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## Integrating STEM Approach at Primary Education in Bangladesh: Perception and Challenges of the Teachers

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**Keywords:** *STEM education, integrated learning, perception, challenges.*

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# Integrating STEM Approach at Primary Education in Bangladesh: Perception and Challenges of the Teachers

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**Abstract-** Bangladesh is aspiring to develop a competitive workforce for the 21<sup>st</sup> century. To reach this aspiration, STEM education can be a good way as it has widely been considered to have the potential to prepare students with 21<sup>st</sup>-century skills. The potentiality of STEM can be fully utilized only when teachers apply STEM approaches effectively in their practices. Since teachers' prior views and perceptions influence their STEM teaching, the study aims to explore the teachers' perception of STEM education. This study also analyzes the challenges of introducing STEM at primary education in Bangladesh. A qualitative research design is adopted in this study. Teachers' perception of STEM education was explored through semi-structured interviews. Additionally, in-depth and semi-structured interviews were conducted to examine the challenges of implementing STEM education at the primary level. Data were analyzed thematically following an inductive approach. One of the key discoveries made in this research is that a large majority of teachers have limited knowledge about STEM education. Despite this lack of familiarity, it was observed that these teachers occasionally apply the STEM approach unintentionally. Most teachers perceive STEM education as effective, however, it has several challenges to implement, such as a lack of teachers' knowledge about the discipline and pedagogical approach, inadequate physical facilities, lack of STEM-related training, the mindset of stakeholders, etc. The findings of the study can be practical guidelines for academic institutions, curriculum developers, teachers' trainers, and policymakers.

**Keywords:** STEM education, integrated learning, perception, challenges.

## 1. INTRODUCTION

The 21st-century world is very complex and fast-changing. In this complex world, it is necessary to make the future citizen an effective workforce who can think innovatively through proper reasoning and critical thinking. The Government of Bangladesh (GoB) is concerned with developing human resources, and that is why several initiatives were taken in the education sector (Chowdhury & Sarkar, 2018). Nevertheless, it is a matter of great concern that a substantial number of individuals become educated but struggle to bridge the gap between theoretical knowledge and practical

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application. Consequently, they encounter challenges in effectively utilizing their skills within a professional context, resulting in a deficiency of competence (Drucker, 2013). STEM education would be a solution to overcome this situation, as it would allow the students to learn with real-world experience and hands-on activities (Thomasian, 2011). Furthermore, STEM offers meaningful learning opportunities and positively influences students' attitudes toward STEM, potentially shaping their future careers (Tseng et al., 2013).

The term STEM (science, technology, engineering, and mathematics) was often used in the 1990s to describe anything that involves one or more of the four disciplines: science, technology, engineering, or mathematics (Bybee, 2010). Over the course of recent decades, STEM education has predominantly emphasized the enhancement of science and mathematics as independent disciplines (Breiner et al., 2012), with limited attention given to the integration of technology or engineering (Bybee, 2010).

STEM initiative aimed to offer critical thinking skills to all students so that they would become creative problem solvers and the ultimate workforce in the competitive job market. It is believed that someone who is STEM literate would be at an advantage over other students from general schools (White, 2014). The significance of STEM education is widely recognized for assisting students in acquiring 21st-century skills such as critical thinking, cooperation, problem-solving, etc in every area of their lives (Erdogan & Ciftci, 2017). Existing study shows that students' learning is effective when they can connect their knowledge to real-world situations, and this may be accomplished by learning with the STEM approach, which influences students' attitudes toward STEM learning in their future careers (Tseng et al., 2013).

Hence, STEM education should be introduced in primary schools to develop the perception and knowledge of STEM education from the elementary level (Nadelson et al., 2013). Despite the significant scope of STEM education, its implementation was not successful at the school level owing to inadequate preparation, a lack of competent STEM teachers, a lack of funding for teachers' professional development, a lack of STEM-related research collaboration, etc. (Ejiwale, 2013).

