Avraamidou and Zembal-Saul, 2010; Davis and Smithey, 2009). Therefore, the
pedagogical content knowledge should be a significant focus in teacher education. Shulman (1986) introduced PCK as the knowledge of teaching that includes the process of presenting the subject to make it understandable for others. Magnusson et al. (1999) introduced five elements of PCK for teaching science such as knowledge of curriculum, knowledge of instructional strategies, knowledge of assessment, knowledge of attitudes towards science teaching and knowledge of approaches to children’s learning. In Bangladesh, Rahman and Sultana (2016) indicated that to some extent these five elements of PCK was discussed by Magnusson et al. (1999) are reflected in the current initial teacher training (DPEd) science curriculum. They also stated that child-centred learning and teaching approaches are central in the DPEd to develop the quality of teaching to ensure better children’s involvement and participation in their learning. However, the question remains, what is the current state of teachers applying this knowledge in their classrooms?

Over past decades, there is an increasing demand for teacher professional development (PD) in the area of primary science teaching (Aalderen-Smeets and Mole, 2015). The National Action Plan (2008–2012) for school science in Australia tackles this issue and suggests better provision of professional learning (to refresh teachers with an updated knowledge of science) and “improve their pedagogical and pedagogical content knowledge, particularly those inquiry-based pedagogical strategies that develop scientific literacy” (Goodrum and Rennie, 2007, p. 20).

A number of studies recognized the value of teacher professional development that includes an inquiry-oriented learning approach followed by using a constructivist learning model for example hands-on science activities, inquiry-based teaching methods, cooperative learning, using role-models and challenging misconceptions about science content (Carleton et al., 2008; Osborne, 2014). Slavin et al. (2014) argued that teachers’ professional development should focus on developing teachers competency so that they can better match their teaching to context rather than on established methods for teaching.

Bahr et al. (2007) noted that teachers PD is a process of learning and it can improve through extended discussion with colleagues. In Bangladesh, present provision for science teachers’ PD includes subject-based training, lesson study process (plan-see-do cycle) and sub-cluster training. Currently, there is minimal information about the effectiveness of this type of training. However, Mullick and Sheesh (2008) noted that training programs are not always properly planned and tend to focus on content knowledge rather than inquiry-based experience. This study considers teachers professional development as an ongoing process of professional learning to acquire knowledge and skills so that they can develop their quality of teaching.

The term, quality education, is frequently used by the politicians, practitioners and scholars in the field of education (Ng, 2015). In Bangladesh, the government is also striving towards achieving quality education by formulating different projects and programs. The core objective of the Primary Education Development Program (PDEP-4) is to provide: “quality education for all our children” (DPE, 2018). The concept of quality education has diverse meaning and understanding and it varies according to national context and culture (Tikly and Barrett, 2007; Tikly, 2011). Houston (2008) defined quality education with reference to three basic measures the learner’s achievement (knowledge, skills, and attitudes); contribution to the economy and applicability of education in society.

The Delors et al. (1996) UNESCO’s report underlined that the quality of education can be understood on the basis of four pillars, such as learning to know (allows that learners construct their own knowledge), learning to do (places emphasis on the application of learning, learning to live together (living without discrimination and have opportunity to develop themselves) and learning to be (i.e. give attention to the skills required for individuals to develop their full potentials). Government policy documents did not define clearly what was meant by quality education (Nath and Chowdhury, 2008). However, a number of factors to support a quality of education at primary level such as physical facilities, training, learning and teaching, school management, wider stakeholders and academic supervision of schools. In relation to the objectives of this study, the term quality can be defined as a continuous process of improving learning and teaching practice with a vision to achieve certain desired goals in schools at elementary level.

Preferably, quality teaching can be defined as that which leads students to achieve high standards in respective outcomes and the effectiveness of teaching must be assessed against the progress being made by the students (Coe et al., 2014). According to the Sutton Trust (Coe et al., 2014) quality teaching is the likely combination of several factors, such as teachers’ subject knowledge, quality of instruction (effective questioning and assessment by teacher), classroom environment (quality of collaboration between teachers and students), classroom management (effective use of lesson time, materials and manage students behavior), beliefs and professional behaviors (engagement in professional learning, helping colleagues). The challenge is that these factors are defined with various or differing meanings and interpretations (Coe et al., 2014).

Current international research on education has also placed emphasis on the quality of classroom process and cognitive-constructivist or socio-constructivist models of learning and teaching for effective science teaching (Decristan et al., 2015). In Europe, the quality of classroom process comprises cognitive activation, supportive climate, and classroom management (Klieme et al., 2009). A similar model of classroom practice is also used in the United States (instructional support, emotional support, and classroom organization) (Reyes et al., 2012).

However, teachers need to challenge children’s prior knowledge, use challenging tasks and questions to stimulate cognitive conflicts and engage students in higher-level thinking processes (Baumert et al., 2010).

Stoll (2015) stated that for effective teaching there is an urgent need for teachers to talk with children about their learning, respond to students’ problem and engage children; to be open minded for new learning and challenges; use a variety of strategies to develop children’s thinking and learning skills; to appreciate students prior knowledge; to use assessment for learning and to talk about teaching with their colleagues.

For the purpose of this study, these features are considered as the key elements for quality or effective science teaching.

2. Methodology

2.1. Research design

For the purpose of this study, a convergent parallel mixed method was used which comprises of both quantitative and qualitative components. Hence, this study examined the current practice of science learning and teaching through survey questionnaires, interviews, observations (small scale) and an analysis of National documents. The quantitative approach includes both teachers and students’ survey questionnaires whereas the qualitative approach is comprised of observations, document analysis and interviews with Headteachers, Assistant Upazila Education Officers (AUEOs), and Instructors from PTI and URC. In is important to note that all these personnel play a pivotal role in ensuring better science teaching at primary level. However, for classroom-based observation, a total of four science classes (Grade 2, Grade 3, Grade 4 and Grade 5) were observed purposefully from the sampled schools.

2.2. Population and sampling

The study was conducted in a division, which is one of the eight divisions of the People’s Republic of Bangladesh and it is divided into six districts. The study comprised the population from two sub-districts. A random stratified sampling approach was used to select two (one urban and one rural) schools from each sub district. A sampling procedure using a stratified method was used to select 32 students from urban schools and 28 students from rural schools and of these 50% was boys and 50% were girls to ensure a gender balance. For the purpose of the student survey, grade five students were selected because children of this grade are more
cognitively developed rather than the lower grade students. The two sub-districts involved in this study support a total of 359 primary Schools. The entire population of 400 (approximately) science teachers was surveyed, and of these, 150 completed and returned questionnaires providing a 38% return rate. The sample of 150 teachers comprised 48 male (32%) and 102 female reflects the National gender difference and which may be explained by the fact that the teacher recruitment policy determines that 60% of teachers must be female.

