Children's STEAM Learning in Early Years: A Case Study from a Preschool

By

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A thesis submitted to Brac Institute of Educational Development in partial fulfillment of the requirements for the degree of
Master of Science in Early Childhood Development

Brac Institute of Educational Development
Brac University
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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Approval

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Ethics Statement

Title of Thesis Topic: Children's STEAM Learning in Early Years: A Case Study from a Preschool

Student name: Nasima Akhter Sirajee

1. Source of population: Educators and parents of a STEAM practicing preschool

2. Does the study involve (yes, or no)

   a) Physical risk to the subjects (no)
   b) Social risk (no)
   c) Psychological risk to subjects (no)
   d) discomfort to subjects (no)
   e) Invasion of privacy (no)

3. Will subjects be clearly informed about (yes or no)

   a) Nature and purpose of the study (yes)
   b) Procedures to be followed (yes)
   c) Physical risk (N/A)
   d) Sensitive questions (yes)
   e) Benefits to be derived (yes)
   f) Right to refuse to participate or to withdraw from the study (yes)
   g) Confidential handling of data (yes)
   h) Compensation and/or treatment where there are risks or privacy is involved (yes)

4. Will Signed verbal consent for be required (yes or no)

   a) from study participants (yes)
   b) from parents or guardian (N/A)
   c) Will precautions be taken to protect anonymity of subjects? (yes)

5. Check documents being submitted herewith to Committee:

   a) Proposal (yes)
   b) Consent Form (yes)
   c) Questionnaire or interview schedule (yes)

Ethical Review Committee:
Authorized by:
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Abstract

STEAM education has been gaining significant attention and acceptance throughout the world at all levels of education. It is considered that to get better learning outcomes in STEAM, the foundation should be weaved from the early years of life. The purpose of this study was to explore the knowledge and attitudes the educators and parents hold about STEAM in a STEAM-practicing preschool. This research flaunts the practices preschool educators do to promote STEAM and the challenges educators face in implementing it. The study followed a case study under a qualitative approach. In-Depth Interviews on four educators, one Focus Group Discussion on six parents of preschoolers and five Class Observations were carried out. The case study revealed that all the participants were well familiar with the term- STEAM, and they consider it important in the early years. The case study indicates that though educators know about the interdisciplinary approach of STEAM but most of them lack the skills in integrating Engineering and Technology in-class activities. The study also found parents were having less understanding of STEAM than teachers and there was a lack of knowledge sharing between them. Study findings indicate that the classroom practices are aligned with the understanding of the teachers. The findings showed that all the educators feel the requirement of trainings specifically on Engineering and Technology. The study also revealed that despite of having some basic facilities, the school lack planned indoor space. Therefore, the study recommended for further training with a specific focus on Engineering and Technology areas. This study also highlighted the requirement of nationwide advocacy and awareness program on STEAM incorporation in early-years education. Lastly, further large-scale research is recommended.

Key words: STEAM; Integration; Interdisciplinary; 21st-century skills; 4C's

Dedication

This thesis is dedicated to the children in shelters who are forcibly displaced by conflicts, climate change, and natural calamities.

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Table of Contents

List of Acronyms

ATC21S	Assessment and Teaching of 21st century skills
BRAC	Bangladesh Rural Advancement Committee
ECD	Early Childhood Development
FGD	Focus Group Discussion
ICT	Information and Communications Technology
IDI	In-Depth Interview
STEAM	Science, Technology, Engineering, Arts and Mathematic
STEM	Science, Technology, Engineering, Arts and Mathematic
USA	United States of America
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

Chapter I: Introduction & Background

Introduction:

In recent years, STEAM education has increasingly been getting acceptance in all levels of education globally. Many countries view STEAM as the foundation of economic growth, so it has been gaining continuous attention (Lee et al., 2018). The term STEAM is an acronym that stands for Science, Technology, Engineering, Arts, and Mathematics. This interdisciplinary approach in teaching is being adopted in many countries in response to the increased demand of the technological world. Campbell et. al. (2018) cited Chubb as "In the next 5-10 years, 75% of the fastest growing occupations will require STEM-related skills and experience" (as cited in Campbell et al., 2018). Regarding the importance of STEAM education, Bers et. al. (2013) and DeJarnette (2018) stated, "In order to seek better learning outcomes in STEAM education, actions are needed at the earliest levels of education i.e., early childhood education, which provides the highest rates of return on the development of the individual's motivation and abilities and ensures their further sustainable improvement" (as cited in Monkeviciene et al., 2020). STEAM education in early years arouses curiosity in children. It fosters their creativity, communication, critical thinking, and problem-solving skills (Bertrand & Namukasa, 2020). STEAM practices require active participation, collaboration, and communication; and young children have a natural disposition for STEAM learning. Van Meeteren (2015) stated, "In the block center, preschoolers work hard to build structures under many constraints or limitations. They must consider space, shapes, sizes, materials, the numbers of blocks available, and of-course gravity" (as cited in DeJarnette, 2018). Through STEAM

practices, educators enable opportunity to instill the attitude towards learning; foster the skills and abilities that children require to face the challenges of the 21st century.

Hence, teachers' and head teachers' pedagogical knowledge and attitude toward STEAM are very critical in facilitating the STEAM experience for preschoolers. In this regard, Papadakis et. al. (2021) stated, "In order to achieve the implementation of STEAM education effectively, teachers need to apply appropriate teaching methods which are going to lead students to develop various necessary skills, such as critical and creative thinking, innovation and the ability in finding solutions to various problems that they may encounter in their daily lives" (as cited in Kastriti et al., 2022). Hence it can be said that the effective implementation of STEAM education depends on the appropriate teaching method, stimulating environments, materials, and proper guidance. In addition, teachers need to arrange the whole environment in such a way that it instills communication, collaboration, creativity, and critical thinking skills in preschoolers. Moreover, as the concept of STEAM education does not necessarily mean teaching only the subjects separately, so it is very important for preschool teachers to understand STEAM from the approach of inter-disciplinary relations. Regarding this integration, Breiner et. al. (2012) stressed, "Teachers should use teaching methods that will treat the separate disciplines of Science, Technology, Engineering, Arts and Mathematics as a unit and then teach them as a coherent entity" (as cited in Kastriti et al., 2022). For these reasons, teachers' content knowledge and attitude toward STEAM are very critical because these shape their pedagogical and instructional practices (Alghamdi, 2021).

Furthermore, the family is the first institution from which learning begins. That is why parents' role is very influential in the development of children. As parents are a part of the microsystem, according to Bronfenbrenner's Ecological Systems Theory,

they are directly and indirectly connected with the children's school as well. In addition, parents can arouse curiosity in children to explore their world by providing appropriate stimulation. According to Kristiana (2021), "In STEAM learning, parents act as teachers for children. Parents must be able to motivate children, be able to encourage the formation of new skills" (Kristiana, 2021).

Statement of the Problem:

For the implementation of STEAM, the content knowledge and attitude of preschool teachers are very important. Yet teachers lack knowledge, values, and skills regarding STEAM education. Research suggests that the majority of teachers do not feel competent in implementing STEM in preschool education, though it is paramount of significance (Yildirim, 2021). Sometimes the implementation of STEAM in early childhood education is spontaneous and poor; fails to create a significant impact on the development of different skills in children i.e., math, science, language, etc. (Monkeviciene et al., 2020). According to DeJarnette (2018) and Yildirim (2021), compared to middle and high school teachers, preschool teachers are less informed and less experienced in STEM (as cited in Karademir & Yildirim, 2021). Studies also found that teachers, who implement STEAM in pre-primary classes, are few and scattered in approach (Shrestha, 2021). Regarding the content knowledge of teachers, it is stated in an article that, "Studies show that teachers lack subject which reduces the effectiveness of STEAM education, since teachers' communication with children in the context of their natural explorations does not help them to reflect their discoveries from the perspective of different subjects" (Monkeviciene et al., 2020). So, from these studies, it can be extracted that due to the lack of content knowledge, sometimes teachers feel uncomfortable and unprepared to teach STEAM as an integrated method. Thus, these inadequacies in subject knowledge, skills, and

attitudes of early years' teachers on STEAM education bring challenges to the implementation of STEAM in classrooms. In addition, this gap limits the potential of building the generation equipped with 21st century skills.

Though the above paragraph describes the importance of teachers' content knowledge and attitude, the reality is there are limited researches that focus on teachers' perception and practices on STEAM. According to Boon Ng (2019), "There has been a limited amount of research to identify the prerequisite knowledge, skills, attitudes, values and experiences that constitute competence in STEM and the challenges that teachers face in implementing STEM effectively" (Boon Ng, 2019).

However, realizing the benefits of STEAM education, many countries have drawn the attention of educators and researchers on it. But this concept is very new in Bangladesh. Here a few preschools have introduced this concept in their educational approach but nationally it is yet lying far behind to embrace STEAM education (Chowdhury et al., 2019). Bangladesh has made tremendous progress in ICT (Obaydullah & Rahim, 2019). ICT subjects are compulsory at the secondary level along with mathematics. Moreover, general science is compulsory up to class eight. At the primary level, science, mathematics, arts, and crafts are being taught as independent subjects. In the pre-primary curriculum-math and science are taught. But the integration of STEAM approach is yet to get focused on primary and pre-primary levels. In Bangladesh STEM education program consists of poor infrastructure and few initiatives were taken to integrate STEM fields (Tahmeedul & Jawad, 2020).

Moreover, there is very limited research has been found in this regard, specifically in the field of pre-primary education. That is why this is critical to explore the opportunities and challenges of STEAM integration in early childhood education from the perspectives of pre-primary educators and parents.

Purpose of the Study:

This study intends to explore the knowledge and attitudes the educators and parents hold about STEAM of a STEAM-practicing preschool in Chattogram city. The study also aims to explore the practices the educators do to implement STEAM approach in their preschool classes. Furthermore, another purpose of this study is to find out the challenges educators face to implement STEAM education in their classes.

Justification of the Study:

Bangladesh has made tremendous progress in digitalization. Therefore, this shifting towards the digital world cannot be effective without preparing its citizen for the fast-changing world, which requires the acquisition of different skills i.e., critical thinking, problem-solving, creativity, digital literacy, collaboration, etc. A study, by the Center for Policy Dialogue (2021), shows that 40% of employers in Bangladesh want their employees to acquire new skills to cope with the advancement in technology (Khatun et al., 2022). There is also an economic context of incorporation of STEAM education. With the global change of economic activities, the upcoming generations need to adopt new skills to become competent with these changing scenarios. According to Chubb (2013), "The future prosperity of many countries is dependent on lifetime engagement with STEM education" (as cited in Campbell et al., 2018). Bangladesh's economy largely depends on RMG and remittance. So, it is now inevitable to put focus on preparing its future workforce, equipped with new diversified skills (Tahmeedul & Jawad, 2020). According to Dugger (2010), "An educational system, based on the traditional learning techniques, i.e., reading, writing, and arithmetic skills, has been found wanting in the technological world of today and tomorrow" (as cited in Chowdhury et al., 2020). That is why many countries are

stepping towards the adoption of STEAM in their education system. But regarding Bangladesh context an article mentioned that there would be a significant shortage of skilled workers in coming decades unless STEM education is heavily invested now. To provide Bangladesh with a constant and sufficient supply of competent workforce, STEM education is a critically contributing factor (Chowdhury, 2019). In another article it is stated, “In Bangladesh, education is not empowering youth with the right skill sets which can be deemed employable in the job market” (Khatun et al., 2022). Moreover, from the literature review of the global context, it is found that many teachers from preschools do not have an understanding of STEAM. A study revealed that the existing STEM education program in Bangladesh is deprived of sufficient infrastructure and initiatives when it comes to integrate STEM fields (Tahmeedul & Jawad, 2020). Hence, at this point, it is necessary to initiate studies and researches to have a deep and particular understanding of STEAM in early education. Therefore, this study has been conducted to investigate the knowledge and attitude of preschool teachers about STEAM integration in their classrooms. This study provides insight of preschool educators and parents regarding the opportunities and challenges of integrating STEAM education. It may help the policymakers to take necessary initiatives in STEAM implementation for the early learners. Furthermore, it may be beneficial to the policymakers, educators, and different stakeholders to bring awareness-building program and professional development workshop which would focus on the integration of STEAM. On top of that, this study may be a resource for the researchers as well as the students and ECD practitioners to get insights about how the preschool educators and parents perceive STEAM education. This study also can be a resource to conduct large-scale research in this field.

Research Questions:

i) What is the knowledge and attitude the preschool educators (head teacher and preschool teachers) and parents hold on STEAM education?

ii) What practices do preschool teachers do to promote STEAM education in their classrooms?

iii) What are the challenges the preschool teachers and head teacher face to integrate STEAM education into their classroom?