Additionally, there are constraints at the individual, institutional, and societal levels in developing countries like Bangladesh (Siddiq & Braga, 2019). Moreover, research shows that teachers' prior views and

perceptions impact on how they teach STEM subjects (Margot & Kettler, 2019). According to Gess-Newsome (2015), teacher perception and belief may serve as a filter and enhancer for teachers' actions. Therefore, teachers' views and challenges are important forces to develop an appropriate framework in the particular context to integrate the STEM approach into teaching.

Bearing this in mind, this study aims to explore primary school teachers' perceptions of STEM education and the challenges to implementing STEM at primary education in Bangladesh. To address these objectives, the following research questions are selected:

- a) What are the perceptions of primary teachers about integrated STEM education?
- b) What are the challenges in integrating the STEM approach at the primary level?

## II. LITERATURE REVIEW

### a) *Perceptions of Teachers of STEM Integration*

While providing definitions and concepts of STEM is simple, putting STEM education into reality is considerably more difficult. Teachers play a significant role in allowing students to actively participate in STEM activities. STEM teaching, on the other hand, needs a distinct knowledge base of science teaching. The role of the teacher is different in STEM compared with the traditional approach but as important as the traditional approach. Teachers must offer inquiry-based teaching that promotes critical thinking and innovation while improving students' comprehension of subjects and concepts (Nadelson et. al, 2013). Teachers must employ unconventional questioning methods to encourage students to engage in higher cognitive processes to make them think deeply about concepts and ideas to solve STEM problems (Bruce et al., 2014). However, Srikoom et al. (2017) showed that the majority of teachers in Thailand (85.5%) had never heard of STEM education, whereas 19% couldn't define it. Moreover, teachers believe that STEM education is important, but many teachers have concerns about engineering topics. Even some teachers consider it is science-math oriented, others believe it is based on engineering, and some believe it is inquiry-based learning (Srikoom et al., 2017; Weld et al., 2016). Thus, administrators and policymakers need to understand what teachers feel and what constraints resist them to develop STEM talent in schools. According to Johnson (2006), many teachers perceived that they don't possess the skills to conduct inquiry-based learning experiences for their students. Yet, Margot and Cattler (2019); Smith et al. (2015); Park et al. (2016) revealed that teachers' perceptions depend entirely on teacher variables such as age, experience, gender, and interest in STEM.

Existing literature also shows that teachers agreed about the importance of design, engineering, and technology, but they were unfamiliar with the contents of STEM (Hsu et al., 2011). Many teachers also identified some aspects and factors of STEM education, such as learner motivation/engagement in the classroom, challenges associated with pedagogy, curriculum, school structures, and so forth (Gess-Newsome, 2015; Lesseig et al., 2016). Similar to the prior research, Park et al. (2016) mentioned that the majority of teachers had a favorable impression of STEM education but they recognized some challenges, such as time, additional workload, and lack of financial or administrative support (Park et al., 2016). Moreover, a group of teachers considers that STEM education's four components or disciplines cannot be connected and STEM is seen as a separate concept (Bybee, 2013). In addition, studies indicated different perceptions and resistance from teachers respectively towards the interdisciplinary approach and changing the way of teaching where teacher's education, age, gender, and school level were the determinants (Al Salami et al., 2015).

### b) *Challenges of STEM integration*

It can be said without any doubt that for authentic learning experiences, the importance of STEM education is obvious. However, the realization of its importance hinges on its proper and effective implementation. Numerous challenges impede the effective implementation of integrated STEM education, affecting not only teachers but also students and stakeholders. Extensive research has been conducted to identify and address these challenges in the successful integration of STEM education. As posited by English (2017) and Bybee (2013), the challenges surrounding STEM education encompass several aspects, including the need for seamless integration of STEM disciplines while preserving the integrity of each individual subject. Moreover, there are concerns regarding equitable attention being given to all subjects, the absence of engineering in traditional STEM disciplines, and the integration of engineering within an already comprehensive curriculum. Additionally, the successful execution of integrated STEM hinges upon teachers' willingness and ability to effectively incorporate the diverse disciplines of STEM education. In their study, Asunda and Walker (2018) identified several challenges associated with integrated STEM education. Notably, these challenges encompass a lack of collaboration among teachers and a limited understanding of what integrated STEM truly entails. Moreover, the scarcity of tools, administrative support, and financial resources to acquire essential materials poses further hurdles. Additionally, inadequate knowledge and skills among teachers in regard to integrated STEM teaching and learning, along with the complexities of assessing