This study considered Headteachers (four), AUEO (two) and Instructors (one from PTI and one from URC) as the participants for interviewing purposes in order to get purposeful qualitative data. It is noteworthy to mention that these interview participants play a pivotal role in ensuring better science teaching at primary school level. For instance, Head teachers observe and monitor teachers’ class performance within the schools; AUEOs regularly visit schools and observe classrooms practice; the science instructor at PTI is involved with the initial teacher training program; and the instructor from URC mainly is involved with the teachers’ continuous professional development. In order to secure qualitative information, this study used a purposeful sampling process which is helpful to better understand the central phenomenon (Creswell, 2014). In essence, this research considered the following sampling process, which was modelled from the multilevel mixed method sampling process of Teddlie and Yu (2007, p.94).

- Sampling schools within districts: probability sampling (stratified sampling),
- Sampling Headteachers and classrooms within schools: probability sampling and purposive sampling,
- Sampling students within the classroom: random stratified sampling.

2.3. Research instruments

This study was undertaken by using survey questionnaires, interviews and observations as research instruments that consulted a wide range of stakeholders. This study also reviewed other relevant documentation. All data collection tools were firstly developed in Bengali language then data was converted into English. The home language was used for collection of the primary research data to enable the participants to use a richer source of language to answer the research questions and not be constrained by their knowledge of a foreign language.

2.3.1. Survey questionnaires

For the purposes of collecting quantitative data, this study developed two different forms of questionnaires, one is for teachers’ survey and other one is for students’ survey. The reason for choosing questionnaires is that they can be used to gather a large amount of information within a limited time and the results of the questionnaires can be analysed more methodically and purposefully in comparison with the other types of research instruments (Cohen et al., 2011). Questionnaires were developed using three major sources for guidance such as the studies of Goodrum et al. (2001), Ogummade (2005) and inspection guidance for of primary schools in Wales (ESTYN, 2010). A four point response format (strongly agree, agree, disagree and strongly disagree) was used for both questionnaires in order to achieve more straightforward results.

The teacher questionnaire was divided into five sections such as background information, teachers’ views about the purpose of teaching science, current practice of learning and teaching science in the classroom, factors inhibits the quality of teaching science, and recommendations to improve the quality of science teaching. The student survey questionnaire was consisted of three sections namely demographic information, children’s opinions about the actual classroom practice and open-ended questions concerned with the purpose of their learning science and how their learning of science can be improved.

2.3.2. Credibility of survey questionnaires

Bolarinwa (2015) stated that the researcher can ensure the validity of the questionnaires by using a panel of experts from relevant field to assess the questionnaires. Hence, the questionnaires of this study were assessed by three specialists in the field of elementary science education for ensuring the validity of content. Their suggestions were considered and incorporated. The survey questionnaires were also piloted on a randomly selected number of teachers and students. The rationale of piloting was to validate the tool and to check its reliability. Moreover, through piloting questionnaires, the researcher can improve the questions based on the participants’ responses and is able to determine the accuracy of the questionnaires (Bryman, 2012). The result of the pilot was used to further improve the survey questions.

2.3.3. Interviews

A semi-structured face to face interview was conducted which contained open-ended questions. Probes and prompts were used to further develop replies of the respondents in a non-directive way whilst attempting to maintain the natural flow of interview (Sapsford and Jupp, 2006). The interviews were conducted with eight participants with sessions recorded by consent of the interviewees. During the interview, the major questions asked were about the current practice of teaching and science teaching at primary schools, challenges of teaching science and their suggestions for improving the quality of children’s science learning and teachers’ training.

2.3.4. Observation

This study considered observation as a research technique in order to get a more realistic picture of the particular classroom settings (Cohen et al., 2011). The selected classrooms (four science classes of Grade 2, Grade 3, Grade 4 and Grade 5) were observed purposefully from the sampled schools using a semi structured observation schedule. The observation schedule focused on specific areas, such as inquiry base engagement, assessment for learning, teaching aids and classroom context.

2.3.5. Data analysis procedure

As this study was undertaken using a mixed method design, the researcher collected both qualitative and quantitative data for constructing knowledge. At the preliminary stage, both text and numeric data were analyzed individually. Statistical package software SPSS V. 24 was used in order to analyze the scale based items from teacher and students survey questionnaires. Respondent opinions on the open-ended questions were coded into groups and the frequency of responses of each group was calculated. A descriptive statistical approach was used to present the numerical data by using percentages, means and standard deviations where appropriate. Data from interviews were analyzed by considering the steps of Creswell (2014), such as transcribing, organizing, coding, developing themes, making connections and interrelations, and developing a larger meaning of the data.

Lastly, the findings from the teacher and students survey questionnaires were compared with the qualitative result from interviews. Statistical trends were analyzed through qualitative themes. The information from the documentation and classroom observations were linked to the results from different tools to better understand the theory and practice of teaching science.

2.3.6. Result triangulation

Data was collected from as wide a field as possible within the limited time limits set. This included a range of schools and a wide range of year groups within those schools. In addition a range of data collection techniques was used such as individual interviews and questionnaires within the range of identified pupils. Triangulation was achieved from
the use of wide range of collection techniques collected from a wide range of pupils. Data produced from the described sources had common themes and issues which have been described within this article. This research is approved by the ‘University of South Wales Masters Committee for Ethical Approval’. Before data collection written consent from the participants were ensured.

3. Findings and discussions

3.1. Background information

The data revealed that nearly half of the teachers (46%) had a Master's degrees and a large majority of the sampled teachers (83%) had attended initial teacher education programs. More than half of the teachers (53%) had 6–20 years teaching experience. Almost all of the teachers teach science along with other subjects. Very few teachers (3%) only taught science. The class sizes ranged between 10 to 73 students and the most common class size was between 40–49 students. The average number of children in a science class was 36.6, with approximately one third of the classes being below 29 but nearly one quarter of class was in excess of 50. This research also collected data from 60 students in grade five through questionnaires about the current learning and teaching activities in science and their suggestions to improve the study of science.