Operational Definition

STEAM: It is already mentioned that STEAM is the acronym for Science, Technology, Engineering, Arts, and Mathematics. It is an integrated teaching approach that includes these five disciplines. According to Bati et. al. (2018), Wang et. al. (2018), and Ata Akturk et. al. (2017), "STEAM is defined as holistic education, integrating the fields of science, technology, engineering, arts, and mathematics, as a model of interdisciplinary creative education" (as cited in Monkeviciene et al., 2020). Connor et.al. (2015), stated STEAM as an emerging model through which "boundaries between traditional academic subjects can be removed"; and science, technology, engineering, arts, and mathematics are planned into an integrated curriculum (Connor et al., 2015). From this definition, it can be said that STEAM does not mean teaching its five disciplines rather it involves an interdisciplinary approach. For example, in preschool classes, while children build a bridge with blocks at that time, they should be offered different challenges that not only foster construction or engineering skills but also other areas as well. For instance, they should be asked about the cause and effect, the shapes or numbers of the block, or

even the aesthetic feature of the bridge. Hence, in this study, the term 'STEAM' is defined as the integration of these different disciplines in the educational approach.

Knowledge: The word knowledge is a noun, and it refers to the act of knowing something or state of knowing the existence of something. Oxford Language dictionary refers the term knowledge as "awareness or familiarity gained by experience of a fact or situation". In another way, it is mentioned as "facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject". In this study, the word knowledge is defined in parents' case as 'the awareness or familiarity with STEAM for early- year learners. On the other hand, regarding educators, the term knowledge is defined as facts, information, and skills acquired through experience or education; the theoretical or practical understanding of STEAM education for early learners.

Practice: It can be extracted from the Oxford Language dictionary that the word 'practice' refers to the real execution of any idea or method or belief. In this research, this term is stated as the actions of preschool educators in implementing STEAM education in their classrooms.

Early years learners: The term early years refers to early childhood years. According to a report by World Health Organization (WHO), the period from prenatal development to age eight is mentioned as early childhood years (Irwin et al., 2007). According to UNICEF, "Pre-primary educational programmes are typically designed for children 3 to 5 years of age" (UNICEF data). In this study, the term early years' learners refers to the age of preschool years which means ages from three to five.

STEAM practicing preschool: With the clause 'STEAM practicing preschool' the study refers to a preschool that integrates science, technology, engineering, arts, and

mathematics as an interdisciplinary approach in their teaching-learning process, and facilitates the environment to foster 21st-century skills.

21-st Century Skills: The term 21st-century skill was developed in 1991(Javed et al., 2019). Voogt and Roblin (2010) stated it as **"**an overarching concept for the knowledge, skills, and dispositions that citizens need to be able to contribute to the knowledge society" (as cited in Joynes et al., 2019). According to ATC21S researchers, 21st -century skills are summarized as the following 10 skills, these are creativity and innovation, critical thinking, problem-solving, decision-making learning to learn, communication, collaboration, information literacy, ICT literacy, personal and social responsibility, life and career; and citizenship (Suto, 2013).

Chapter II: Literature Review

Theoretical Underpinning:

The theoretical underpinning of STEAM is constructivism, specifically the Sociocultural Theory of Vygotsky (1978). Wilson said (1996), "Constructivist theory emphasizes the importance of providing students with authentic learning experiences where they can relate real-world problems and situations to the task at hand" (as cited in DeJarnette, 2018). In the STEAM experience, students engage language to acquire new skills and interact with others. Here teachers' role is critical in providing appropriate scaffolding. Vygotsky marked learning as a social process and children's perception of the real world is shaped by their experience in the social environment (Baltsavias & Kyridis, 2020). According to Vygotsky, children develop higher mental functions i.e., language, logic, problem-solving, etc. through social interaction (Jackman, 2012). In STEAM, teachers create environments to provide children with opportunities for communication, collaboration, and critical thinking.

The historical development of the term STEAM:

The term STEAM originated from STEM which was first proposed by the US National Science Foundation in the 1990s (Boon Ng, 2019). Though the National Science Foundation started using the term SMET, due to phonetic reasons later on it was decided to change the term SMET to STEM (Wahyuningsih et al., 2020). That is why the term STEM was widely used. STEM refers to science, mathematics, engineering, and technology (Simoncini & Lasen, 2018). But to value creativity and artistic self-expression, the term became STEAM with the inclusion of Arts (Alghamdi, 2021). Therefore, this study includes Arts and aims to explore STEAM.

A number of studies were conducted globally on STEAM in early education. To conduct this study, multiple literatures are reviewed to get insights of contemporary researches and their findings. This part discusses the studies which have been conducted to explore preschool educators' and parents' knowledge, attitude, and practices; and also the importance and challenges of STEAM integration in preschool.

Global Context:

Importance of STEAM education for preschool children:

Children should get exposure to STEAM from their early years of life. "STEAM education incorporates 4C's of 21st-century skills: Creativity, Critical thinking, Collaboration, and Communication" (Singh, 2021). It can be extracted from Mcclure et. al. (2017) that, STEAM education not only developed 21st-century skills but also helps to foster children's cognitive and social development (Akpinar & Akgunduz, 2022). Another study reported that "STEM implementations made during preschool period improved creativity, critical thinking, cooperation and communication skills covering academic skills and school readiness" (Toran et al., 2020).

Role of preschool teachers in STEAM education:

In preschool, the STEAM learning experience depends on the ability of teachers who offer the appropriate environment, materials, and challenges to arouse children's curiosity. According to Conradty and Bogner (2020), "STEAM is about facilitating learning and addressing the individual needs of the children through carefully crafted STEAM lessons" (as cited in Shrestha, 2021). Moreover, teachers need to know the way of scaffolding to support children to work and solve the problem with their own effort. STEAM is a perfect avenue to scaffold children by providing feedback and information, offering hints, and adding challenges (Fernandez and Hartl, 2022).

Awang et.al. (2020) suggested teachers to ask open-ended and closed-ended questions to the learners (Awang et al., 2020). He also added that teachers need to encourage children to participate in discussions and provoke children's thinking to ask questions.

The required teaching-learning method and materials:

There are different teaching-learning methods suitable for STEAM in preschool classes. The most commonly suggested methods are- play-based, inquiry-based, project-based, problem-based instruction, etc. Smelová and Stolinská, (2021) said, "Integration of play-based activities with STEAM approach will be one of the innovative strategies for pre-school teachers to guide them in their teaching and learning process. As play not only aids in their growth but also serves as a source of information for the teachers" (as cited in Wanyi et al., 2022). In another article, it is mentioned that inquiry-based instruction is suitable for early learners. Because inquiry encourages active experience and helps developing vocabulary, problem-solving, critical thinking, communication, and reflection (Linder & Eckhoff, 2020).

Materials are important to facilitate hands-on learning experience through STEAM approach. But having expensive materials is not necessary to implement STEAM approach in preschool classes. According to Casey et. al. (2016), "STEAM education does not always require sophisticated materials. Things such as blocks, twigs, stones, seeds, paper rolls, milk cartons, buttons; and other everyday materials are perfect for STEAM learning" (as cited in Rahardjo,2019). In an another article Eckhoff (2017) mentioned that STEAM experience involves different types of materials but the use of commercial and manufactured materials is not necessary (Eckhoff, 2017)

Preschool Educators' Perceptions of STEAM education:

A study done in Australia reported that although educators acknowledged that they use inquiry-based approaches for science but no one mentioned STEM-specific pedagogy (Campbell et al., 2018). Another study done by Simoncini and Lasen (2018) in Australia found that the majority of the early childhood professionals, who participated in that study perceived STEAM as disciplinary areas of science, technology, engineering, and mathematics (Simoncini & Lasen, 2018). The same perception is explored by Baltsavias and Kyridis (2020) who stated, “It is reasonable to state that teachers approach these subject areas differently” (Baltsavias & Kyridis, 2020). A study was done in Vietnam and it is reported that out of 460 preschool teachers who participated in this study 92% of them have not heard of this education approach (Dinh, 2021). This study also stated that though 62.5% of school managers know the model, yet “awareness of preschool teachers and managers about STEAM is not officially and systematically equipped” (Dinh, 2021). In his study, Alghamdi (2021) stated, “Teachers were very familiar with the term STEAM but had limited knowledge of the integration process and basic strategies and skills needed for its implementation.” (Alghamdi, 2021). Another study has been conducted by Wang in 2020 on 65 kindergarten teachers; and revealed that more than 35% of teachers did not hear the term STEM; and 1.3% of teachers are unwilling to carry out STEM classes (Wang, 2020). Furthermore, this research also found that “79.7% of teachers think they lack engineering and technical knowledge in particular” (Wang, 2020), which means the majority of pre-k teachers lack the knowledge in implementing interdisciplinary STEM teaching (Wang, 2020). From a similar objective another research, done on 104 kindergarten teachers in Greece, reported that 41.7% of respondents do not know anything about STEAM knowledge (Foti, 2021). On the other hand, most of the respondents believe that STEAM education is important for

preschool children. According to Zamil et. al. (2018), “STEAM, practitioners face challenges interpreting and enacting STEAM in their classrooms. This can result in an over-simplified understanding of STEAM, with teachers interpreting STEAM as a series of activities and tasks rather than a holistic approach to learning” (as cited in Boice et al., 2021)

Parents’ Perceptions of STEAM education for preschoolers:

There is very limited research available that highlights parents’ perception on STEAM learning for preschoolers. However, a study, done by Tay et.al. (2017), reported that parents believe participating STEM program developed the potential of their children in their interest areas. They also believe that this participation also offers challenges with meaningful experience (Tay et al., 2017). This study also stated that parents consider STEM as a valuable experience for their children (Tay et al., 2017). Another study done by Lopez and Cabello (2022) reported that parents who participated in this study “Perceive STEM disciplines as necessary in their children’s education” (Lopez & Cabello, 2022). This study also stated that parents also want to get more information about STEM activities occurring in their children’s classrooms (Lopez & Cabello, 2022). A survey was done on the parents and teachers of Pre-K in Los Angeles, USA, reported that out of 55 parents who participated in this survey, 80% consider that STEAM learning should get priority in Pre-K classrooms (Barrett, 2017). Another study done by Voicu et. al (2022) it is revealed that, “Many parents are aware of the existence of STEAM education and have a minimum understanding of its philosophy” (Voicu et al., 2022).

Preschool teachers’ Practices in STEAM class:

Though STEAM does not mean teaching subjects separately but the study found different scenarios in implementation. A study done in Australia revealed that generally, teachers do not incorporate STEAM in an interdisciplinary approach (Campbell et al., 2018). In USA, a study revealed that, teachers are often underprepared to teach using a STEAM and inquiry-based approach (Williams, 2022).

The Challenges, preschool teachers face in STEAM implementation

A study by Monkeviciene and Autukeviciene in 2019 reported the following things as the challenges of STEAM implementation, "Big numbers of children, Shortage of time, Insufficient financing, No time provided for informal meetings, Out-dated events of professional development, Shortage of sets of methodological material" (Monkeviciene & Autukeviciene, 2019). Though teachers play a critical role in the implementation of STEAM but, in reality, the preschool and elementary teachers have little training or no instruction (DeJarnette, 2018).

Bangladesh Context:

Very few studies have been conducted in Bangladesh. Moreover, it is found that the available studies on STEAM focused mostly on areas of education like, Girls in STEAM, STEAM in higher education, etc. But studies are unavailable on STEAM in early childhood education. A study was done to explore lower secondary science teachers' perceptions regarding STEAM and inquiry-based learning. This study reported that the "participant understand and practice a certain degree of inquiry and STEM-based science education" (Shahidullah, 2016). It also explored that, the curricula and instructional materials are inadequate to integrate more than one discipline (Shahidullah, 2016). Another study done by Chowdhury et. al. (2019), revealed some reasons as the challenges of STEM implementation in Bangladesh.

This study concluded that lack of well-equipped science laboratories, lack of finance and materials, large class size, and negative attitude of learners are the key factors that hinder STEM implementation in Bangladesh (Chowdhury et al., 2019). Regarding STEM integration in Bangladesh, in a study it is stated that "primary and secondary level uses the same strategy to teach STEM subjects as it does to teach a social science or an arts subject (Tahmeedul & Jawad, 2020).

From the above national and international literature reviews, it can be extracted that the perception of STEAM education is yet to be full-bodied and largely heterogeneous among a big number of educators.

Chapter III: Methodology

Research Design:

This study has followed a case study under a qualitative approach to explore the in-depth knowledge of preschool educators and parents on STEAM education as well as to understand their attitudes and practices. It can be extracted from Creswell (2006) that, case study research involves the in-depth study of an issue that is explored through one or more cases within a bounded setting or context (Creswell, 2006).

Regarding qualitative study, Gay et.al. (2012) stated, "Qualitative research is the collection, analysis, and interpretation of comprehensive narrative and visual (i.e., nonnumerical) data to gain insights into a particular phenomenon of interest. Qualitative research methods are based on different beliefs and designed for different purposes" (Gay et al., 2012).

The in-depth interview, observation, and focus group discussion (FGD) were used to collect data. This triangulation by using more than one method strengthened the validity and credibility of this study (Noble & Heale, 2019). The data are descriptive and it reflects the knowledge and attitude of participants regarding STEAM education; and also, the challenges they face in the implementation process.