students' activities, emerge as significant obstacles. Furthermore, the dearth of accessible professional development programs for teachers in the realm of integrated STEM education adds to the challenges faced in this domain. Herschbach (2011) asserted that engaging students in integrated STEM instruction poses significant challenges, while another obstacle lies in the misconception held by many teachers, who perceive it as suitable only for the secondary level. He also said that the lack of training for pre-service teachers to incorporate technology successfully is another challenge. Teachers' capacity, meeting with students' abilities and educational aims and policies at the national level are also barriers to integrated STEM education (Lee et al., 2019). In another study, it was found that students learning might not be identical in all subjects, it could be too much for students' cognitive processes (Pearson, 2017). He also indicated that lack of timing, funding, and planning are also potential challenges of integrated STEM education. According to Ryu et al. (2019) school structure and instructional methods, heavy workload, difficulty in shifting learners' minds from traditional methods to collaborative and interactive learning strategies, pushback from teachers to implement integrated STEM approach, a lack of content knowledge apart from teachers field of expertise, a lack of role model or model teachers and model curriculum to follow on how to teach and develop curriculum for integrated STEM approach are some of the challenges of integrated STEM education. In line with that Dare et al. (2018) claimed that not only teachers but also students found it troubling to connect the components of STEM in the classroom. While conducting experiments, students were unable to measure equipment accurately and had difficulties in correctly interpreting the data (Glancy et al., 2017). Hsu and Fang (2019) pointed out that, low motivation of students and teachers' beliefs are also barriers to the successful implementation of integrated STEM education. Tao (2019) in his study stated that there are several challenges to the successful implementation of integrated STEM such as teacher's unfamiliarity with STEM education, a lack of participation in workshops and seminars, poor confidence while discussing technology and engineering with students, developing integrated STEM lessons, shortage of confidence to conduct the integrated STEM activities, inadequate preparation to implement integrated STEM approach in the classroom, lack of training on integrated STEM, insufficient experience, large classroom and busy daily routines. From these discussions, it is visible that though the integrated STEM approach is a great asset for STEM teaching and learning, it comes with a lot of challenges and barriers.

### III. METHODOLOGY AND SAMPLE

For this study, we have opted an interpretative (Ernest, 1989) approach as this approach would allow us to interact with teachers closely and would enable us to construct the knowledge of reality from their perspective. It is a wide-ranging assumption that qualitative methods are closely associated with interpretivism (Passer et al., 2009).

Data was collected by semi-structured interviews, which were conducted with the primary school teachers to find their views about integrated STEM education. To identify the challenges of the schools (e.g., the physical facilities) and the curriculum to integrate the STEM approach, semi-structured interviews and in-depth interviews were conducted with the teachers (from both the STEM and traditional primary schools) and primary education curriculum experts. The questions of the interview were mainly open-ended in nature and all interviews were recorded (audio).

Data was collected from the teachers of both primary schools and STEM schools in Bangladesh. A total of 12 primary schools (06 urban and 06 rural) were selected from different metropolitan cities, municipalities, and villages of Bangladesh through stratified and purposive sampling. Semi-structured interviews were conducted with 12 primary teachers (one from each school) practicing science and mathematics subjects. Besides, four STEM teachers (who are practicing the STEM approach in their teaching) were selected through purposive sampling. A total of nine in-depth interviews were conducted where the participants were two primary curriculum experts, four head teachers, and three STEM experts. The selection of schools in different areas would allow us to explore how the perception of different groups of people varies and what the challenges are to integrate the STEM approach for a specific context. Moreover, respondents were notified that they could exit the study anytime. Participants were assured that their identity and the information they provide will be kept confidential and not shared with anyone else.