3.2. Rationale of teaching and learning science

Data from Table 1 reveals that encouragingly, about half of the teachers (45%) believe that the main purpose for teaching science is to develop scientific understanding and to develop scientific literacy. Also a quarter (26%) stated that getting children to apply and understand the wider context of science in their everyday life was important. However, about a quarter of teachers (23%) stated that the main concern was for examination preparation and preparing children for the next phase of their learning. The majority of the children noted that they learn science in order to pass examinations, however a smaller number of students (30%) learn science in order to improve their scientific knowledge.

About a half of the teachers believe that the purpose of teaching science at elementary level is to develop students’ scientific mind and nurturing students’ inquiry. Interestingly, their views are in line with the policy documents and curriculum objectives which stated that the aims for science education in preparing the learners to develop their science literacy. also a considerable number of children reported that they complete lots of demonstrations. Disappointedly, when a teacher asks questions, about a half of the students stated that teachers also provide the answers. A substantial percentage of teachers (60%) claimed to use class discussion with summaries at the end of everyday class activities. A comparison of Students and Teacher perceptions in Figure 1 revealed that only about a third of students’ ask direct questions (37%) and a similar number have opportunity for hands-on practical work and classroom talk. A smaller number of teachers (25%) start their lessons with questions or set problems and children have opportunity to talk and ask if they find work hard (40%).

A comparison of Students and Teacher perceptions in Figure 1 revealed that only about a third of students’ ask direct questions (37%) and a similar number have opportunity for hands-on practical work and classroom talk. A smaller number of teachers (25%) start their lessons with questions or set problems and children have opportunity to talk and ask if they find work hard (40%).

Data in Table 2 indicates that 72% of the teachers performed a whole class discussion with summaries at the end of everyday class activities. Encouragingly, a substantial percentage of teachers (60%) claimed to use a wide range of strategies flexibly to meet the pupils need. Disappointingly, a small section of the teachers (19%) encourage the students to plan their experiments and investigate their own experiments. Slightly, more than half of the teachers (53%) do not observe each other’s classes as part of sharing and improving teaching strategies all or most of the time and about a one third believe that children are not highly engaged in their classes.

Data from Table 2 shows that almost all the students (93%) listen to the teacher's explanation all or most of the time. However, a majority of students (59%) reported that there is a limited scope to explain their thinking with others. Children frequently listen and watch teachers' demonstrations. Disappointedly, when a teacher asks questions, about a half of the students stated that teachers also provide the answers. A considerable number of children reported that they complete lots of writing in the classroom (42%) and do not know what to do and who to ask if they find work hard (40%).

Table 1. Purposes of teaching and learning science (n = 150, 60).

| Purpose | N | Percent |
|---------|---|---------|
| Teacher's | | |
| Helping children to read and understand the content | 44 | 29.3 |
| Encouraging students to acquire the knowledge of science | 38 | 24.6 |
| Supporting learners to develop scientific minds | 68 | 45.3 |
| Preparing children for the next class in science | 17 | 11.3 |
| To pass the examinations | 18 | 12 |
| Helping pupils to understand the context of the modern world | 27 | 18 |
| Enabling children to apply science in their daily life | 12 | 8 |
| Student's | | |
| To pass the examination | 29 | 48.3 |
| To pass the examination with high scores | 25 | 41.6 |
| To become a science related professionals | 14 | 23.3 |
| To know about the science knowledge | 18 | 30 |
| To understand the environment | 8 | 13.3 |

Note: Some respondents response more than one, so the total percent is more than 100.
with students about their learning. Students had less chance to talk and the class is teacher centered not child centered” (Instructor, PTI, 24/05/2017). Almost all respondents agreed that teachers talked most of the time, there was limited scope for students to talk, to think and to engage in hands on activities in the class. Reading from the text is the most common method of presenting a topic. “Most of the time the teacher describes the text and students listen. Limited hands on activity... Teacher talking most of the time (60%)” (Headteacher-2, 20/05/2017). However, Smardon and Bewley (2007) argued that listening to the learner voice and asking questions about how they learn, what they are learning and how they will know they have learnt it, is important to improve pupils learning and achievement (ESTYN Government guidance for the Inspection of Primary Schools in Wales, 2010). Furthermore, “The Let’s think approach” in the CASE project (Cognitive Acceleration through Science Education, King’s College, London, A series of research programs from 1981 to the present (Shayer and Adey, 1981) emphasized that each lesson should start by setting a challenge or problem and children should be invited to solve problems in order to develop their thinking skills.

### 3.4. Assessment practice

In Table 3, it can be seen that the greater majority of respondents (89%) stated that the most commonly used assessment strategies are written examinations, scrutiny of pupils’ note books with almost all

| Practice                                                                 | N    | SA + A | D + SD |
|--------------------------------------------------------------------------|------|--------|--------|
| I give oral feedback and marking enable pupils to know how well they are doing, and what they need to do to improve | 149  | 92     | 7.4    |
| I analyse assessment findings to identify the gap in pupil achievement  | 149  | 79.3   | 20     |
| I use the assessment information for future planning                     | 150  | 50.7   | 49.3   |
| I assess the pupils' existing knowledge and that is used as a guide to lesson planning. | 150  | 54.7   | 45.4   |
| I assess pupils' outcome by looking through their note book or written exam paper. | 150  | 88.6   | 11.3   |

Note: SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree.

### Table 2. Teachers' and student's views about the learning and teaching practice (n = 150, 60).

| Extent of Practice                          | N    | AL + MT | NO + NE |
|---------------------------------------------|------|---------|---------|
| Teachers                                    |      |         |         |
| At the end of activities whole-class discussion occurs with summaries of the main ideas | 150  | 72      | 28      |
| Students are encouraged to plan their own experiments to investigate their own questions | 149  | 19.3    | 80      |
| I use a range of strategies flexibly to meet pupils need | 149  | 60      | 39.3    |
| Pupils are highly engaged in my lesson      | 150  | 66.7    | 33.3    |
| For sharing and improving instructional strategies, science teachers in this school regularly observe each other classes | 149  | 52.7    | 46      |
| Students                                    |      |         |         |
| Teacher asks questions, but answer them themselves | 59  | 51.7    | 46.7    |
| I watch the teacher do experiments          | 60   | 68.3    | 31.7    |
| I listen to the teacher explaining ideas   | 60   | 93.4    | 6.7     |
| I know what to do and who to ask if I find my work hard | 60  | 40      | 60      |
| I do a lot of writing in science lesson    | 60   | 41.7    | 58.3    |
| I have to explain my thinking to other people | 59  | 40.6    | 59.4    |

Note: AL = All of the time; MT = Most of the time; NO = Not often; NE = Never.