Research Participants:

Preschool teachers, the head teacher, and parents from a STEAM practicing preschool. For the inclusion criteria, a preschool with STEAM practice has been taken into consideration.

Research Setting:

This study has been carried out in Chattogram city, Bangladesh.

Sampling/Participant Selection Procedure:

Ten participants were selected to collect data that include three preschool teachers, one head teacher, and six parents. IDI and Class Observation were done with same teachers. Convenient sampling was followed for the data collection. The In-depth Interview was carried out with three teachers and the head teacher; and the Focus-Group-Discussion was with six parents.

Measures/ tools:

In order to gain a comprehensive understanding, self-administered In-depth Interview (IDI) guidelines, Class Observation checklist, and Focus Group Discussion (FGD) guidelines were used to collect the data. In the class observation process, the data was gathered by watching the participants (teachers) in natural settings. It was considered that pairing observation with interviews would be helpful to be compared with the self-reports of the research participants (Gay et al., 2012). According to Easwaramoorthy and Zarinpoush (2006), "Interviews are an appropriate method when there is a need to collect in-depth information on people's opinions, thoughts, experiences, and feelings" (Easwaramoorthy & Zarinpoush, 2006). The In-Depth Interview (IDI) guidelines were based on some open-ended questions to explore the knowledge and attitude of the participants, and to know about their practices as well. The IDI guidelines reflected the research questions and the questionnaire included the socio-demographic status, knowledge, practices, and challenges, the participants used to face in implementing STEAM education. Here Class Observation checklist was used to explore real features of STEAM practices in the classroom. The class observation included a semi-structured class observation protocol. To prepare the class observation checklist, the theoretical base of STEAM concept was taken into consideration. That means there is a reflection of the Socio-Cultural Theory of Vygotsky. In addition, the operational definition of STEAM guided the preparation of

the class observation checklist. All the tools were reviewed by the expert academicians of the BRAC IED.

Data Collection Procedure:

The data was collected through the IDI, Classroom Observation, and FGD. After reviewing the tools by academicians, the piloting was done with two teachers; and two parents who share similar characteristics to the research participants. Furthermore, a trial observation of the classrooms was also done. This piloting was carried out to find the challenges and complexities of the tools. After getting the feedback, those tools were reviewed and finalized.

To carry out the data collection, few permission-seeking applications were sent to the head of some STEAM-practicing preschools, in Dhaka and Chattogram. Details of the research objectives and data collection plan were attached with the application. The most convenient one was selected from those schools that consented. After that different schedules were fixed for IDI, FGD, and Class Observation. At the beginning the objectives of the interview, focus group discussion, and class observation were explained to the participants. All the participants signed the consent form and all the data was gathered through an in-person modality. The class observations were done before the interview to get the real feature assuming that if the interview occurs before the class observation that may impact the real class practice. A total of five classes were observed that includes two classes for each teacher. Though, initially, it was planned to observe six classes, one class could not be observed finally, as the teacher was not available for an unavoidable reason. Prior to the class observation, rapport was built with the children through a short introduction of the researcher, to avoid the stranger phobia of the children; and also, to make them comfortable. The researcher took a corner to avoid any distractions. During the observation, field notes were taken

to obtain both descriptive and reflective information. The field notes had been recorded as soon as the observation was done. During the observations, the researcher was conscious to neutralize the biases and preconceptions, and efforts were there to see things from the participants' perspective.

IDI were conducted with the same preschool teachers, whose classes were observed, and also with the head teacher of the school. At first, rapport was built through some informal questions. During the interview, an audio recording was done with their consent, to avoid data missing. At that time, judgment, debate, or interruption was avoided. Moreover, participants were allowed to speak frankly and their answers were listened to and recorded with patience as long as they wanted to talk. The interviews were about 50 to 60 minutes in length.

For the FGD, six parents of preschool children were selected by the school authority. During the FGD, it was ensured that all participants would get the scope to share their thoughts. The audio recording was done with their consent. The length of FGD was about 65 minutes.

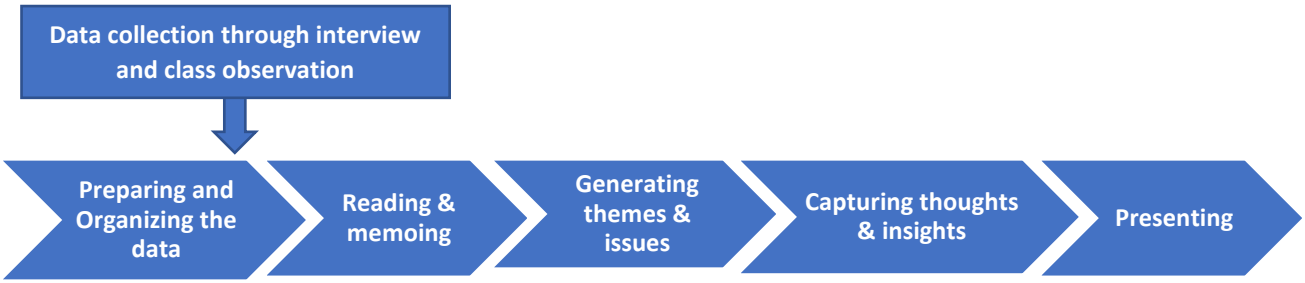
Data Analysis:

Data Analysis during Data Collection: In qualitative research, the data analysis begins during the data collection procedure (Gay et al., 2012). In this regard, during the data collection procedure, it was tried to narrow down the topic progressively through checking and reviewing data each time after coming back from the field. Thus eliminated the less useful data, and planned for new data whenever required.

Data Analysis after Data Collection: After collecting data, the Content Analysis technique was applied for analyzing the data. In this process, the following five steps were followed: a) preparing and organizing the data, b) reading and memoing, c) generating themes and issues, d) capturing thoughts and insights, and e) presenting.

Firstly, in the data organizing step, all the collected data from field notes, transcripts, and memos were checked for completeness. Then sequencing and labeling were done. All data was stored in a computer according to data types and stages and a backup was made. A specific name was given for each file and a master data catalog was created to find data easily. In the second step, data was read several times, and highlighting was done corresponding to the research questions. In the third step, data was reviewed and looked for themes. Considering the similarities, differences, and relationships across the categories the theme was generated and aligned with the primary research questions. In the fourth step, the themes were reviewed and modified and, finally, named. Themes were categorized into some subthemes. In the fifth step, all data was summarized under each theme and some direct citations were given relevant to the theme. And finally, those findings were discussed in light of literature review, research questions and researcher's reflection on them. In this stage triangulation of data was done.

Figure: Data analysis flowchart



Validity and Reliability of the Research Tool:

For validity assurance, IDI guidelines, Class Observation checklist and FGD guidelines were reviewed by the thesis supervisor and the academicians of BRAC IED. During the data collection procedure, persistent observation was done. Furthermore, the peer review was taken on the tools. To ensure credibility, piloting of

the research tools was done. The triangulation of data, through In-depth Interviews, Class Observations, and FGD, also ensures the validity of the study.

Ethics:

Before starting the data collection procedure the thesis proposal along with the research protocol was reviewed by the Review Board of Brac IED, Brac University. After the ethical approval, the data collection procedure was initiated. The objectives of the study were explained to the participants. To help them decide about their participation, they were also provided with a consent form. Neither any inducement nor any misleading information was provided to influence the participants.

The participant was informed that they would reserve all rights to withdraw from the interview and skip answering any question if they would be unwilling to. Furthermore, they were also informed that the researcher would leave the classroom if her/his presence creates discomfort**.** It was also ensured that confidentiality and anonymity would be maintained strictly. During data collection, no physical, social, or psychological harm was occurred to any participants or other life and objects; and no interruption or judgment was made. Moreover, the participants were not forced to participate in this study and their answers have not been manipulated.

Limitations of the Study:

One of the limitations of this study is the availability of STEAM-practicing school. Though the study followed convenient sampling but due to the limited number of STEAM practicing preschools, there were not many options to choose schools for the data collection. Another limitation is, the initial class observation plan was six which means two class observations for each teacher. But due to unavailability of one teacher in one of her/his classes, practically the class observation number was five.

Chapter IV: Findings and Discussions

Socio-demographic information:

A total of ten participants took part in the data collection procedure which included one head teacher, three preschool teachers, and six parents. All the participants were from a STEAM practicing preschool. The school introduced the STEAM approach approximately five months earlier than the date of the data collection. It is a primary school and data was collected from the preprimary teachers and parents of play, nursery and kindergarten classes. There were three preprimary classes in that school and number of children in each preprimary class was below twenty. There were both male and female participants participated in the data collection procedure. The head teacher has been working in that school for seven years and his educational qualification is graduation. Out of the three assistant teachers, two have Bachelor's degrees and the rest has Master's degree. Of the parents, five of them are postgraduate and one is a graduate. Among the parents, four of them are post-graduates and two are graduates and the rest one studied till higher secondary level. All of their children were enrolled in play, nursery and kindergarten classes at the time of the data collection. The teachers were having five to eight years of working experience as early-years teachers. All the teachers attended different in-house and other professional training namely 'Active Learning', 'Constructive Learning', 'Developing low cost or no cost materials' etc. They had some in-house training on STEAM specifically 'STEAM in Early Years' and 'Introduction to STEAM'.

Findings and Discussions:

This chapter includes two different parts- Findings and Discussions. The Findings part presents the data, obtained from the four IDI, one FGD, and five Class Observations.

In the ‘Discussion’ part data will be evaluated in the view of relevant literature and the researcher’s own reflection. This chapter will end with a conclusion and recommendations based on the findings of this study.

The data presented in this chapter were collected from the participants to explore their perceptions, practices, and challenges on STEAM learning in the early years. All the participants of this case study were from a STEAM-practicing preschool, and a case study was done on that school to get the holistic insights into it. To go deeper into the case of the STEAM practicing school, the study involved teachers and parents, the two major stakeholders of the school, and undertook class observation as an important element of case study. All the questions, asked during IDI and FGD, and the observation, done in the class, were relevant to the research questions.

Findings:

This findings part is presented in the following six themes that are identified from the examination of different categories. Furthermore, most of the themes are again presented in some sub-themes.

Theme 1: Educators’ and Parents’ perceptions and attitude regarding STEAM

The findings presented under this theme are relevant to the first research question which is to explore the knowledge and attitude the preschool educators (head teacher and preschool teachers) and parents hold about STEAM education. This is relevant to research question one. The findings under this theme are again described in the following sub-themes:

Educators’ and Parents’ understanding of STEAM: This sub-theme reflects a common understanding of STEAM that is all the participants heard the term STEAM

and most of them identified the letters of STEAM as Science, Technology, Engineering, Arts and Math.

From the In-depth Interview (IDI) on educators, it is found that all the interviewees said STEAM includes five discipline and they perceived STEAM as a teaching-learning. Furthermore, all the respondents who participated in IDI shared their perception that STEAM does not mean teaching or learning Science, Technology, Engineering, Arts and Math separately rather it is an approach of involving more than one of these disciplines during a single activity. One of the respondents stated that,

> *"STEAM is a learning method through which it is possible to build concepts on more than one discipline. That means the concepts of Science, Technology, Engineering, Arts and Math can be integrated together. It means, STEAM approach promotes skills on more than one disciplines in a single activity rather than teaching about the disciplines separately"* (IDI#4, 11.10. 2022).

Another participant perceives that STEAM does mean learning its disciplines separately. Instead it integrates those to solve any problem. The interviewee stated,

> *"To me, STEAM is not about learning- science, technology, engineering, arts, and mathematics. It is more about involving skills on these five disciplines to solve problems and challenges while learning"* (IDI#1, 08, 10. 2022).

From the FGD on parents, it is revealed that all the parents understand what STEAM stands for. Most of them could elaborate on the term fully by naming all disciplines of STEAM, and few of them named three or four disciplines. But none of them did mention anything particular about the interdisciplinary approach of STEAM. Furthermore, most of them could not mention anything other than naming the

disciplines of the term. One of the participants mentioned, *"Here, Science, Engineering, Math, etc. have been taught together"* (FGD #5, 10.10.2022).

To another parent,

> *"I have heard the term from teachers. Here Math, Science, Engineering, etc. are being taught together. Do not know more than this"* (FGD#6, 10.10.2022).

Understanding of how the integration of STEAM happens in early-year classes: All the respondents who participated in the IDI and FGD agreed that it is possible to integrate disciplines of STEAM for the early-year learners. All the participants mentioned that the STEAM approach can be implemented even through a block-building or drawing activity for preschool-age children.

Educators who participated in the IDI mentioned that if teachers know about STEAM, then any age-appropriate activity can be turned into a STEAM-embedded experience. One of the participants stated,

> *"For example, at the time of building a house with blocks, a child thinks about the different aspects of blocks to put one on another. That promotes Engineering skills. Again while he/she plans for windows and doors by thinking about air and light, it fosters scientific thinking. At the same time to give the house a good look, the child also considers different colors, and thus it involves Art skills"* (IDI#2, 10.10.2022).