### IV. FINDINGS

In this chapter, interviewed data is analysed in line with the objectives of the study. The focus of the analysis is to understand primary school teachers' perceptions of STEM education and to find out what are the challenges in integrating the STEM approach at the primary level. The demographic information of this study is shown in the table-1.

Table 1: Demographic Information

Male Govt. teachers: 06	Female Govt. Teachers: 06
Rural Govt. Teachers: 06 (Code: TR)	Urban Govt. Teachers: 06 (Code: TU)
Trained Govt. Teachers: 08	Untrained Govt. Teachers: 04
STEM Teachers: 04 (Code: ST)	Head Teachers: 04 (Code HT)
Curriculum Experts: 02 (Code: CE)	STEM Experts: 03(Code: SE)

a) Perception of teachers regarding integrated STEM education

Table-2 summarizes the findings of the perceptions of primary school teachers about STEM education.

Table 2: Teacher’s Perception of Integrated STEM Education

Theme	Male			Female			Male			Female		
	TU-1	TU-2	TU-3	TU-4	TU-5	TU-6	TR-1	TR-2	TR-3	TR-4	TR-5	TR-6
PERCEPTION												
Before briefing session												
Familiar with STEM	√											
Familiar with the integration approach												
After briefing session												
Familiar with STEM	√	√			√				√			
Understand the STEM approach	√	√			√		√		√	√	√	
STEM approach is interesting	√	√	√	√	√		√	√	√	√	√	
Familiar with the integration approach												
Multidisciplinary					√			√				
Trans-disciplinary												
Interdisciplinary	√	√	√	√	√		√	√	√	√	√	√
STEM approach applied without intention		√		√	√		√				√	√
To integrate the STEM approach-												
Knowledge of various disciplines	√	√	√	√	√	√	√	√	√	√	√	√
Necessity of ICT skill	√	√	√	√	√	√	√	√	√	√	√	√
STEM helps teachers to become more skilled	√	√		√		√	√	√	√		√	√
STEM approach will prepare students for-												
21st-century skilled citizen	√		√	√	√	√	√	√	√	√	√	√
To become a skilled workforce		√	√	√	√		√	√			√	√
To change traditional mindset	√		√		√		√		√	√		
Concerning issue to fulfill academic expectation through STEM education-												
Parent												
Teacher	√	√	√	√	√	√	√	√	√	√	√	√
Students		√	√		√	√		√	√		√	
Aged teachers prefer to teach-												
Conventional/traditional	√	√	√	√	√	√		√	√	√		√
Without technology	√	√	√		√	√		√	√	√	√	√

b) Teacher’s knowledge about STEM Education and its integration into disciplines

The findings of our study show that STEM education is very unfamiliar to teachers at the primary level. Most of the teachers have not heard about STEM education previously. The only teacher who had heard about it was from an urban area but did not know it in detail. After briefing about STEM to them, a few of the

teachers expressed their familiarity with the STEM approach and some of the teachers were able to understand the STEM approach eventually. One of them said,

*So, STEM can be said as an integrated learning process including two or more components: Science, Mathematics, Engineering and Technology, where students will learn through activities and problem-solving. (TU- 2)*

Our analysis shows that none of the teachers knew about the types of integration (e.g., disciplinary, multidisciplinary, interdisciplinary, and trans-disciplinary) before the briefing session. However, after the session, most teachers perceived that the interdisciplinary approach would be more relevant and appropriate for introducing STEM education in primary schools. Yet, two of the teachers argued with this statement and one of them mentioned,

*The students are learning and solving problems as an individual discipline which is traditional and students are habituated with that. If the authority wants to apply an interdisciplinary approach replacing the traditional approach, it will not be easy for the students to get used to it. (TR-2)*

The teachers also shared their experiences of integrating the content knowledge of different subjects. They believe that better learning happens in most cases when students encounter integration. However, weak students often struggle to cope with it. Some of the teachers stated that mixing content knowledge during classes was quite obvious but unintended; sometimes, they do it to get students' attention. Although they were never exposed to STEM approach before, they occasionally followed the knowledge integration technique.