![Figure 1. A comparison of teachers' and student's perception regarding teaching and learning activities in primary school classrooms.](image-url)
teachers (92%) providing oral feedback. About half of the teachers (49%) agree that they did not use assessment information for future planning and nearly half of the teacher did not assess student's existing knowledge. These results are consistent with a previous study of Hassan and Ehsan (2013) which indicated that teachers mainly focus on written assessment.

In interviews it was revealed that assessment of learning is conducted by written tests. Sometimes weekly or fortnightly tests are used to gauge pupils learning. The participants claimed:

“Traditional assessment, some questions prepared and take exams...no continuous assessment on students learning. No record is maintained about children learning” (Instructor, URC, 28/05/2017).

“First term, second term exam and final term exam is taken based on the syllabus in a single year. Examination is question dependent and only for grading or reporting. It encourages students to memorize the text” (AUEO-1, 24/05/2017).

Encouragingly, Headteachers noted that “this formal test base assessment cannot capture the students actual achievement and support students learning” (Headteacher-2, 20/05/2017). They need to “assess practical work, pupils’ interest, observation skills, after every chapter needed to assess how much competency they achieved” (Instructor, PTI, 24/05/2017).

Therefore, they further stated that “inappropriate assessment and follow-up strategies are the common factors that inhibit the quality of science learning” (Headteacher-3). It is noticeable that assessment of learning is conducted by a formal testing regime. The purpose of assessment is for grading and reporting to parents. There is a little practice of continuous assessment for learning.

3.5. Resources and facilities for learning and teaching science

As presented in Figure 2, the majority of sampled teachers indicated that they lack classroom space (63%) and have insufficient teaching materials (68%). Furthermore, about three quarters (73%) reported that their schools do not provide sufficient materials and they have very little opportunity to use digital strategies. However, the vast majority agree that improvements have been made over the past five years in resource provision.

Data from Table 4 shows that almost all the teachers (92%) reported that the quality of student's science textbooks is either good or satisfactory. Interestingly, teacher's opinion was equally divided on the quality of support from their academic supervisors.

In interviews the respondents also indicated that teachers get limited support from head teachers, AUEO and Instructors. Headteacher-2 noted that there is a “little support from the academic supervisor for improvement of science teaching” (20/05/2017). Interestingly, an instructor from URC stated that “no teacher comes to talk to me about their teaching, because they think if they come to me they will have to teach my way” (28/05/2017).

It is reasonable to conclude that both of these views are undermined science teaching. An additionally raise questions regarding the monitoring and feedback process.

“Teachers give less time to give feedback in their classroom to improve pupils learning, sometimes they do not provide feedback due to the lack of time or commitment” (AUEO-2, 27/05/2017).

“Parents and SMC need to cooperate with the teachers and provide support where necessary to the school in collecting materials” (Headteacher-4, 22/05/2017).

“There is a need for ... effective coordination among the teachers, Headteachers, academic supervisors and for monitoring and evaluation of science activities in the primary Schools” (Instructor, PTI, 24/05/2017). Coburn et al. (2012) and Penuel et al. (2009) noted that supportive interactions with the academic supervisors and teaching colleagues can help teachers to improve their teaching skills.

It is clear from the respondents’ that science teachers feel they do not get enough support from various stakeholders to improve their quality of science teaching. Where AUEOs visit schools for monitoring purposes, teachers in most cases get oral feedback without any written follow-up or further support. Interestingly, this replicates in some degree the way that students feel about getting support in their learning from their teachers. There should be better co-ordination among the different stakeholders for the monitoring and evaluation of science teaching. Schools in this respect should be encouraged to create strong relationships with the wider community.

![Figure 2](url) Resources and facilities enjoyed by the primary science teachers.
3.6. Teachers Knowledge and Professional Learning

Data from Table 5 reveals that the greater majority of teachers (80%) had high expectations of all children. They also believe taking time for preparation (95%) and discussion in groups (87%) are helpful for students’ learning. However, a significant number of teachers agreed or strongly agree that they do not know enough about inquiry-based science teaching strategies (41%). Also, they feel that they do not possess sufficient subject knowledge in all topics (42%) and about a third is not satisfied with their current standard of science teaching (36%). These results are supported by Ahmed et al. (2005 p.93), “teachers had serious deficiency in their knowledge of teaching content and basic pedagogic techniques”. Nearly three quarter teachers (72%) agree or strongly agree that they use the majority of the lesson time to present the lesson (teacher talking), whilst slightly more than half of the teachers (53%) did not share their learning outcomes with their pupils. As important, more than half of the teachers stated that they do not have time to work with their colleagues and majority of teachers do not have enough opportunity to attend training and workshops to improve their teaching.

Teachers’ quality is an important factor for effective science teaching. The interview members claimed:

“Currently, teachers’ techniques are not developed enough to teach science and they (teachers) need to develop better techniques to present their lessons. Proper subject based training is essential for every teacher to deliver the lesson appropriately” (Headteacher-2, 20/05/2017).

However, AUEO-2 noted slightly different views that “there is a lack of interest to improve their teaching. Teachers’ have to think to about their teaching”. Apart from these AUEO-1 further added “Teachers need to read the relevant materials including text books, TG (Teachers Guide) and share with their colleagues to understand the content and its delivery process for improving their teaching” (AUEO-1, 27/05/2017).

The questions about teachers knowledge is an international concern that primary teachers’ generally lack sufficient science knowledge and confidence to teach science (Hobbs et al., 2013). As mentioned, Duschl et al. (2007) noted that the majority of primary school teachers have a lower understanding of scientific knowledge. Most of the participants reported that schools do not have adequate number of teachers with the proper pedagogical knowledge and teaching skills. Teachers have little opportunities and little desire to improve their teaching by sharing with their colleagues and others. Therefore, Headteachers and AUEO’s have suggested that teachers need to be more fully engaged in a continuous professional development process.

3.7. Present status of DPEd program

The participants commented on the current scenario of science training and said.

“There is a large number of trainee teachers in a single classroom and it is difficult to provide hands on activities for them and give the teachers helpful feedback” (Headteacher-3, 22/05/2017).

“There is a limited use of resources in the classroom to present the topic and sometimes all topics are not quite clear to the instructor. There is not sufficient training or knowledge of assessment for learning strategies” (Instructor, PTI, 24/05/2017).

The respondents also made recommendations to improve the quality of science training and added:

“Emphasis should be placed on practical work, hands on activity in the class rather than theory. Teachers’ in their placement schools should be monitored and checked effectively” (Headteacher-2, 20/05/2017).