Similar responses were found from the parents in FGD. All of them named some common activities, i.e. paper boat making, gardening, and rhyming, through which STEAM can be implemented for preschoolers. They shared ideas about how integration of disciplines happens during these activities. According to a participant,

"I think bringing different disciplines of STEAM into one activity is possible. For example, paper boat-making activity involves the concept of how many boats, what is the color" (FGD#4, 10.10.2022).

Understanding of the required teaching-learning method to implement STEAM in the preschool: Regarding the required teaching-learning strategies to implement STEAM all the teachers who participated in IDI have shared a common understanding. All of them emphasized that play-based and inquiry-based learning methods are appropriate to implement STEAM in preschool classes. The interviewees also added that children of preschool age like to play and they also tend to ask questions. One respondent shared that,

"I think play-based learning is most appropriate for pre-primary children. Children of this age group always get involved deeply in play. So, learning through play helps to remember everything. Besides, inquiry-based learning is also suitable as children like asking questions. It is possible to promote inquiries by allowing them to observe something" (IDI#4, 11.10.2022).

Understanding of classroom environment and materials to implement STEAM (settings, materials, and others): From the IDI it is found that all the participants are on the same page about their understanding of the required teaching-learning environment and materials. All of them shared that any materials can be used in the STEAM learning process. They think that materials are very important but it is always not necessary to purchase those with high cost. They shared that any available no-cost, low-cost and recycled materials can be used in STEAM learning. According to one of the educators,

> *"Well, it is obviously true that a focused STEAM learning facility requires a planned and rich arrangement. But my experience also says that it is not impossible to promote STEAM learning in a basic school arrangement. For example, I can say, every physical object around us is comprehensible and explainable through measuring, comparing, drawing, writing, usability, appearance, and so on. If there are no other tools only our body and body parts are good enough for a STEAM activity* (IDI#1, 08, 10. 2022).

All the participants opine that both indoor and outdoor settings are important to implement STEAM but the settings for a specific activity correspond to the requirement of the activity. Most of them also added that a big outdoor field is not always mandatory for an outdoor class. According to their opinion, even a terrace or rooftop of the school building can be used as outdoors. To one of the interviewees,

> *"Having filed is not always a must. The terrace and the rooftop of the school building can be utilized as outdoors. For example, 'introducing leaves' is a nice activity for STEAM. This activity is possible by planting plants in a sunny terrace or rooftop* (IDI#2, 10.10.2022*).*

On the other hand, most of the parents also shared that any materials can be used for STEAM. According to one of the respondents*, "It is always no need to buy materials. Paper, sticks, leaves everything can be used for STEAM learning"* (FGD#2, 10.10.2022). Few parents think that some commercial materials are needed to purchase. According to one of the parents *"Now-a-days children are using robots. So, these types of materials are needed"* (FGD#5, 10.10.2022)

Theme 2: Teachers' understanding of teachers' role in implementing STEAM

The findings, presented under the theme two, are in compliance with the first research question which is to explore the knowledge and attitude of the preschool educators (head teacher and preschool teachers) about STEAM. Based on the different coding this theme is again arranged under three subthemes.

Teachers are the facilitators: From the IDI, it is revealed that all the participants realize that teachers are the facilitators of teaching-learning environments in implementing STEAM in early-year classes. They opine that teachers need to plan and arrange the environment and materials beforehand. All of them think that students are active persons during the activity. One of the participants stated,

> *"Teachers' prime role is selecting the appropriate environment. Facilitating with the materials is also an important task of her/him"* (IDI#3, 10.10.2022).

Teachers are the motivators: As explored from the IDI, all the teachers think that teachers need to motivate children with clues and guidance in problem solving. Few of them mentioned that teachers scaffold children during hands-on activities. According to one interviewee, *"While children do any hands-on activity that time teachers should support the headway with clue and motivation"* (IDI#2, 10.10.2022).

Intriguers of queries: The participants, who took part in IDI, stressed that teachers need to ask different questions during the activity. It will help to develop STEAM-related skills. All the teachers expressed that it is the teachers' role to intrigue queries in children through creating such an environment. As per one of the respondents,

> *"Teachers should ask different STEAM-related questions and thus will help to build the concepts. Simultaneously teachers will ensure such an environment so that children feel inspired to ask questions"* (IDI#3, 10.10.2022).

Theme 3: Educators' and parents' understanding of the importance of STEAM in early years

The findings, illustrated under theme three, are also pertinent to research question one to explore the attitude of educators and parents toward STEAM education. The following two subthemes have been identified under this theme: The importance of STEAM education for early learners and The skills that can be fostered through the STEAM approach.

The importance of STEAM education for early learners: Data from the IDI and FGD show that all the participants realize the importance of STEAM for early learners. The educators who participated in IDI opine that the early-years is the critical stage to build the foundation for later life. According to one participant,

> *"STEAM approach is very important to make children ready for the growing demand of the fast-changing world. Through STEAM, we can spark the critical thinking skills in our children. This is a unique approach that enables the teaching-learning environment to nurture multiple skills even from a single activity alone"* (IDI#1, 08.10.2022).

Similar views were found from the parents in FGD. One of the parents said,

> *"Of course, it is important. If children learn anything through observation and analytical mind that will enable them to explain the cause and effect of anything in later life"* (FGD#6, 10.10.2022). According to another parent,
>
> *"I feel it is important because it will arouse curiosity to know something from different aspects instead of single aspect. If the curiosity develops in early stage, then it will make the future learning easier"* (FGD#3, 10.10.2022).

The skills that can be fostered through the STEAM approach: All the participants have named some certain skills that can be developed through STEAM approach**.**

From IDI 'creativity' and 'communication' came as the common answers from most of the educators. Some of them named 'collaboration' as another skill. Few of them talked about 'alternative thinking skills'. Some of them said that 'critical thinking' can also be fostered. One interviewee shared that,

> *"It enhances the creativity of children and intrigues their alternative thinking. Besides, it also helps developing creative thinking skills"* (IDI#3, 10.10.2022).

From FGD data, it is explored that some of the parents named creativity as a skill. Few of them included that leadership and collaboration also can be developed through STEAM. To one of the parents, *"It helps to develop leadership skills. In addition, it boosts creativity and develops a collaborative mind* (FGD#2, 10.10.2022).

Theme 4: Classroom Practices on STEAM education:

The findings, reported in theme four, are compliant to the research question two that explores the classroom practices of STEAM in this preschool. These findings are extracted from IDI, FGD and Class Observations. It is to mention that some questions were asked to teachers and parents about the practices of this school. The findings under this theme are described in following five sub-themes. These are- Settings and the teaching-learning environment, Teaching learning strategies, The changes brought to implement STEAM in classrooms, Disciplines of STEAM are addressed during the activity; and 21st-century skills are addressed through the activities.

Classroom settings and teaching–learning environment: It is found from the data, obtained from IDI, FGD and Class Observations, that the school has certain basic facilities to implement STEAM in its pre-primary classes. In terms of settings, all the

participants mentioned about both indoor and outdoor activities takes place in STEAM classes. The similar observations were found from the classroom practices. Another feature of the classes was small class size. The numbers of children of those classes were found not more than fifteen. Parents also mentioned about the small class size. In addition, all the parents said that their children learn here with 'enjoyment'. During class observation children were found happy and involved with activities. Furthermore, according to most of the parents, children learn here without pressure and fear. Besides, children's active engagement is another attribute which were revealed from the data obtained from IDI, FGD and Class Observation.

Data, gathered from the IDI, reveals that all the educators mentioned about conducting STEAM classes in both indoor and outdoor settings. One educator said,

> *"We have a small ground, a planned garden, sensory areas, and many open-ended outdoor play materials"* (IDI#1, 08.10.2022). Regarding the children's engagement, s/he added *"Children are being addressed frequently and gradually becoming the center of the learning"* (IDI#1, 08.10.2022).

Similar responses were found from the FGD. All the parents mentioned that the classes in this school take place both in indoor and outdoor settings. One of the participants shared that,

> *"Here teachers connect children with outdoor environment. They don't keep lessons limited to books and copies. Materials are used from surroundings. Children enjoy learning of this kind"* (FGD#3, 10.10.2022).

Another parent added that *"Here learning is pressure-free and fear-free"* ((FGD#4, 10.10.10). Regarding class size, one parent said, *"Here they do not enroll more than fifteen students*" (FGD#4, 10.10.10).

Data revealed from Class Observation shows that some classes were held in indoor and some in outdoor. One of the indoor class activities was ‘building house with block’; another was ‘how does the clock’s hands move’. The outdoor activities were ‘observing flowers with magnifying glass’, ‘paper boat making and floating in water tub’, and ‘making cookies with wet sand’. Twelve to fifteen children were involved in each activity. Children were found actively involved in the activities. During the activity ‘how does the clock’s hands move’, it was found that all the children were involved in moving the wheels and watching movement of clock hands in effect, and participated in discussion with one another (Class Observation notes#5,10.10.2022). It is also observed that during Class Observation all the teachers were found cheerful and engaged. During the paper boat-making and floating activity teacher was making playful expressions with hands and face to show how the boat moves in water when heavy wind blows (Class Observation notes #4, 10.10.2022). Another common thing was observed that children were engaged in the activities and showing excitements. During the ‘observing flowers with magnifying glass’ activity, children were found very curious about the magnifying glass and one of them were saying “Hey, look, How big the flower is!” (Class Observation notes#3, 11.10.2022).

Teaching learning strategies: Data obtained from IDI, FGD and Class Observation reveal that, the teachers follow different methods in implementing STEAM approach. Data, extracted from IDI, reveals that all the educators said, play-based learning and inquiry-based learning methods are widely practiced in their classes. From their statement it is also explored how they integrate STEAM in an activity. All the teachers shared that they engage different STEAM relevant conversations during the activity. According to one of the teachers,

"I try to build STEAM related concepts in children through play. For example, while children play with dough I ask them about the shape, size, color, and also to count what they made. I also make questions like- why do we use this and what happened if we do not have this'' (IDI#3, 10.10.2022).

The data from FGD demonstrates various statements of parents regarding the teaching-learning strategies of this school. All the parents mentioned about hands on learning and how teacher connects lessons to real life event. Some of them also mentioned that they know that their children learn STEAM. One participant said, *"I know my child learn STEAM here. Do not know more than that"* (FGD#5, 10.10.10). Few parents shared that children learn many things together in the STEAM classes. Another parent mentioned that *"One day I have observed that children were counting leaves in the garden and teacher also asking questions like do the plant has life''*(FGD#2,10.10.2022). One parent stated,

"Here, they use many materials for teaching something and they collect those from the surroundings. One day a teacher asked my child to bring two red apples from home. From this task children can learn about color and counting. Thus they learn from the available materials at home. Therefore, beside books they connect learning also with real life" (FGD#6, 10.10.2022).

Data, obtained from Class Observations, presents different aspects of teaching learning methods. In all classes, children were found engaged in different hands-on learning activities. In some classes, children were busy in playing, in some classes, they were observing any situations. In all classes, both children and teachers were seen involved in doing queries and answering those. In all classes the teachers were trying to connect the activities with real-life events. In an activity it was found that teacher was asking 'when do we use clock'; and children's answers were like- 'to

watch TV', 'to come to school' etc. (Class Observation#5, 10.10.2022). The integration of more than one discipline of STEAM is seen to be a common strategy in the activities. In the classes, teachers were integrating two or three disciplines within one activity which were mostly Science, Math, and Arts. But, no classes were found to focus on disciplines like Engineering and Technology. Furthermore, it was also found that in all classes teachers were using different STEAM conversations like 'how many', 'what is the shape', 'what is the color' etc. In 'building house' activity it was found that teacher was engaging different STEAM relevant conversations i.e., 'what to put in your house to allow air and light'; 'what is the shape of the roof', 'what are the colors of your house' etc. (Class Observation#2, 10.10.2022).

In some classes, teachers were found trying to intrigue curiosity by making situations while in other classes teachers were trying to arouse curiosity through some questions. During the activity 'how does the clock's hands move', it was seen that teacher was uncovering clocks from a box and asking questions 'guess what I have in the box' 'what is this', 'what will we do with this' (Class Observation#5,10.10.2022).

The changes brought to implement STEAM in classrooms: Regarding the changes in teaching–learning practices data found from IDI, FGD, and Class Observation it is found all the educators mentioned that changes were not made in curriculum but in approach. One of the educators mentioned that the school already had foundation to implement STEAM approach. According to one of the educators,

> *"I think STEAM is nothing we planted from outside; rather it has been a great potential, previously hidden beneath our ignorance, now explored and enjoyed in our educational practices. First, we have educated and trained our teachers about STEAM. Then we have incorporated STEAM with lesson plan where teacher put the plan and description of the activities. As we have been in*

*experiential learning from earlier time it helped us incorporate STEAM approach in our school education" (*IDI#1, 08.10.2022).