In the current context, there are many topics commonly taught in two or three subjects. Pointing to an example one of the teachers said,

*Most integrations happen when I teach students about "environment" as it is an important chapter and has been included in subjects, such as Bangladesh and Global Studies, Language and Science. So, whenever I take classes on environment in English, I used to link it with the environment in science. Students also find it interesting. (TR-2)*

Another teacher from the urban area said,

*I try to integrate two or more disciplines. To determine the length, width or area of something in science, we need to use the measurement of mathematics. Also, they can learn basic engineering by measuring the tables and benches in the classroom. There are more scopes of integration in math and science compared to other subjects. (TU-1)*

#### c) Teacher's view on the importance of discipline knowledge

All the participants have perceived that integration is essential for conducting classes through the STEM approach to allow the students to reshape their learning system. A participant has emphasized that,

*Content knowledge is important for integrating various disciplines. It was mentioned that teaching or delivering lessons properly is not possible if the content knowledge of the teacher is not enough. (TR-3)*

The content knowledge of mathematics and science was found more important to conduct a fruitful

class and to integrate subjects, but teachers should be aware of student's workload during integration.

#### d) Teacher's view of the effectiveness of the STEM approach

- To hold students' interest

Most teachers perceived that STEM is very interesting and will work well with students. Teachers felt that students of this generation would like this type of integration and activity-based learning. Students welcome that whenever they are allowed to work according to their interests. According to them, STEM will make learning more interesting to the students as they do not enjoy the lecture method. This (new approach) will pave the way to learning something through problem solving and real-life-based learning. When students do project work, they will become more confident about science. Respondents have also said that the students will be able to link one subject knowledge with another; it is a more comprehensive, analytical, creative approach which will ensure better learning outcomes. However, a few teachers believed that effectiveness is mostly dependent on teachers' quality as well as the representation of the STEM approach.

- To meet 21st-century skill

Most respondents indicated that students will learn 21st-century's skills through STEM education. STEM is believed to replace memorizing habits with scientific and logical reasoning among students. One of the urban teachers stated that STEM can be a gateway to clarifying various concepts of science, which is not very feasible in the current mode of teaching. She said,

*STEM is a relevant concept and will be very effective for students. There are a lot of topics in science and technology that can be related to mathematics and engineering. This will help the students understand science clearly to fulfill the needs of the 21st century. (TU-5)*

- To change students' traditional mindset and prepare a skilled workforce

Most of the teachers shared their views that the current status and culture of the job market are being changed. The recruiters focus more on skills and experiences than traditional degrees. STEM is believed to provide the necessary skills and expertise to students and will change their career aspirations. Teachers mentioned some skills that might be acquired through STEM practice. Some of those skills, such as leadership skills, technological skills, collaboration and communication, professional skills, computer literacy, information skills, mathematical and logical reasoning, problem-solving skills, etc., are perceived as the most important for the 21st-century job market. Moreover, students should care about their passions and interests. Teachers also believe that STEM can guide students to the desired skills and career paths.

Some of the teachers shared their opinions and said that students, after skills development through STEM activities, would change their traditional mindset while choosing their desired careers. As the number of government jobs is limited, students prefer skill-based professions over white-collar jobs. Respondents also added that the aim of education in the last century was narrow in terms of skills and activities, but it has now widened. Students in Bangladesh have already been switching their career options and want to become more self-dependent. One of the teachers from the urban area said,

*STEM will enhance the learning of the students. This will help them to achieve good learning outcomes, which help them to be highly ambitious about their career. (TU-2)*

Teachers also hoped that the new workforce would contribute more to nation-building than the traditional one as the STEM workforces are expected to have more entrepreneur mentality. STEM students are likely to be highly skilled and are expected to work efficiently. This skilled generation will create jobs rather than look for them.