“Assessment for learning should be emphasised to support the teacher to enhance their learning on teaching science” (Instructor, URC, 28/05/2017).

The majority of respondents clearly indicated that curriculum guidelines sometimes lack clarity to ensure a successful continuous assessment and feedback process. The instructor-teacher ratio is too high as a result instructors face challenges to give proper support to the teachers. The respondent indicated that the teacher education program should emphasize hands on practical activities. There is an urgent need for a better monitoring of newly qualified teachers to give them more effective support, particularly in their placement schools. Currently, teachers are appointed and are largely left in their own devices.

3.8. Limiting factors and ways of improving learning and teaching of science

Data in Figure 3 shows that the greater majority of sampled teachers (87%) indicate that the most important factors that limit the quality of science learning and teaching is the lack of provision of teaching

| Table 4. Resources and facilities. |
|-----------------------------------|
| Resources and facilities          | N     | Good | Satisfactory | Poor |
| Quality of the student science textbook(s) | 149   | 45.3 | 46.7         | 7.3  |
| Quality of teaching guides        | 149   | 28   | 52.7         | 18.7 |
| Support from the academic supervisors | 149   | 9.3  | 40.7         | 49.3 |

| Table 5. Teachers’ opinions on learning and teaching (n = 150). |
|---------------------------------------------------------------|
| Views                                   | N | SA + A | D + SD |
| I can demonstrate good up-to-date subject knowledge in all the topics. | 150 | 55.3 | 44.7 |
| I have a high expectations of all pupils                        | 150 | 80 | 20 |
| I believe discussion in groups in the class is helpful for pupils learning. | 144 | 87.4 | 10 |
| I believe taking time to fully prepare before conducting lesson is important | 150 | 95.3 | 4.7 |
| I know how to use inquiry/investigation-oriented teaching strategies | 144 | 55.4 | 40.7 |
| I am satisfied with the quality of teaching in my classes       | 147 | 62 | 36 |
| I shared my learning objectives with the students               | 150 | 47 | 53 |
| I take most of the time to present the topic                     | 146 | 72 | 25.3 |
| I have time during the regular school week to work with my colleagues on the science curriculum and teaching | 150 | 47.3 | 52.6 |
| I have sufficient opportunity to attend training and workshops to improve my teaching | 147 | 35.3 | 62.7 |

Note: SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree.
materials. A significant number of teachers reported a lack of training (44%), a lack of a suitable classroom environment (42%) and a high pupil ratio (43%). A minority of teachers reported on their high teaching contact hours, lack of their personal teaching skills and knowledge of teaching approaches which were important factors that limit the effective teaching of science.

Data displayed in Table 6 shows that to improve the quality of science teaching most of the sampled teachers suggest a need for more subject based training (65%) and the provision of better resourcing (77%) (see Table 7). The sampled students suggested that the study of science can be improved by better resourcing; engaging students with hands-on activities; giving clearer instruction, and a more supportive attitude with student’s problems. A similar number stated that better assessment is needed to support their learning. Clearly the students had little or no experience of assessment for learning techniques and were unaware of its benefits in their learning.

The participants claimed:

“Students’ accommodation and space is not enough to run the science class properly. The government should allocate more money to improve classroom conditions” (AUEO-1, 24/05/2017).

“When a teacher goes from class to another without a break I cannot expect good lessons from them. Teaching hours per week should be reduced” (Headteacher-3, 22/05/2017).

“There are insufficient materials to meet the large number of student demand in classes. Sometimes the class size is about 50 and it is beyond the capacity of teachers” (Headteacher-2, 20/05/2017).

However, one Headteacher reported a different position and claimed that “the school have some materials, but they (teachers) are not interested in using them” (Headteacher-1, 21/05/2017).

Most of the respondents pointed out that there is a lack of materials, insufficient space in the classroom, poor funding for schools and teachers are overloaded with their classes. Class sizes are large and as a consequence teachers face challenges in teaching science. However, the respondents stated that to improve effectiveness of science learning and teaching, greater funding is principally required for the reduction of class sizes.

3.9. Suggestions on the DPEd program to improve science teaching

The most common suggestions given by the respondents (Table 8) about the teacher education program includes: provide training based on hands on activities (63%), lesson demonstrations (61%), advice on developing and using materials in the classroom (62%) and better use of practical work (42%) in the classroom. A significant minority of teachers suggested better access to ICT materials in the classroom and enhancing the monitoring and feedback processes of teachers. Interestingly, very few remarked on continuous assessment to support children’s learning.

The participants commented on the current scenario of science training and said:

“There is a large number of trainee teachers in a single classroom and it is difficult to provide hands on activities for them and give the teachers helpful feedback” (Headteacher-3, 22/05/2017).

“There is a limited use of resources in the classroom to present the topic and sometimes all topics are not quite clear to the instructor. There is not sufficient training or knowledge of assessment for learning strategies” (Instructor, PTI, 24/05/2017).

The respondents also made recommendations to improve the quality of science training and added:

“Emphasis should be placed on practical work, hands on activity in the class rather than theory. Teachers’ in their placement schools should be monitored and checked effectively” (Headteacher-2, 21/05/2017).

“Assessment for learning should be emphasised to support the teacher to enhance their learning on teaching science” (Instructor, URC, 28/05/2017).

The majority of respondents state that curriculum guidelines sometimes lack clarity to ensure an effective continuous assessment and feedback process. The instructor-teacher ratio is too high and as a result instructors find it difficult to provide proper teacher support. There is also a need for better monitoring of newly qualified teachers to provide them more with more effective support in their placement schools. Currently, teachers are appointed and are largely left to their own devices.
3.10. Study limitations

One of the major weaknesses of this study was the lack of interview data from science teachers that may provide further insights into their classroom practice. Another important issue is that this study did not have time to consider opinions from other stakeholders such as parents and the SMC members. The students survey used only grade five children and does not reflect the wider pupils’ opinions. Although a limited time frame was used, it could be argued a longer time frame for this study might have generated different results. The study considered only the GPS School however there are several other types of schools in Bangladesh. Data was gathered from two sub-districts. Therefore, the views and perspectives of the respondents is limited in the context of the wider educational system in Bangladesh.