Another teacher expressed that,

"Though we are practicing STEAM in recent time, it has started bringing some changes. Be it Science, Math or be it Arts, earlier we used to focus on one discipline only during any activity. But now we try to focus on as many as disciplines we can involve from STEAM in an activity. For this we prepare the lesson plan beforehand'' (IDI#4, 11.10.2022).

Data, found from FGD, explores that most of the parents did not specify anything about the changes of practice rather they were talking about the existing practice. One parent shared differently*, "Math, Science, and Arts are being taught together. Earlier they used to teach those in separate classes'' (*FGD#5, 10.10.2022).

Class Observation has explored that all the teachers were trying to focus on more than one discipline in all the classes.

Fostering 4C's through the activities: Data shows that commonly all the educators have shared about how they foster the 4C (communication, collaboration, critical thinking, and creativity) skills in children. One of them expressed that to promote collaboration s/he encourages children to share their materials and also ask children to help other children (IDI#3, 10.10.2022). According to another participant,

"I try to be aware to find them scopes to exchange among their peers. When children remain engaged in group work, they try to help others. For instance, they say 'it will be like this'. I also plan some group activity to promote collaboration among children" (IDI#2, 10.10.2022).

Regarding creativity and critical thinking, one of the interviewees said,

"I encourage creativity in children by providing new materials and giving clues to work with those" (IDI#3, 10.10.2022). The participant also added,

*"Though I am not clear about critical thinking but I ask different questions while children do any activity. For example, when a child builds houses, I ask 'what will happen if there is no window' or 'what do we need to put in the house to light it at the night" (*IDI#3, 10.10.2022).

During Class observation, it was found that all the teachers were asking different thought-provoking questions to foster critical thinking. In the paper boat-making activity it was observed that teacher was asking questions like *'What will happen to the boat if wind blows strongly'* (Class Observation# 4, 10.10.2022).

During class observation, no teacher was found promoting collaboration rather all of them were focusing on communication, critical thinking, and creativity.

Regarding problem-solving, few teachers shared that they have no idea about how to encourage that. Another respondent said that s/he provides different materials like block, puzzles, sand and tell them to make anything. According to another participant, *"I encourage problem-solving. I tell them- You did it nicely- as they complete any task"* (IDI#4, 11.10.2022).

From Class Observation it is found that during some activities like 'house building', 'the clock's hands move activity' some teachers were offering problems to solve. In some classes teachers were found doing the same by asking questions.

Theme 5: Challenges of implementing STEAM in preschool settings:

Theme five presented the findings which are relevant to research question three to explore the challenges of implementing STEAM in preschool settings. The findings under this theme are arranged into some sub themes. These are: Lack of enough

training, Lack of planned indoor space and materials, Difficulties to comprehend some disciplines like Engineering and Technology, Traditional mindset of teacher.

Lack of enough training: Data from IDI revealed that all the participants marked STEAM implantation as a new thing in their school. So they sometimes cannot understand what to do. One participant stated that *"Though I have interest in STEAM but I feel like I lack enough training"* (IDI#3, 10.10.2020).

According to another participant, "As *STEAM concept is new here, sometimes we cannot understand it properly. Training can help us to improve"* (IDI#2, 10.10.2020).

Lack of planned indoor space and materials: Most of the educators, participated in IDI, did not mention anything about the materials and space. Few of them shared that they feel the lack of planned and specious indoor space. One interviewee said,

> *"We have many materials in our school but there is a need for the infrastructural facility to utilize those materials. When we use some materials in the classroom, at that time it is felt that we need more space. If we could create some corners to keep those in the classroom then our children could have used whatever they want''* (IDI#4, 11.10.2022).

Another participant expressed that*, "Some good science and engineering materials are beyond our reach"* (IDI#1, 08.10.2022).

Difficulties to comprehend disciplines like Engineering and Technology: Data revealed that all the educators who participated in IDI told, they sometimes get confused to understand how to integrate Engineering or Technology in an activity. To most of them Science, Engineering and Technology seem same. One teacher shared that, *"I have confusion about Science, Technology and Engineering. I am lagging behind in this regard"* (IDI#4, 11.10.2022). Another respondent expressed that,

> *"Sometimes I mix up Technology and Engineering. Sometimes I feel that Science, Technology, and Engineering are the same. So, more training is needed in these areas''* (IDI#2, 10.10.2022).

Besides the above-mentioned challenges, few participants mentioned some issues about implementing STEAM. These are- Traditional mindset of teachers, parents and teachers' inertia to act for new concepts, traditional teaching-learning experience of teachers in their own student life etc. (IDI#1, 08.10.2022). One participant also added,

> *"As it is being practiced in very few schools, the exchange of professional practices, experiences and knowledge are not happening yet"* (IDI#1, 08.10.2020).

To respond the question- 'the difficulties their children face in school due to STEAM implementation' most of the parents in FGD expressed that they do not observe any challenge in their children. Few of them told that sometime children may get confused to understand more than one discipline at a time (FGD#2, 10.10.2022). Most of them also added that it would be more effective if the parents could get the idea about how STEAM activities take place. Few of them did not mention anything about that.

One of the parents said *"Do not feel such challenge because, my child likes her/his teacher. He wants to bring his teacher at home. So, I think there is no obstacle in the learning process''* (FGD#3, 10.10.2022).

Another respondent expressed that, *"No complexity is there. My child is very interested in going to school. But it would be nice if we, the parents, could know more about STEAM''* (FGD#5, 10.10.2022).

From class observation, it was found that in most of the classes Science, Math and Arts were the areas which were addressed through activity. Engineering and

Technology were addressed in very few activities. Another feature was seen that there was not enough dedicated space in the classroom to keep the teaching materials. In some classroom, materials were brought by the teachers from the office room.

Theme 6: Measures to overcome the challenges:

Data obtained from IDI and FGD shows that the participants have suggested some initiatives to be taken to overcome the challenges. All the educators talked about arranging more training and some specific training on Engineering and Technology. Few of them wanted to have more planned space and enriched materials. In addition, most of the participants that include teachers and parents talked about sharing STEAM concept between parents and teachers. According to a IDI participant,

> *"I feel the necessity of more training. Besides, if parents are being introduced with this concept, then they may help their children's queries at home* (IDI#4, 11.10.2022).

One parent who participated in FGD shared that, *"Like other I also think that we, the parents, should have knowledge on STEAM''* (FGD#6, 10.10.2022). Furthermore, few of the educators talked about exchange programs. Few of them expressed about the necessity of national-level promotion on STEAM.

Discussion:

The case study was done on a STEAM-practicing preschool to explore the perception and attitude of the educators and parents regarding STEAM in the early years. This study also aimed to examine the practices of STEAM in that preschool. Furthermore, another purpose of this study is to find out the challenges in implementing STEAM in early years' classrooms. The findings of this study contribute to get the insights of

how the educators and parents of a STEAM-practicing school perceive STEAM for Early learners. Through the class observations, the study also digs out how the STEAM integration happens in the preschool classrooms. Furthermore, this study finds out the challenges of STEAM implementation in that school.

In this section, the interpretation and analysis of the findings are presented. The interpretation is done in the light of the research questions, the reflection of the researcher, and also the findings of the research are discussed against the references from different literature. The discussion has been presented under five themes, and also some subthemes under those themes stated below.

Theme 1: Educators' and Parents' perceptions and attitude regarding STEAM:

Educators' and Parents' understanding of STEAM: The aim of the first research question is to explore the knowledge and attitudes of educators and parents about STEAM in Early Years. The findings show that all the educators who participated in IDI from that STEAM practicing preschool are well familiar with the term STEAM. Alghamdi (2021) also found in his study that teachers were familiar with this term. The participants in IDI could say what STEAM stands for. Most of them said that STEAM stands for Science, Technology, Engineering, Arts and Math which is similar to the elaboration was given by Albahar and Alammari, (2022) that is STEAM stands for Science, Technology, Engineering, Arts and Mathematics.

On the other hand, the study also indicates that all the parents from FGD are acquainted with the term STEAM. Similar findings were revealed by Voicu et. al. (2022). Most of them also could elaborate on the term STEAM fully but they did not mention anything about the interdisciplinary approach. It is clearly appeared that most

of the parents could not mention any details other than naming the disciplines which indicates that educators' understanding is better than parents.

Understanding of how the integration of STEAM happens in yearly years classrooms: Furthermore, regarding the integration, the findings show that all the participants participated in IDI perceive STEAM as a teaching approach. To their perception STEAM does not mean teaching those disciplines separately rather it integrates more than one discipline. This perception is supported by the literature in which it is mentioned that STEAM integrates different disciplines into teaching-learning instead of teaching those discipline separately (Singh, 2021). On the contrary, the findings of this study contrast with the findings of some previous study done by Simoncini and Lasen (2018); and Baltsavias and Kyridis (2020). Those studies revealed that teachers perceive STEAM as teaching these subjects discretely. On the other hand, it is clearly identified that most of the parents who participated in FGD did not specify anything relevant to integration. Only a few parents told that- in STEAM, teachers teach all five disciplines together.

In addition, all the participants from IDI and FGD are similarly found agreed that any age-appropriate activity can be turned into STEAM approach in early-year classrooms. No different opinion was found in this regard. All of them said that different disciplines can be integrated even from a simple activity like block building or crafting or drawing. With the example of activity, all the participants have well explained how the disciplines of STEAM can be incorporated. All the educators participated in IDI, mentioned how early years children consider the shapes, sizes, spaces, aesthetic etc. during a block building or crafting activity. A similar reference is found in DeJarnette (2018). Surprisingly, though the parents yet to get any

knowledge-sharing sessions with teachers on STEAM but they also shared how children relate those features during a block-building or crafting activity.

Understanding of the required teaching-learning method to implement STEAM in the preschool: Regarding the required teaching-learning method, all the educators, during IDI, rightly identified play-based and inquiry-based learning as appropriate methods for preschool children. All the educators believe that preschool children love to play and ask questions. The article by Linder (2020) supports this thought as it mentioned that "STEAM learning for young learners falls under umbrella of inquiry-based instruction'' (Linder & Eckhoff, 2020). In addition, another literature, by Wany et. al. (2022), stressed that integration of play-based approach is an innovative method for preschool teachers in their teaching-learning process. It is clearly appeared that the educators are aware about the teaching-learning methods of STEAM.

Understanding of classroom environment and materials to implement STEAM (settings, materials, and others): Furthermore, it is also visible from the study that all the educators do not consider purchasing materials as necessary to for early-year STEAM classes. They think that any available materials can be used for STEAM lessons. Most of the parents also believe the same. Rahardjo (2019) and Eckhoff (2017) mentioned similar thoughts in their articles.

The discussions above based on findings and literature reviews show that all the participants of that school, who participated in the study, are well familiar with the term STEAM. The study clearly indicates that the educators have basic understanding about STEAM approach but they lack knowledge and skills in Engineering and Technology related disciplines. The educators also could articulate STEAM as an

interdisciplinary approach. On the other hand, most of the parents did not mention anything about the interdisciplinary connections or details about this approach.

Theme 2: Teachers' understanding about their role in implementing STEAM:

Teachers as facilitators: The IDI was done with the educators only and the research suggests that all the educators believe they are the facilitators of the teaching-learning environment. All of them shared that teachers need to plan and arrange the environment and materials. Shrestha (2021) opined same in his article 'Integrating STEAM Education in Preschool and Kindergarten Classrooms: A Case Study'.

Teachers are the motivators: The findings also present another common realization of educators. They believe that teachers need to motivate students with clues and guidance. Few of the participants also mentioned scaffolding as another important role of teachers. These findings of this study are supported by a previous study (Fernandez and Hartl, 2022).

Teachers are the intriguers of queries: According to the findings, all the teachers realize that they need to ask questions to children and also need to create such an environment where children feel encouraged to ask questions. Literature suggests that in order to arouse children's critical thinking teachers may ask questions and also stimulate children to ask questions in STEAM learning (Awang et al., 2020).

According to the findings and literature review it can be said that teachers' understanding of teachers' role is aligned with the STEAM practices for early leaners.

Theme 3: Educators' and parents' understanding on the importance of STEAM in early years:

The importance of STEAM education for early learners: The study clearly reported that all the educators in IDI realized the benefits of STEAM education for early learners. This result is similar to Zamil et. al. (2018). All the parents expressed similar realization in the FGD. In their studies, Tay et. al. (2017); and Lopez and Cabello (2022) revealed identical understanding among the parents in their respective studies.

All the educators and parents from IDI and FGD consider early years as the foundation for later life and STEAM approach enables the teaching-learning environment to develop multiple skills from any activity. Findings also reports that most of the participants think STEAM experience in early years helps children to face problem in later life. Monkeviciene et. al. (2020) also stated that to get better learning outcomes in STEAM education actions should be taken from the early years of life.

The skills can be fostered through the STEAM approach: The study also reported that all the educators, in IDI, and the parents, in FGD, think that STEAM experience helps to develop certain skills in early learners. Most of the participants think STEAM boosts creativity and communication skills. Few of them believe collaboration can be developed through STEAM. Some of them think STEAM also enhances creativity. One respondent added leadership is another skill that can be fostered through STEAM. Toran et.al. (2020) also reported a similar view. The same opinion is seen in the article by Bertrand and Namukasa (2020).