- To become a skilled teacher

It was found that most of the teachers perceived positively about the effectiveness of STEM education. They believe that STEM is not only necessary for science, mathematics, technology and engineering but also for other subjects. For instance, one of the teachers expressed his view as while learning about the scientific names of fruits in English, they will also learn English words (language). The majority of the teachers claimed that STEM integration would not only create scope for invention and creativity among the students but also allow teachers to become more skilled. All of the teachers claimed that for integrating STEM education, ICT skill is vital. One of the urban teachers express,

*..... However, in order to prepare students for 21st-century, teachers need to be skilled too. The teachers need to be skilled in ICT, or else they will struggle to fulfill the needs of the 21st century. (TU-3)*

- e) *Teacher's view on the fulfillment of academic expectations*

All teachers expressed that STEM education will fulfill teachers' academic expectations. However, they perceived that as STEM education is a very unfamiliar approach in Bangladesh, the fulfillment of theoretical expectations through STEM education is a concerning issue. A teacher from a rural area said,

*When a new approach or pedagogy is introduced, teachers and students become puzzled. Most students have the same questions to what extent the teacher will deliver, and the teachers ask themselves to what extent students will accept the process. There will be an argument about meeting academic expectations. (TR-3)*

Teachers also elucidated that there are many teachers with a traditional mindset and they would prefer

to teach in very conventional ways like "chalk and talk". They don't want to integrate technology and student-centric activities. The age of the teachers is perceived to be a big factor in this issue.

Some teachers perceived that STEM would meet the expectations of most students. Primary students are very keen to learn in a joyful and more explorative learning environment. A few students may struggle for some days, but they will surely overcome if the teachers deliver the lesson properly. But the teachers were concerned about fulfilling the expectations of the parents. They said that the parents are mostly reluctant to breach the traditional learning system. They prefer examination scores more than activities and creativity. The teachers of the rural area shared that they faced challenges whenever they tried to involve students in the activities. For example, some parents used to say when teachers involved students in activities, "Oh, if the students work by themselves, then why you teachers are here!!" But teachers also anticipate that if STEM becomes generalized all over the country and everyone gets used to it, then the mindset of parents will also change.

## V. CHALLENGES REGARDING IMPLEMENTING STEM EDUCATION

- a) *Challenges Associated with Discipline Knowledge*

Most teachers perceive that lack of discipline knowledge and pedagogical knowledge are major barriers to integrate the STEM approach at the primary level. They also claimed that there are scarcities of qualified and skilled teachers. Similarly, the STEM teachers think that the initiative of integrating the STEM approach will be hampered due to the lack of experienced and subject-expert teachers. One of the STEM teachers said,

*Teachers themselves are a challenge. We do not have subject expert teachers at the primary level and they also do not possess the required skills to conduct STEM classes. (ST-1)*

Besides, teacher's unwillingness to adopt a new approach is perceived as another challenge by the participants. One of the head teachers expressed,

*Our teachers are not motivated. They do not want to accept changes. Also, there is a lack of qualified teachers, which is also a big challenge. (HT-1)*

Moreover, teachers discussed that the lack of effective training to develop teacher's capacity for discipline knowledge is another potential challenge. They think that training failed to address the necessary pedagogical knowledge as well as discipline knowledge for integrating the STEM approach in their teaching practice.

b) *Challenges associated with teaching strategies*

Most teachers expressed that conducting classes with different activities is a challenging task as they have to look after many students in the classroom. Teachers also feel that lack of time to prepare for a class will make it difficult for teachers to conduct activity and problem-based classes. Similarly, one STEM expert said,

*Though project-based learning is an effective strategy for STEM, however, it has some limitations, such as it is time-consuming, lack of materials and lack of skilled teachers (SE-01)*