4. Conclusions and recommendations

The findings of this research demonstrated that although the purpose of teaching science is to develop scientifically literate citizens, teachers mainly focused on exam. The present practice of science learning and teaching is mostly teacher centered, which is both didactic and theoretical. The rational of assessment is for grading and reporting, with little use of assessment for learning strategies. The findings also revealed that science teachers do not receive sufficient support from stakeholders to improve the quality of science teaching. There is also a lack of provision of materials, insufficient space in the classroom, poor funding for schools and teachers are overloaded with their classes. To improve the quality of science teaching the teachers need to enrich their subject knowledge and strengthen understanding of inquiry based science teaching. Present teacher training programs provides insufficient training particularly on

| Table 6. Suggestions for improvement in learning and teaching (n = 150). |
|-----------------------------------------------|
| Sectors                              | Suggestions for improvement | N  | %       |
|-----------------------------------------------|
| Teachers                              | Increase subject base training to develop their skill for teaching science | 98 | 65.3    |
|                                       | Refresher training          | 12 | 8       |
|                                       | Attitude, discussion and collaboration with colleagues | 34 | 22.6    |
| Materials                             | Proper use of resources in the classroom | 115 | 76.6    |
|                                       | Suitable classroom environment with enough space for science teaching | 48 | 32      |
|                                       | Using ICT materials         | 20 | 13.3    |
|                                       | Lab facility                | 11 | 7.3     |
|                                       | Books with more information | 13 | 8.6     |
| Pedagogy                              | Use assessment for learning | 6  | 4       |
|                                       | Providing hands on activity | 45 | 30      |
|                                       | More time for science lessons | 4  | 2.6     |
|                                       | Arrange science fair yearly (cluster base) | 9  | 6       |

| Table 7. Children’s opinion for improving their science learning (n = 60). |
|-----------------------------------------------|
| Suggestions                                                  | N  | %       |
| Adequate materials are use in the classroom                  | 19 | 31.6    |
| Teachers give opportunity for students talk in the classroom  | 6  | 10      |
| Teachers give clear instruction for children                 | 8  | 13.3    |
| Teachers positive attitude to students response (friendly respond to the students' problems) | 8  | 13.3    |
| Teachers give homework and check it regularly                | 7  | 11.6    |
| Engage children in hands on activities                       | 16 | 26.6    |
| Teachers assess the pupil’s learning by checking note books | 8  | 13.3    |

Note: some students’ suggest more than one, so the total percent is more than 100. The 60 students made a total of 84 suggestions for improvement.

| Table 8. Teachers’ suggestions on teacher education program. |
|-----------------------------------------------|
| Suggestions                                                  | N  | %       |
| Provide training based on hands on activities                  | 95 | 63.33   |
| Give focus on developing and using materials                   | 93 | 62      |
| Need training for science Trainer (instructor)                  | 23 | 15.33   |
| Emphasis on discussion about the strategy of elementary science content delivery | 65 | 43.33   |
| Emphasis on practical work                                     | 63 | 42      |
| Assessment for learning                                       | 9  | 6       |
| Experiment method                                             | 10 | 6.6     |
| Demonstration lessons or ideal lessons                         | 52 | 61      |
| Enhance monitoring and feedback processes for the teachers     | 38 | 25.33   |
| Use more ICT materials in the teacher education program        | 24 | 16      |

Note: Some respondents suggested more than one, so the total percent is more than 100.
hands-on activities. Hence, to ameliorate the quality of teacher delivery within the class room the current DPEd program needs focus on more hands on activities in training rather than more theoretical approaches. It also needs to maintain appropriate trainee teachers/instructor ratio, develop instructors’ capacity of assessment of learning and monitoring teachers in their placement schools. However, this research comes up with several recommendations which are cost neutral and are as follows:

At national level there should be a specific plan to promote the understanding of scientific literacy as a desirable outcome of primary science. There is a need to clarify the purposes of learning and teaching science to reduce pupil teacher ratio to global levels and for teachers to use more effective inquiry based instruction. A nationally developed performance management system is also essential for regular monitoring of all teachers in the school system to ensure accountability and quality. The capacity of AUEOs for the monitoring of science teaching to ensure the development of an inquiry-based curriculum and associated AfL techniques needs to be improved. The provision of formative assessment (assessment for learning) guidelines and tasks are required for teachers to better support children’s learning. In conjunction with these techniques greater access to digital resources is essential. It should be statutory that all new teachers attained initial teacher training programs as a precursor to their career with competency being assessed at the conclusion of the program before confirmation of appointment. A review of the current initial teacher training program is therefore essential and should include a more robust element of AfL guidelines and techniques. In DPEd program all trainee teachers should be provided with the opportunity to conduct science lesson. In addition placement schools should be monitored more effectively through building a better relationship between schools and PTI.

Both at school level and at national level, a substantial professional development initiative is required for ensuring effective continuous professional development that focuses on classroom oriented PD for teachers.

At school level a collaborative action plan is required to evaluate science practice and compare the intended curriculum guidelines with actual classroom practice. There should be ample opportunities for the teachers to collaborate with their colleagues to further develop and refine their practice.

At a personal level teachers should more frequently use inquiry based science learning and teaching. They also need to incorporate a wider variety of assessment techniques with increased emphasis placed on AfL strategies. Additionally, they should talk with children about their learning (ESTYN, 2010; Stoll, 2015). Teachers need to better use the use the outdoor environment as learning and teaching resources (Rye et al., 2012).

Declarations

Author contribution statement

M. M. Rahman Talukder: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

C. Green: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

M. Mamun-Ur-Rashid: Analyzed and interpreted the data; Wrote the paper.

Funding statement

This work was supported by the Primary Education Development Program (PEDP-3), Ministry of Primary and Mass Education, Bangladesh.

Data availability statement

The authors do not have permission to share data.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

This research acknowledges anonymous reviewers for their valuable suggestions for the improvement of the article. We also acknowledge all the participants for their kind cooperation.

References

Aalderen-Smeets, S.I., Mole, J.H., 2015. Improving primary teachers’ attitudes toward science by attitude-focused professional development. J. Res. Sci. Teach. 52 (5), 710–734.

Ahmed, M., 2007. Education in Bangladesh: the vision for 2025. J. Bang. Stud. 9 (1), 1–14. Available at:

Ahmed, M., 2011. The sector-wide approach in Bangladesh primary education: a critical view. In: CREATE Pathways to Access. Research Monograph No. 57. Institute of Education and Development, BRAC University, Dhaka, Bangladesh.

Akeron, V.L., 2005. How do elementary teachers compensate for incomplete science content knowledge? Res. Sci. Educ. 35 (2), 245–268.