The discussions found that all the educators and parents, undoubtedly agreed about the importance of STEAM implementation for early-year learners. They also emphasized it by explaining the reasons. None of them showed disagreements.

Theme 4: Classroom practices on STEAM education:

Classroom settings and teaching-learning environment: Other than IDI and FGD, Class Observation was also carried out for the study. Since this theme is about the practices therefore alongside of IDI and FGD, Class observation findings related discussions have been discussed under this theme. To explore the classroom practices on STEAM in that school it is revealed from IDI, FGD; and Class Observations that the school has both indoor and outdoor facilities where the STEAM implementation is being practiced. The study has identified that all the educators mentioned that they conduct classes in both indoor and outdoor settings. Parents, who participated in FGD, also shared the same experience. The similar reflection was also found during Class Observations. Some classes were observed in outdoor settings and some in indoors. Halton and Treveton (2017) also suggested maximization of the use of the natural environment to implement STEAM in early year classes.

Teaching-learning strategies: Analysis of the fourth theme also revealed that STEAM learning in this school includes active engagement of children. According to the findings from IDI, it is explored that all the educators engage children in hands-on experience during any activity. The parents who took part in FGD also shared that teachers facilitate hands-on learning experiences to their children. During Class Observation, it was found that in all the activities children were engaged in different hands-on experiences. Roberts et.al. (2018) also shared that STEAM learning can be interesting and motivating when it is presented through engaging and hands-on ways.

It is appeared in the findings that the class size of this STEAM practicing school is limited to 15 children. During Class Observation, the same number was found present in the classroom. Some of the parents also mentioned the benefit of small class sizes. In a study, Chowdhury et. al. (2019) revealed ‘large class sizes’ as one of the challenges of STEAM implementation. Therefore, by analyzing the findings of this

study and comparing these with the previous literature, it can be assumed that the small class size of the case-study school is supportive for STEAM implementation.

The findings also revealed that all the participants commonly named some teaching-learning methods as the practice of that school. During IDI all the educators mentioned that they practice play-based and inquiry-based learning mostly. The parents, who participated in FGD, also shared similar experiences about the school.

Besides, the reflections of their statement were found during Class Observations. The findings presented that during the observation it was observed that children were playing with paper-made boats, wet sand, observing clocks etc. All the children and teachers were found busy in asking and answering questions. This finding is supported by Linder and Eckhoff (2020); and Wany et. al. (2022).

The analysis also explored that in the teaching-learning process teachers connect the concepts with real-life events. During FGD the parents talked about how the teachers connect the activity with real-life events. The Class Observation supports the parents' observation. Chen and Tippett (2022) also emphasized that integration of children's life experiences should be made in early years STEM classes.

From the findings, it is also revealed that all the educators have shared how they facilitate different disciplines of STEAM from any activity. The participants gave some examples like gardening, block building, paper boat making etc. through which they focus on different disciplines like Science, Math, Arts etc. The findings explored from FGD also presented similar observations from parents. They shared how they found teachers who were turning a gardening activity into the acts of Science, Math, or Arts. Findings from Class Observations it is also revealed that teachers were engaging more than one disciplines, for instance Science, Math, or Arts, in a single

activity. Connor et.al. (2015) support this interdisciplinary approach of STEAM. Then again, this finding is dissimilar to Campbell et. al. (2018), where it was explored that teachers do not implement STEAM in an interdisciplinary approach.

Findings show that all the teachers in IDI talked about how they involved STEAM conversations during an activity. An assortment of STEAM talks, like 'how many', 'what colors', 'what to put in your house to allow air and light' etc. were found during Class Observation which supports teachers' responses in IDI. Awang et.al. (2020) also stressed engaging active STEAM conversation in the teaching-learning process.

Additionally, findings from the Class Observation indicate that the teachers were conversant in triggering curiosity in children. A similar experience was revealed from the parents' group who took part in FGD. In his study McClure (2017), also revealed the importance of children's engagement and curiosity in STEAM learning.

The changes brought to implement STEAM in classrooms: Findings from IDI show that all the educators commonly brought a major change in teaching-learning approach for implementing STEAM. According to the findings, the curriculum and materials remained same but the approach became different. From their statement, during any activity, they used to focus only on one discipline earlier. Now they focus on multiple disciplines during same activities. From the results, it can be said that the school has attained some foundations in teachers' skills to implement STEAM.

Then again, findings from FGD showed that most of the parents said nothing particular about the differences with earlier practices. Rather they focus on existing practices. However, one parent mentioned about the specific changes in approach.

These changes in approach, precisely 'the integration of different disciplines', was observed in the classes. What teachers said about changes; and also found from Class

Observations are supported by Brewer (2022) in his article titled ‘What is STEM? ‘A guide for parents and educators’, as he also mentioned that STEAM is nothing new, this is just the approach of understanding and applying of integration.

Fostering 4C’s through the activities: The findings of this study also showed that all the educators mentioned how they foster creativity, communication, collaboration, and critical thinking which are known as 4C’s skills. In their article, Liao et.al. (2016) also talked about promoting 4C’s skills through STEAM approach.

Few of them talked about group tasks to facilitate collaboration. Won and You (2022) also emphasized creating space for collaborative tasks in STEAM activities.

In findings it is also evident that all the teachers, who participated in IDI, fostered creativity and critical thinking skills by offering new materials and asking questions.

The Class Observation also explored how all the teachers were asking thought-provoking questions to trigger the critical thinking. Awang et.al. (2020) mentioned the relevance of open-ended questions with critical thinking in STEAM implementation.

According to the study, teachers also foster communication skills in children by engaging in different conversations. Teachers shared in IDI about how they initiate conversation and facilitate the environment so that students get involved in some sort of communication. Similar reflections were observed during Class Observation.

The evidence of Class Observations, IDI and FGD indicate that the teachers of this school not only have the basic perception of STEAM but also their practices are aligned with STEAM education for early years. The Class Observation found teachers comfortable in conducting STEAM classes. The findings of the study suggest that the educators of the school are committed to implement STEAM in their school. Furthermore, Class Observation and parents’ statements, extracted from FGD, suggest

that children of that STEAM practicing preschool enjoy their class activities. The discussions also indicate that though most of the educators did not mention the terms like 21st century or 4C's but their practices evident that the skills they try to foster through the activity are the reflection of 4C's and other 21st century skills.

Theme 5: Challenges of implementing STEAM in preschool settings:

The challenges of STEAM implementation are discussed under this theme. The findings from IDI showed that STEAM practice is new in that school. The study found that, the teachers lack enough training to implement STEAM from all aspects.

Furthermore, the study revealed that few educators think they lack planned indoor space and materials for Engineering and Technology relevant activities. Findings from the Class Observation also indicated the insufficiency of indoor space for all kinds of activities. (Monkeviciene and Autukeviciene (2019) also revealed the 'shortage of sets of methodological material' in their study. In their article, Ogegbo and Aina, (2020) also mentioned lack of technological resources as one of the barriers of STEAM implementation. In addition, the classroom lacks designated space to keep the materials. The materials were stored in the office room which limits children from free choice activities. Besides, findings from IDI show that most of the teachers lack knowledge in Engineering and Technology. The Class Observation also reflects same view. In most of the classes, teachers were addressing concepts relevant to Science, Math, and Arts more than Engineering and Technology. This finding is supported by the study Wang (2020) in which he revealed the majority of the teacher lack Engineering and Technology related knowledge. Nesmith and Cooper (2019) also support this finding. Most of the teachers also felt the need for parents' involvement in this regard. Similar findings were revealed in the study by Cabello et.al. (2021).

On the contrary, according to the findings from FGD, it is evident that most of the parents found no difficulties exist in the STEAM education of their children. The findings suggest that learners enjoy the activities. However, most of the parents want to know more about STEAM. This finding is supported by Lopez and Cabello (2022).

The findings of this study explored some suggestions from the respondents. Most of the teachers suggested about the arrangement of more training on STEAM for the early years. Furthermore, they also added about the need of particular training on Engineering and Technology relevant issues. Additionally, the exchange program is another requirement the educators want to attend. Few of them also wanted to have planned indoor space, and Engineering and Technology relevant materials. There has been a common finding where both the groups (teachers and parents) shared about involving parents in the knowledge-sharing sessions so that parents can have a better understanding on STEAM. On top of that, very few educators realized that a national-level awareness program on STEAM for yearly years is important.

Conclusion:

STEAM learning is considered to be critical to prepare children for 21st century skills. Early education caters early learners to prepare them to take on the challenges of this era (Wahyuningsih et al., 2020). STEAM based education in early years begets sustained learning as these are the years children learn most.

The aim of the case study was to explore the knowledge and attitude of educators and parents about STEAM education for early-years learners in a STEAM-practicing preschool. The study also intended to reveal the practices and challenges of STEAM implantation in early-years classrooms. The study showed that both the teachers and parents are familiar with the term STEAM. As teachers' had some basic training, they

have more knowledge than the parents. But as the school lacks direct collaboration between parents and teachers, parents do not have improved understanding of STEAM. But the educators and the parents both hold a positive view regarding STEAM implementation for the early-year learners. Despite of having better knowledge than parents, teachers lack knowledge when it comes to integrate different disciplines, particularly engineering and technology. In the other disciplines of STEAM, their practice is corresponding to the level of their understanding.

This school has some basic facilities to implement STEAM for their preschool. It has a small garden, a small school ground, sensory areas, many open-ended materials like blocks, puzzles, a small science lab equipped with microscope, telescope, magnifying glasses, jars, funnels, room thermometers, measuring tools, etc. Yet the teachers require more training for the further integration of STEAM from all aspects. Besides, the school lacks facilities to provide its teachers and children with sufficient scope to experience equipment-based disciplines like Technology and Engineering. The indoor space does not have any dedicated place for material storage too.

The study indicates that the experiential learning approach of this school works as a foundation to implement STEAM approach in its pre-primary classes. The teachers were comfortable and enthusiastic in facilitating children with the learning process. The children were found active and enjoying the activities with curiosity and excitement, which are the strengths of STEAM implementation of the school. Connecting activities with real-life events and offerings of hands-on learning are the other strengths of this preschool. Though most of the preschool educators did not mention the term 21st-century skills or 4C's but they all were found fostering most of those skills in the classes. In addition, what parents shared about their experience of STEAM from this school is aligned with what teachers practice in the classroom.

Recommendation:

Under the light of findings, the recommendations are-

- More teachers' training is required on STEAM education with a special focus on integration of technology and engineering to early-years education.
- Indoor space needs to be designed in a way so that there should be sufficient space for learning activities and related materials essential to run a full-fledged STEAM school. Since STEAM education is a need of the 21st-century education, it is inevitable to develop culturally appropriate and easily available materials so that this becomes widespread among the wider children.
- Regular exchange program with advanced STEAM practicing schools is required to enhance knowledge and experience of teachers of this school.
- Many ways need to be identified on how to involve parents with the process so that they can be well aware about STEAM education. Thus school also knows about the strengths of families and leverage on that in implementing STEAM.
- Nationwide advocacy and awareness program is recommended to promote the incorporation of STEAM education in early years with national curriculum
- Large-scale research on a broader sample needs to be carried out to depict a nationwide perspective and on the basis of which more STEAM schools can be built. This kind of research needs to be done often which can be helpful for the iteration of STEAM education in Bangladesh.

References:

Alghamdi, A.A. (2021). Exploring Early Childhood Teachers' Beliefs About STEAM Education in Saudi Arabia. *Early Childhood Education Journal.* https://doi.org/10.1007/s10643-021-01303-0

Albahar, M., & Alammari, A. (2022). STEAM Education in Saudi Arabia: Early Childhood Teachers' Perceptions. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 13(5)*, 13A5I, 1-10. http://TUENGR.COM/V13/13A5I.pdf DOI: 10.14456/ITJEMAST.2022.

Akpinar, B. C., & Akgunduz, D. (2022). The Effect of STEM Applications in Preschool on Students' Carrier Goals and Perceptions of Engineering. *International Journal of Early Childhood*, 1-21.

Akturk, A. A., & Demircan, H. O. (2017). A review of studies on STEM and STEAM education in early childhood. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD), 18*(2), 757-776.

Awang, Z., Yakob, N., Hamzah, A., & Talling, M. M. (2020). Exploring STEAM Teaching in Preschool Using Fred Rogers Approach. *International Journal of Evaluation and Research in Education*, *9*(4), 1071-1078.

Barrett, D. (2017). STEAM Framework Feasibility Study. *Research and Evaluation Department Los Angeles Universal Preschool*, 1-17.