Furthermore, primary teachers discussed that due to deficiencies in knowledge and skill to use various teaching strategies in the classroom, teachers are often reluctant to use teaching aids even if they have access to them. STEM teachers also shared the same view as primary teachers. They think that teachers-students ratio, class duration and lack of availability of teaching aids are some challenges to integrate the STEM approach. One of the experts said,

*I think the lack of teaching materials to conduct various activities is a challenge. Also, the duration of each class is not enough to conduct activity-based work. Each teacher has to deal with a lot of students in a class. (ST-2)*

They also feel that lack of relevancy of content for the STEM approach, teachers' unwillingness to look at the curriculum and teachers' guide are some other challenges to be faced while implementing the STEM approach.

c) *Challenges associated with the learning system*

Most teachers identified the classroom and school infrastructure as a potential challenge. They think that to conduct various experiments or activities in the classroom, a lot of space is needed and that is quite unlikely in Bangladesh context. Most of the classrooms in this country are small and occupied by a lot of students. Few teachers talked about the mindset of their colleagues and guardian as a potential barrier, as they do not want to accept changes. One of the teachers said,

*One day I took my students outside the classroom to teach about plants and their classification. After conducting the class, I got complaints from my colleagues and also guardians about my approach. They told me that what I was doing was not acceptable. (TR-5)*

Other teachers said that they want to take classes using various activities, but their school does not have adequate resources. Most participants agree that the schools' infrastructure will be a problem in implementing the STEM approach as schools do not have adequate financial support. One of the participants said,

*I think the schools do not have the proper financial support to have the necessary resources, and infrastructure to implement the STEM approach in classrooms. (ST-1)*

Furthermore, they said that seating arrangement, classroom culture, and structure are some other challenges that teachers will have to face in the classroom.

d) *Challenges associated with expectations*

Fulfilling academic expectations is another challenge identified by the teachers. They argued that the integrated STEM approach might not be accepted among the teachers and the guardians as this approach might not fulfill their expectations. One of the teachers said,

*Our guardians expect that the teachers will highlight the passages from the textbook that students will memorize. If we do activity-based learning in the schools, then the guardians will not see any highlights or marks in the textbook. Then they will assume that their children are not learning anything. So, they will not accept this new approach. (TR-1)*

Teachers also feel that most senior teachers (old/aged) do not accept any changes in the education system. They expect everything will be same as it always was. They believe that this mindset persists in some other teachers too, and giving a few training sessions to these teachers will not change their belief. One of the teachers said,

*I fear that this new approach will not be accepted by all teachers. Some teachers do not want any change. They want everything to remain the same. Especially the older teachers. (TU-5)*

Some teachers fear this new approach won't meet students' expectations. Some students have a desired learning style. Students may struggle with this new approach. During integration, slow learners cannot remember prior lessons from different topics, and teachers lose their teaching flow. Consequently, students may not accept this integration, stop attending school, and create a learning gap.

## VI. DISCUSSION

To develop a skilled, creative, and competent 21st-century workforce, there is no alternative to implementing the STEM learning approach, and this approach cannot move forward without the acceptance and readiness of the teachers. Hence, this qualitative study has explored teachers' perceptions and challenges to embrace STEM education in primary schools. It seems interesting that the findings of other contemporary studies were quite similar to this research.

This research has revealed that earlier teachers were unfamiliar with STEM education but after interference by the researchers, they realized that it would be very effective for the students and teachers of primary level. This finding is closely similar to a few other researches where teachers also perceived that a STEM approach would increase the efficiency and confidence



of the learners and facilitators (Lehman et al. 2014; Van Haneghan et al. 2015).

Besides, teachers were found very appreciative of activity-based and integrated learning systems, though some of the respondents were focusing more on technology-enhanced learning (TEL) rather than focusing on integrating four components. The teachers were also aware of the importance of discipline knowledge so were the participants in the findings of Stohlmann et al. (2012). Moreover, similar to Daugherty and Carter (2017), all of the respondents in this research found an interdisciplinary approach is very appropriate for implementing STEM education. Teachers also insisted that mixing up discipline knowledge is helpful but becomes complex for weak students.