Alake-Tuente, E., Biemans, H.J.A., Tobi, H., Wals, A.E.J., Oosterbeert, I., Mulder, M., 2012. Inquiry-based science education competencies of primary school teachers: a literature study and critical review of the American National Science Education Standards. Int. J. Sci. Educ. 34 (17), 2609–2640. Available at:

Alam, G.M., 2009. The role of science and technology education at network age population for sustainable development of Bangladesh through human resource advancement. Sci. Res. Essays 4 (11), 1246–1270. Available at:

Alamgir, M., December 24, 2019. Primary education quality: long way to go. The Daily Star. Available at:

Austin, S., Harford, W., Hayes-Bircher, A., Javaherian, S., Omolubori, O., Tokushige, Y., 2008. Improving the Quality of Education in Bangladesh. Workshop in Public Affairs, International Issues, Spring 2008. Robert M. La Follette School of Public Affairs University of Wisconsin–Madison. Available at:

Avramidou, L., Zembal-Saul, C., 2010. In search of well-started beginning science teachers: insights from two first-year elementary teachers. J. Res. Sci. Teach. 47 (6), 661–686.

Azam, M., Kingdon, G.G., 2015. Assessing teacher quality in India. J. Dev. Econ. 117, 74–83.

Bahr, Nanette, Dole, Shelley, Bahr, Mark, Barton, G., Davies, Kim., 2007. Longitudinal evaluation of the effectiveness of professional development strategies. In: Excellence in Research Australia (ERA) - Collection School of Education Publications. University of Queensland and Bond University, Australia, Queensland, Brisbane.

Bau, N., Das, J., 2017. The Misallocation of Pay and Productivity in the Public Sector: Evidence from the Labor Market for Teachers Policy Research Working Paper No. 8050. World Bank, Washington, DC. Available at:

Baumert, J., Usler, M., Blum, W., Brunner, M., Voss, T., Jordan, A., Tsai, Y.M., 2010. Teachers’ mathematical knowledge, cognitive activation in the classroom, and student progress. Am. Educ. Res. J. 47, 133–180.

Bolarinwa, O.A., 2015. Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. Niger. Postgrad. Med. J. 22 (4), 195–201. Available at:

Bryman, A., 2012. Social Research Methods, third ed. Oxford University Press, Oxford.

Carleton, L.E., Fitch, J.C., Krockover, G.H., 2008. Akin-service teacher education program’s effect on teacher efficacy and attitudes. Educ. Forum 72 (1), 46–62.

Coburn, C.E., Russell, J.L., Kaufman, J.H., Stein, M.K., 2012. Supporting sustainability: teachers' advice networks and ambitious instructional reform. Am. J. Educ. 119 (1), 137–182.

Coe, R., Aliasi, C., Higgins, S., Major, L.E., 2014. What makes great teaching? Review of the Underpinning Research. Sutton Trust, London.

Cohen, L., Manion, L., Morrison, K., 2011. Research Method in Education (7thed.). Routledge, London.

Creswell, J.W., 2014. Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research, 4th ed. Pearson Education Limited, Harlow.

Das, A., Ochiai, T., 2012. Effectiveness of C-inEd course for inclusive education: viewpoint of in-service primary teachers in Southern Bangladesh. Elect. J. Inclus. Educ. 2 (10), 1–12.

Davis, E.A., Smithey, J., 2009. Beginning teachers moving toward effective elementary science teaching. Sci. Educ. 93 (4), 745–770. Available at:

Decristian, J., Klimes, E., Kunter, M., Hochweber, J., Bütten, G., Fauth, B., Höndrich, L., Fathy, I., 2015. Embedded formative assessment and classroom process quality: how do they interact in promoting science understanding? Am. Educ. Res. J. 52 (6), 1133–1159.

Delors, J., Mufti, I.A., Amagi, L., Carneiro, R., Chung, F., Geremek, B., Gorham, W., Nauhaus, Z., 1996. Learning: the Treasure within. UNESCO, Paris.
Diamond, B.S., Maerten-Rivera, J., Rohrer, R.E., Lee, O., 2014. Effectiveness of a curricular and professional development intervention at improving elementary teachers’ science content knowledge and student achievement outcomes: year 1 results. J. Res. Sci. Teach. 51, 655–658.

Directorate of Primary Education (DPE), 2015. Annual primary school census. Available at:...

Directorate of Primary Education (DPE), 2018. Fourth primary education development programme (PEDP), dhaka: Ministry of Primary and Mass education, Bangladesh. Available at:...

Directorate of Primary Education (DPE), 2019. Annual primary school census. Available at:...

Duschl, R.A., Schweingruber, H.A., Shouse, A.W. (Eds.), 2007. Taking Science to School: Learning and Teaching Science in Grades K-8. National Academy Press, Washington, DC.

ESTYN, 2010. Guidance for the inspection of primary schools, Cardiff: inspectorate for education and training in Wales. Available at:...

Fitzgerald, A., Smith, K., 2016. Science that matters: exploring science learning and teaching in primary schools. Aus. J. Teacher Educ. 41 (4), 44Available at:...

Goodrum, D., Rennie, L., 2007. Australian School Science Education National Action Plan 2008 – 2012. Department of Education, Science and Training, Canberra.

Goodrum, D., Hackling, M., Rennie, L., 2001. Science teaching and learning in Australian schools: results of a national survey. Res. Sci. Educ. 31, 455–498.

Hanau, M.M., Elman, M.A., 2013. Present situation of teaching elementary science in the primary school of Dhaka city: an investigation. Am. J. Educ. Res. 1 (12), 576–582. Available at:...

Hobbs, L., Jones, M., Jeff King, J., Chittleborough, J., Redman, C., Coral Campbell, C., Herbert, S., 2013. Science teacher educator partnerships with schools (STEPES): developing an interpretive framework for primary science teacher education. Available at:...

Houston, D.J., 2008. Rethinking quality and improvement in higher education. Qual. Assur. Educ. 16 (1), 61–79.

Kim, M., Tan, A.L., 2011. Rethinking difficulties of teaching inquiry-based practical work: stories from elementary pre-service teachers. Int. J. Sci. Educ. 33 (4), 465–486.

Kline, E., Pauli, C., Reusser, K., 2009. The Pythagoras Study. Investigating effects of teaching and learning in Swiss and German mathematics classrooms. In: Janik, T. (Ed.), The Power of Video Studies in Investigating Teaching and Learning in the Classroom. Munich, Waxmann, pp. 137–160.