Bertrand, M. G., & Namukasa, I. K. (2020). STEAM education: student learning and transferable skills. *Journal of Research in Innovative Teaching & Learning.* 13(1), 43-56. https://doi.org/10.1108/JRIT-01-2020-0003

Boice, K. L., Jackson, J. R., Alemdar, M., Rao, A. E., Grossman, S., & Usselman, M. (2021). Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program. *Education Sciences*, *11*(3), 105

Boon Ng, S. (2019). Exploring STEM competences for the 21st century. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000368485

Brewer, S. (2022). What is STEM? A guide for parents and educators. Retrieved from https://www.steampoweredfamily.com/what-is-stem/

Campbell, C., Speldewinde, C., Howitt, C., & MacDonald, A. (2018). STEM Practice in the Early Years. *Creative Education, 9,* 11-25. https://doi.org/10.4236/ce.2018.9100

Cabello, V. M., Martínez, M. L., Armijo, S., & Maldonado, L. (2021). Promoting STEAM learning in the early years: "Pequeños Científicos" Program. *LUMAT: International Journal on Math, Science and Technology Education*, *9*(2), 33-62.

Chen, Y. L., & Tippett, C. D. (2022). Project-Based Inquiry in STEM Teaching for Preschool Children. *EURASIA Journal of Mathematics, Science and Technology Education*, *18*(4),

Chowdhury, A.N. (2019). STEM education – A concept for 21st century science pedagogy. Bangladesh Post.

Chowdhury, S A., Arefin, ASM S., & Ahmed, F. (2020). Factors behind the implementation of STEM education in Bangladesh. *Journal of Physics: Conference Series,*1563. doi:10.1088/1742-6596/1563/1/012064

Connor, A., Karmokar, S., & Whittington, C. (2015). From STEM to STEAM: Strategies for enhancing engineering & technology education.

Creswell, J.W. (2006). *Qualitative Inquiry and Research Design: Choosing among Five Approaches. (2nd edition).* Sage publications.

DeJarnette, N. K. (2018). Implementing STEAM in the Early Childhood Classroom. *European Journal of STEM Education*, 3(3), 18. https://doi.org/10.20897/ejsteme/3878

Dinh, L. T. (2021). Difficulties in implementing STEAM education model at the Northern mountainous preschool in Vietnam. *Journal of Physics: Conference Series*, 1835(1), 012020. IOP Publishing.

Easwaramoorthy, M., & Zarinpoush, F. (2006). Interviewing for research. *Canada volunteerism initiative*, *6*, 1-2.

Eckhoff, A. (2017). Growing in STEM: STEM resources and materials for engaging learning experiences. *Young Children*, *72*(1), 1-7.

Fernandez, J., & Hartl,N.(2022). Investigation to Integration: The Teacher's Role in Early Childhood STEAM. School Specialty. Retrieved from https://blog.schoolspecialty.com/investigation-to-integration-the-teachers-role-in-early-childhood-steam/

Foti, P. E. (2021). Exploring kindergarten teachers' views on STEAM education and educational robotics: Dilemmas, possibilities, limitations. *Advances in Mobile Learning Educational Research*, 1(2), 82-95. https://doi.org/10.25082/AMLER.2021.02.004

Gay, L. R., Mills, G. E., & Airasian, P. W. (2012). *Educational research: Competencies for analysis and applications*. Boston: Pearson.

Halton, N., & Treveton, N. (2017). Bringing STEM to Life. Understanding and Recognising Science, Technology, Engineering and Maths in Play. TEACHING SOLUTIONS

Irwin, L. G., Siddiqi, A., & Hertzman, G. (2007). *Early child development: A powerful equalizer*. Vancouver, BC: Human Early Learning Partnership (HELP).

Jackman, H. L. (2012). *Early Education Curriculum- A Child's Connection to the World (5th Edition),* Belmont, CA, USA: Wadsworth

Javed, M. S., Athar, M. R., & Saboor, A. (2019). Development of a twenty-first century skills scale for agri varsities. *Cogent Business &Management*, *6*(1), 1692485.

Joynes, C., Rossignoli, S., & Amonoo-Kuofi, E. F. (2019). 21st Century Skills: evidence of issues in definition, demand and delivery for development contexts.

Kastriti, E., Kalogiannakis, M., Psycharis, S., & Vavougios, D. (2022). The teaching of Natural Sciences in kindergarten based on the principles of STEM and STEAM approach. *Adv Mobile Learn Educ Res,* 2(1), 268-277. https://doi.org/10.25082/AMLER.2022.01.011

Karademir, A., & Yildirim, B. (2021). A Different perspective on preschool STEM education: Preschool STEM education and engineering for preservice teachers. *Journal of Turkish Science Education*, *18*(3), 338-350.

Kristiana, D. (2021). Parents' Roles in STEAM Learning in Early Childhood. *In 1st International Conference Of Education, Social And Humanities (INCESH 2021)* (pp. 114-119). Atlantis Press.

Lee, M. H., Chai, C. S., & Hong, H. Y. (2018). STEM education in Asia Pacific: Challenges and development. The Asia-Pacific Education Researcher, 28(1), 1-4.

Linder, S. M., & Eckhoff, A. (2020). Breaking Down STEAM for Young Children. Retrieved from https://www.naeyc.org/resources/pubs/tyc/feb2020/breaking-downsteam#:~:text=STEAM%20for%20young%20children%20falls,solving%2C%20communication%2C%20and%20reflection.

Lopez, L.S., & Cabello, V.M. (2022). Starting at Home: What Does the Literature Indicate about Parental Involvement in Early Childhood STEM Education? *Education Sciences,* 12(3), 218.

Monkeviciene, O., Autukeviciene, B., Kaminskiene, L., & Monkevicius, J. (2020). Impact of innovative STEAM education practices on teacher professional development and 3–6-year-old children's competence development. *Journal of Social Studies Education Research*, *11*(4), 1-27.

Monkeviciene, O., & Autukeviciene, B. (2019). Implementing STEAM in Early Childhood Education: Practices and Factors. ECER2019.Retrieved from: https://eera-ecer.de/ecer-programmes/conference/24/contribution/48435/

Nesmith, S. M., & Cooper, S. (2019). Engineering process as a focus: STEM professional development with elementary STEM-focused professional development schools. *School Science and Mathematics, 119*(8), 487-498. DOI: 10.1111/ssm.12376

Noble, H., & Heale, R. (2019). Triangulation in research, with examples. Evidence-based nursing, 22(3), 67-68.

Obaydullah, A K M., & Rahim, Md. A. (2019). Use of ICT for Primary Science Teaching and Learning at the Primary Schools in Bangladesh. *IJARIIE-ISSN,5(1)*. Retrieved from https://www.researchgate.net/publication/331210394_Use_of_ICT_for_Primary_science_Teaching_and_Learning_at_the_Primary_Schools_in_Bangladesh

Ogegbo, A. A., & Aina, A. (2020). Early childhood development teachers' perceptions on the use of technology in teaching young children. *South African Journal of Childhood Education, 10*(1), 10. https://doi.org/10.4102/sajce.v10i1.880

Partelow, S., Jäger, A., & Schlüter, A. (2021). Linking fisher perceptions to social-ecological context: mixed method application of the SES framework in Costa Rica. Human Ecology, 49(2), 187-203.

Rahardjo, M. M. (2019). How to use Loose-Parts in STEAM? Early Childhood Educators Focus Group discussion in Indonesia. *Jurnal Pendidikan Usia Dini*, 13(2), 310-326.

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., & Cremeans, C. (2018). Students' perceptions of STEM learning after participating in a summer informal learning experience. *International journal of STEM education*, *5*(1), 1-14.

Shahidullah, K.K. (2016). *Teacher Perceptions of Inquiry and STEM Education in Bangladesh* [Doctoral dissertation, University of Nevada, Reno]

Shrestha, P. (2021). *Integrating STEAM Education in Preschool and Kindergarten Classrooms: A Case Study* [Doctoral dissertation, California State University, Sacramento]

Singh, M. (2021). Acquisition of 21st Century Skills Through STEAM Education. *Academia Letters*, Article 712. https://doi.org/10.20935/AL712.

Simoncini, K., & Lasen, M. (2018). Ideas about STEM among Australian early childhood professionals: how important is STEM in early childhood education? *International Journal of Early Childhood*, 50(3), 353-369.

Suto, I. (2013). 21st Century skills: Ancient, ubiquitous, enigmatic. *Research Matters: A Cambridge Assessment Publication*, *15*, 2-8.

Tahmeedul, M. Q., & Jawad, S. (2020). Integrated Stem Education: Bangladesh Perspective. Retrieve from https://www.researchgate.net/publication/352551266_Integrated_Stem_Educatio_Bangladesh_Perspective

Tay, J., Salazar, A., & Lee, H. (2018). Parental perceptions of STEM enrichment for young children. *Journal for the Education of the Gifted*, 41(1), 5-23.

Toran, M., Aydin, E., & Etgiier, D. (2020). Investigating the effects of STEM enriched implementations on school readiness and concept acquisition of children. *Ilkogretim Online*, *19*(1).

Türk, A., & Akcanca, N. (2021). An example implementation of STEM in preschool education: Magnets. *Journal of Educational Leadership and Policy Studies.*

Yildirim, B. (2021). Preschool STEM activities: Preschool teachers' preparation and views. *Early Childhood Education Journal*, *49*(2), 149-162.

UNICEF data (June 2022). Retrieved from https://data.unicef.org/topic/education/pre-primary-education/

Voicu, C. D., Ampartzaki, M., Dogan, Z. Y., & Kalogiannakis, M. (2022). STEAM Implementation in Preschool and Primary School Education: Experiences from Six Countries. In *Early Childhood Education-Innovative Pedagogical Approaches in the Post-modern Era*. IntechOpen.

Wang, S. (2020). Findings from a Survey on Pre-K Teachers' Perception of STEM Integration and Education in Early Years. *Academic Journal of Humanities & Social Sciences*, *3*(6). doi: 10.25236/AJHSS.2020.030603

Wanyi, P., Nor, M. M., & Zhengan, M. (2022). THE USE OF STEAM APPROACH IN PRESCHOOL FOR CHILDREN'S HOLISTIC DEVELOPMENT. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik*, *10*(2), 47-60.

Wahyuningsih, S., Nurjanah, N. E., Rasmani, U. E. E., Hafidah, R., Pudyaningtyas, A. R., & Syamsuddin, M. M. (2020). STEAM learning in early childhood education: A literature review. *International Journal of Pedagogy and Teacher Education*, *4*(1), 33-44.

Williams, B. C. (2022). *Are Teachers Prepared for STEAM Education? A Qualitative Case Study* [Doctoral dissertation, Northcentral University].

Won, H. R., & You, H. (2022). Next-Generation Science and Engineering Teaching Practices in a Preschool Classroom. In M. Ampartzaki, & M. Kalogiannakis (Eds.), *Early Childhood Education - Innovative Pedagogical Approaches in the Post-modern Era [Working Title]*. IntechOpen. https://doi.org/10.5772/intechopen.105564

Appendix 1

In-depth Interview Guidelines for Teachers

Date of Interview: **Place:**

Section A: Demographic information

Name:

Age:

Gender:

Education:

Work Place:

Training Experience:

Section B:

1. Have you heard the word STEAM in teaching-learning? What is your understanding of STEAM Education? Please share your opinion.
2. Do you think Science, Technology, Engineering, Arts, and Math lessons can be incorporated from a single art or block-building activity for preschool children? How?
3. Which discipline of STEAM you can enable from a block-building activity? How?
4. According to you what could be the key methods of STEAM instruction for preschool children?
5. What could be the role of a teacher to facilitate STEAM activities with preschool children?
6. What could be the other elements of the teaching-learning environment that could facilitate STEAM learning? (Such as materials and indoor-outdoor space design).

7. In your opinion what skills (STEAM skills/21st Century skills) could be fostered through STEAM education?
8. In your opinion is STEAM Education important for preschoolers? Why or why not?
9. What type of activity/teaching strategies do you conduct in the classroom that promotes STEAM learning? Please elaborate.
10. Reflecting back what are the differences you are making in your teaching-learning process after incorporating STEAM?
11. Do you promote collaboration among children during any activity? If yes, tell me a little more.
12. Do you promote creativity and critical thinking among children during any activity? If yes, please explain.
13. Do you encourage children to develop problem-solving skills during any activity? If yes, please elaborate.
14. How do you generate STEAM conversation/STEAM vocabulary with your children during any activity that you think can promote STEAM education?
15. Do you see any changes in your children after implementing STEAM in your teaching-learning process?
16. Have you had any formal/professional training in STEAM education? Yes/No. If yes, please mention a few.
17. What are the challenges you think are in preschool education that can be the problem in addressing STEAM education?
18. How do you think these challenges can be overcome?

Appendix 2

In-depth Interview Guidelines for Head Teachers

Date of Interview: **Place:**

Section A: Demographic information

Name:

Age:

Gender:

Education:

Work Place:

Years of experience as Head Teacher:

Section B: **Introductory question:**

1. How many years have you been teaching as Head Teacher in this preschool?
2. From when did your school promote STEAM education?

Section C:

1. You have been implementing STEAM in your school. Would you please, share your concept about STEAM?
2. In your opinion how STEAM learning can be implemented in a preschool setting?
3. In your opinion is STEAM Education important for preschoolers? Why or why not?