Consequently, this study found that teachers' discipline knowledge, pedagogical knowledge, lack of skill, and lack of training are some challenges. This is similar to the studies of Walker, 2018; English, 2017; Lesseig et al., 2016 and Herschbach, 2011; where they found inadequate discipline knowledge and skill of teachers, Lack of pedagogical knowledge and unavailability of teachers' professional development programs as some challenges.

Derived data showed that using collaborative/group work, role play, project work, experiments, discussion, game-based learning, and demonstration methods were perceived as important for STEM implementation, which was also found by Siew et al., 2015; Sutaphan & Yuenyong, 2018; Kim et al., 2020; Gao et al., 2020. In addition, participants mentioned that science fairs, robotics, and other innovation challenges have significance in implementing STEM at the primary level.

In this research, respondents shared mixed reactions to the question regarding the current curriculum and textbooks' support for this new approach. But all of the teachers and experts also agreed that the teaching strategies should be student-centric and more real-life oriented (Burgland et al., 2021; Ritz & Fan, 2015). Besides, it was found that trained teachers were able to align the curriculum, teaching materials, textbooks, teachers' guide and teaching strategies more appropriately with the STEM education compared to the untrained teachers.

Furthermore, this study found that the teacher-student ratio, lack of time for teachers to prepare for classes, lack of teaching aids and class duration, the infrastructure of the school and classroom, teachers' attitude/mindset, lack of resources, and finance are some challenges for performing STEM and activity-based teaching strategy. This finding is similar to the studies of Tao, 2019; Ryu et al., 2019; Walker, 2018; Pearson, 2017; Park et al., 2016 and Lesseig et al., 2016 where they found that inadequate preparation before the class and lack of teaching aids as some barriers to the STEM approach.

This research found that social communities such as parents, SMC, social-political leaders, etc., can successfully contribute to implementing STEM education. However, respondents from rural areas argued that most parents do oppose everything beyond traditional teaching. The same scenario is also seen in the case of senior teachers, which is consistency with the findings of Nadelson et al. (2013), who stated that senior teachers rarely accept anything new. The study also found that accepting the STEM approach is varied according to different context areas whereas gender has no significant effect on this issue. This finding is opposed to Smith et al., (2015) and Park et al., (2016), who argued that gender is a significant factor in STEM teaching. Moreover, the teachers from urban areas and science backgrounds were found to be comparatively more confident and technologically sound, which can be aligned with the findings of Bagiati and Evangelou (2015) and Park et al. (2017). Again, teachers have doubts about the contribution of the learning system as practicing STEM outside the school may not be possible due to students' socio-economic conditions. In a research, Tan et al. (2013) also mentioned that students' socioeconomic condition is a factor in practicing and choosing a STEM-based career.

After all barriers and blessings, teachers hoped that STEM education is expected to generate 21st century's skilled workforce for developing a better nation. They suggested STEM conceptual training, subject-based foundation training for the teachers and counselling for the parents and other stakeholders for better implementations.

## VII. IMPLICATIONS AND CONCLUSION

This study explores the perception of primary teachers about STEM education for integrating this STEM approach into the teaching-learning process. This study also reveals the challenges in integrating STEM education into primary education in Bangladesh. This study has some practical implications for academics and policymakers. Utilizing the findings of the study, the curriculum experts can redesign the primary mathematics and science curriculum to bring these in line with the integrated STEM education. This study can be utilized by the teacher trainers to develop the STEM-based professional skills of the teachers. Again, the teachers must accept to change their mindset from the traditional teaching approach, take interest to undergo relevant training and follow the effective approaches for STEM education. The findings of this study may be helpful to the policymakers to bring significant changes in the policy to make STEM education feasible for all the stakeholders.

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