Ko, J., Sammons, P., Bobkum, L., 2013. Effective Teaching: a Review of Research and Evidence. CBET Education Trust. In: 60 Queens road, reading, RG1 4BS, england. Available at:...

Lederman, J.S., Lederman, N.G., Bartos, S.A., Bartels, S.L., Meyer, A.A., Schwartzs, R.S., 2014. Meaningful assessment of learners’ understandings about scientific inquiry. The views about scientific inquiry (VASSI) questionnaire. J. Res. Sci. Teach. 51, 65–83.

Liang, L.L., Gabel, D.L., 2005. Effectiveness of a constructivist approach to science instruction for prospective elementary teachers. Int. J. Sci. Educ. 27 (10), 1143–1162.

Magnusson, S., Krajcik, J., Borko, H., 1999. Nature, sources, and development of the PCK for science teaching. In: Gess-Newsome, J., Lederman, N.G. (Eds.), Examining Pedagogical Content Knowledge. Kluwer, Dordrecht, pp. 95–152. Chapter 4, Ministry of Education (MoE), 2010. National Education Policy. Bangladesh Government Press, Dhaka.

Ministry of Education(MoE), 2020. Education system. Available at:...

Molina, E., Fatima, S.F., Ho, A.D., Melo, C., Wilchowski, T.M., Pushtparanatma, A., 2014. Measuring the quality of teaching practices in primary schools: assessing the validity of the Teach observation tool in Punjab, Pakistan. Teach. Teach. Educ. 96, 103171.

MoPME, 2018. Bangladesh Primary Education: Annual Sector Performance Report (ASPER)-2017. Ministry of Primary and Mass Education and Ministry and Ministry of Chittagong Hill Tracts. The People’s Republic of Bangladesh. Available at:...

Mullick, J.J., Sheth, S., 2008. ‘Teachers’ Quality and Teacher Education at Primary Education Sub-sector in Bangladesh’. BRAC University Journal, pp. 77–84, 1.

NAPE, 2020. National academy for primary education. Mymensing, Bangladesh. Annual Report 2019-20. Available at:...

Nath, S.R., Chowdhury, A.M., 2008. State of Primary Education in Bangladesh Progress Made, Challenges Remain. Dhaka. Campaign for Popular Education (CAMPE), Bangladesh.

Nath, S.R., Chowdhury, A.M., Ahmed, S., 2015. Moving from MDG to SDG: Accelerate Progress for Quality Primary Education, Dhaka. Campaign for Popular Education (CAMPE), Bangladesh.

Ng, P.T., 2015. What is quality education? How can it be achieved? The perspectives of school middle leaders in Singapore. Educ. Assess. Eval. Account. 27 (4), 307–322.

Ogunnade, T.O., 2005. The status and quality of secondary science teaching and learning in Lagos State, Nigeria. Available at:...

Osborne, J., 2014. Teaching scientific practices: meeting the challenge of change. J. Sci. Teach. Educ. 25, 177–196.

Penuel, W., Riel, M., Krause, A., Frank, K., 2009. Analyzing teachers’ professional interactions in a school as social capital: a social network approach. Teach. Coll. Res. 111 (1), 124–163.

Ramah, S.M.H., Sultana, 2016. Reflection of pedagogical content knowledge (PCK) on DPEd science curriculum. Prim. Educ. J. 9 (1), 54–60. Available at:...

Reyes, M.R., Brackett, M.A., Rivers, S.E., White, M., Salovey, P., 2012. Classroom emotional climate, student engagement, and academic achievement. J. Educ. Psychol. 104 (3), 700–712.

Ryan, C., 2009. Current Challenges in Basic Science Education. UNESCO, Paris.

Rye, J.A., Selmer, S.J., Pennington, S., Vanhorn, L., Fox, S., Kane, S., 2012. Elementary school garden programs enhance science education for all learners. Teach. Except. Child. 44 (6), 58–65.

Sammons, P., Ko, J., 2008. Using Systematic Classroom Observation Schedules to Investigate Effective Teaching: Overview of Quantitative Findings. School of Education University of Nottingham, Nottingham Report of Effective Classroom Practice (ECP) Project.

Sapsford, Jupp, 2006. In: Data Collection and Analysis, second ed. Sage Publication, London.

Shayer, M., Adey, P., 1981. CASE: cognitive Acceleration through science education, Let’s Think through science. Available at:...

Shulman, L.S., 1986. Those who understand: knowledge growth in teaching. Educ. Res. 15 (2), 4–14. Available at:...

Shulman, L.S., 1991. Ways of seeing, ways of knowing: ways of teaching, ways of learning about teaching. J. Curric. Stud. 23 (5), 393–396.

Slavin, R.E., Lake, C., Hanley, P., Thurston, A., 2014. Experimental evaluations of elementary science programs: a best-evidence synthesis. J. Res. Sci. Teach. 51 (7), 870–901.

Smardon, D., Bewley, S., 2007. ‘What Students Say About Their Learning - How Can This Improve Learning?’, British Educational Research Association Annual Conference. Institute of Education, University of London, 5-8 September 2007.

Snijstveit, B., Stevenson, J., Menon, R., Phillips, D., Gallagher, E., Geleen, M., et al., 2016. The Impact of Education Programmes on Learning and School Participation in Low-And Middle-Income Countries (Systematic Review Summary 7). London, U.K. International Initiative for Impact Evaluation. Available at:...

Stoll, L., 2015. Three Greats for Self- Improving School System: Pedagogy, Professional Development and Leadership: Executive Summary. National College for Teaching and Leadership, Great Britain.

Teddie, C., Yu, F., 2007. Mixed methods sampling: a typology with examples. J. Mix. Methods Res. 1 (1), 77–100.

The Excellence of Teaching Frame Work 2013, Securing Good Teaching And Aiming For Excellence. Education Achievement Service (EAS), South Wales.

Tilkay, L., 2011. A roadblock to social justice? An analysis and critique of the South African. Int. J. Educ. Dev. 31 (1), 86–94.

Tilkay, L., Barrett, A.M., 2007. Education Quality. Research Priorities and Approaches in the Global Era. University of Bristol, Bristol. Available at:...

Trust, Welcome, 2014. Primary science: is it missing out? Recommendations for reviving primary science. London: UK. Available at:...

Tyler, R., 2007. Re-imagining Science Education: Engaging Students in Science for Australia’s Future. Australian Education Review. Australian Council for Educational Research, Unicef, 2009. Quality primary education in Bangladesh. Unicef Bangladesh. Available at:...

Unicef, 2020. Quality, Continuity for primary education. Available at:...