3. Why did you implement STEAM in your school?
4. Did you find any changes among children, teachers, and/or in the whole school environment after implementing STEAM? If yes, please elaborate.
5. What is the available play environment that provides the opportunity to explore STEAM activities in your setting?

6. Do you train teachers on STEAM education in preprimary classes? If yes please name a few.
7. What are the challenges of implementing STEAM in preprimary classes?
8. How do you think these challenges can be addressed?

Appendix 3

Focus Group Discussion (FGD) Guidelines (Parents)

Date of Interview: **Place:**

Section A: Demographic information

Name:

Age:

Gender:

Education:

Section B: **Introductory question:**

1. Your child has been attending in this school, do you have any idea about the teaching-learning system of this school? If yes, would you please describe it?
2. For how many years have your child/children been attending this school?

Section C: Parents' knowledge/attitude on STEAM Education.

1. Do you think teaching one discipline can be incorporated with other disciplines? (For example, while reciting rhymes like 'One two, three four five, once I caught a fish alive' that time he/ she can use math/ science/).
2. Have you heard the term STEAM? If yes then please share your understanding of STEAM Education.
3. Do you have any idea how your child is learning Science, Technology, Engineering, Arts, and Mathematics in this school?
4. Do you find any differences in teaching Science, Technology, Engineering, Arts, and Mathematics in your child's school? If yes, please, explain the differences.
5. Do you see any changes in your child after attending the STEAM integrated classes? If yes, please, explain.

6. Do you see your child using one discipline of STEAM in another discipline? For example, while drawing artwork on animals at that time he uses math concepts like shapes, and ‘how many’; ‘big or small, or science vocab like ‘animal has life’, ‘it can eat’ etc.
7. Do you think your child enjoys his/her class? How do you understand that?
8. Do you think STEAM education is important for preschool-age children? Why do you think so? Please, share your opinion.
9. Do you think your child faces any challenges in attending this STEAM-enriched class? If yes, please explain. (For example, do the child say ‘my math/science activity was tough’).

Appendix 4

STEAM Class Observation Checklist

Date of Observation_____ Place_____

Staring Time_____ End Time_____

Name of Teacher_____ Gender_____

Class_____ Number of Students_____

1.Setting: ☐ Indoor ☐ Outdoor

2. Types of materials: ☐ Open-ended ☐ Close-ended

Comment_____

3. a) Name of the activity is going on the class_____

b) Disciplines of STEAM have been addressed through this activity:

☐ Science ☐ Technology ☐ Engineering ☐ Arts ☐ Math

Comment_____

4. Teaching -learning strategies involved in the classroom:

☐ Project based ☐ Inquiry Based ☐ Play Based ☐ Passive listening

☐ Other

Comment_____

5. How are the students engaged in active participation?

☐ Involved in discussion ☐ Hands-on activity ☐ Inquiry-based ☐ Other

Comment_____

6. Do the teacher connects the activity with a real-life event

☐ Yes ☐ No

Comment_____

7. Is the teacher providing situation that triggers curiosity?

☐ Yes ☐ No

Comment_____

8. Does the teacher ask open-ended questions during the activity?

☐ Yes ☐ No

Comment_____

9. Does the teacher make a situation that triggers students to ask queries?

☐ Yes ☐ No

Comment_____

10. Does the teacher attend to students' queries?

☐ Yes ☐ No

Comment_____

11. The 4Cs involved during the activity:

☐ Communication ☐ Collaboration ☐ Creativity ☐ Critical Thinking

Comments_____

12. How does the teacher promote creativity?

    Comments_____

13. How does the teacher promote critical thinking?

    Comments_____

14. Does the activity offer problem to solve

    Comments_____

15. How are the students collaborating with each other? Students are working in:

☐ Pair ☐ Small group ☐ Large group ☐ Individually

16. Do the teacher uses STEAM conversation (vocabulary i.e.; Explore, design, plan, measure, explain, organize, etc.)

☐ Yes ☐ No

    Comments_____

17. Which STEAM Vocabulary Teacher has been involved?

☐ Science ☐ Technology ☐ Engineering ☐ Arts ☐ Math

18. Science conversation has occurred

    Comments_____

19. Technology conversation has occurred

    Comments_____

20. Engineering conversation has occurred

    Comments_____

21. Arts conversation has occurred

    Comments_____

22. Math conversation has occurred

    Comments_____

23. Was the teacher comfortable using STEAM: ☐ Yes ☐ No

    Comments on context_____

24. Are the children enjoying STEAM classes?

Comments_____

Appendix 5

In-depth Interview Guidelines for Teachers (Bangla)

শিক্ষক

সাক্ষাতকার গ্রহণের তারিখ : স্থান :

'ক' শাখা জনতাত্ত্বিক তথ্য :

নাম :

বয়স :

লিঙ্গ :

শিক্ষাগতযোগ্যতা :

কর্মক্ষেত্র :

অভিজ্ঞতা :

প্রশিক্ষণ :

খ শাখা

১) শিখন-শিক্ষণ কার্যক্রমে আপনি STEAM শব্দটি শুনেছেন কি? দয়া করে STEAM শিখন নিয়ে আপনার ধারণা একটু ব্যক্ত করুন।

২) আপনি কি মনে করেন, বিজ্ঞান প্রযুক্তি, প্রকৌশল, কলা ও গণিত বিষয়গুলোর পাঠকে একটি আকার ক্লাস বা ব্লক অন্তর্ভূক্ত করা যায়? যদি যায় তাহলে দয়া করে বলবেন কি, কিভাবে করা যায়?

৩) ব্লক দিয়ে কিছু বানানোর কার্যক্রমে STEAM এর কোন বিষয়গুলোকে সক্রিয় করা যায়?

৪) আপনার মতে প্রাক্-প্রাথমিক শিশুদের STEAM কার্যক্রমে কোন ধরণের শিখন-শিক্ষণ পদ্ধতি উপযোগী?

৫) প্রাক্-প্রাথমিক শিশুদের STEAM কার্যক্রমে শিক্ষকের ভূমিকা কী হতে পারে বলে আপনি মনে করেন?

৬) আপনার মতে শিক্ষণ-শিখন পরিবেশের আর কোন উপাদানগুলো STEAM শিখনকে সহযোগিতা করে (যেমন - উপকরণ এবং আভ্যন্তরীণ ও বহিরাঙ্গণ পরিকল্পনা)

৭) আপনার মতে, STEAM শিখনের মাধ্যমে শিশুদের কোন দক্ষতাগুলো পরিচর্যা করা যায়?

৮) আপনি কি মনে করেন, প্রাক্-প্রাথমিক শিক্ষার্থীদের জন্য STEAM শিক্ষা গুরুত্বপূর্ণ? কেন এমন মনে করেন?

৯) আপনি কোন ধরণের শিক্ষণ পদ্ধতি বা কার্যক্রম পরিচালনা করেন যেগুলো কিনা STEAM শিখনকে উৎসাহিত করে।

১০) STEAM অন্তর্ভূক্ত করার কারণে শিক্ষণ-শিখন প্রক্রিয়ায় আপনি কি ধরণের পরিবর্তন এনেছেন?

১১) শ্রেণি কার্যক্রম চলার সময় আপনি কি শিশুদের মধ্যে পারস্পরিক সহযোগিতাকে উৎসাহিত করেন? যদি হ্যাঁ হয়, বিস্তারিতভাবে বলুন।

১২) শ্রেণি কার্যক্রম চলার সময় আপনি কি শিশুদের মধ্যে সৃজনশীলতা critical thinking কে উৎসাহিত করেন? যদি হ্যাঁ হয়, বিস্তারিতভাবে বলুন।

১৩) কোন কার্যক্রম চলার সময় আপন কি শিশুদের সমস্যা সমাধানের দক্ষতাকে উৎসাহিত করেন? দয়া করে একটু বিস্তারিত বলবেন কি?

১৪) কোন কার্যক্রম চলার সময় শিশুদের সাথে আপনি কিভাবে STEAM কথোপকথন বা STEAM শব্দাবলী ব্যবহার করেন অথবা শিশুদেরকে বলতে উৎসাহিত করেন।

১৫) শিক্ষণ-শিখন প্রক্রিয়ায় STEAM বাস্তবায়নের কারণে আপনি কি শিশুদের মধ্যে কোন পরিবর্তন লক্ষ্য করছেন? যদি হ্যাঁ হয়, বিস্তারিত বলবেন?

১৬) STEAM শিক্ষার উপর আপনার কোন আনুষ্ঠানিক বা পেশাগত প্রশিক্ষণ আছে? যদি থাকে তাহলে দয়া করে, সেগুলোর নাম বলুন।

১৭) প্রাক্-প্রাথমিক শিক্ষায় STEAM বাস্তবায়নে কী কী প্রতিকূলতা আছে বলে আপনি মনে করেন?

১৮) আপনার মতে এ প্রতিকূলতাগুলো হতে কীভাবে উত্তরণ করা যায়?

Appendix 6

In-depth Interview Guidelines for Head Teacher (Bangla)
প্রধান শিক্ষক

সাক্ষাতকার গ্রহণের তারিখ : স্থান :

'ক' শাখা জনতাত্ত্বিক তথ্য :

নাম :

বয়স :

লিঙ্গ :

শিক্ষাগতযোগ্যতা :

কর্মক্ষেত্র :

প্রধান শিক্ষক হিসেবে অভিজ্ঞতা :

খ শাখা-

১) আপনি কত বছর ধরে এই প্রাক্-প্রাথমিক বিদ্যালয়ে প্রধান শিক্ষক হিসেবে কাজ করছেন?

২) আপনার বিদ্যালয়ে কবে থেকে STEAM ধারণা চালু করেছেন?

৩) আপনি তো আপনার বিদ্যালয়েও STEAM কার্যক্রম বাস্তবায়ন করেছেন? দয়া করে STEAM নিয়ে আপনার ধারণাটা একটু বলবেন কি?

৪) আপনার মতামত অনুযায়ী একটি প্রাক্-প্রাথমিক বিদ্যালয়ের পরিবেশে কিভাবে STEAM শিখন বাস্তবায়ন করা যায়?

৫) আপনার মত অনুযায়ী প্রাক্-প্রাথমিক এর শিশুদের জন্য STEAM শিক্ষা কি গুরুত্বপূর্ণ? কেন এমন মনে করছেন?

৬) আপনার বিদ্যালয়ে কেন STEAM কার্যক্রম চালু করেছেন?

৭) STEAM কার্যক্রম বাস্তবায়নের কারণে আপনি এই বিদ্যালয়ের শিশুদের, শিক্ষকদের অথবা সামগ্রিক বিদ্যালয় পরিবেশে কোন পরিবর্তন লক্ষ্য করেছেন? যদি করে থাকেন তবে দয়া করে একটু বিস্তারিত বলবেন।

৮) আপনার বিদ্যালয়ে কি ধরণের খেলার পরিবেশ আছে যা কিনা STEAM কার্যক্রম চর্চা করতে সুযোগ দেয়?

৯) আপনি এই বিদ্যালয়ের প্রাক্-প্রাথমিক শ্রেণীর শিক্ষকদের STEAM শিক্ষার উপর প্রশিক্ষণ এর আয়োজন করে থাকেন? যদি করে থাকেন তাহলে একটু বিস্তারিত বলবেন।

১০) প্রাক্-প্রাথমিক শ্রেণিতে STEAM কার্যক্রম বাস্তবায়নে কোন প্রতিবন্ধকতা আছে কি? থাকলে দয়া করে বিস্তারিত বলুন।

১১) কিভাবে এই প্রতিকূলতা দূর করা যায় বলে আপনি মনে করেন?

Appendix 7

Focus Group Discussion (FGD) Guidelines for Parents (Bangla)

অভিভাবক

সাক্ষাতকার গ্রহণের তারিখ : স্থান :

'ক' শাখা জনতাত্ত্বিক তথ্য:

নাম :

বয়স :

লিঙ্গ :

শিক্ষাগতযোগ্যতা :

কর্মক্ষেত্র :

অভিজ্ঞতা :

প্রশিক্ষণ :

১) আপনার সন্তান তো এই বিদ্যালয়ে পড়ছে, এই বিদ্যালয়ের শিক্ষণ-শিখন পদ্ধতি নিয়ে আপনার কি কোন ধারণা আছে? যদি হ্যাঁ হয়, তবে দয়া করে বিস্তারিত বলবেন কি?

২) কতদিন ধরে আপনার সন্তান এই প্রাক্-প্রাথমিক বিদ্যালয়ে পড়ছে?

৩) আপনি কি মনে করেন কোন একটি বিষয়ে শেখানোর সময় অন্য বিষয়/বিষয়গুলোকেও অন্তর্ভূক্ত করা যায়? (ধরুণ যখন শিশু `1, 2, 3, 4, 5, once I caught a fish alive' ছড়াটি পাঠ করে তখন এই ছড়ার মাধ্যমে সে গণিত বা বিজ্ঞানও জানতে পারে?)

৪) আপনি কি STEAM শব্দটি শুনেছেন? যদি শুনে থাকেন তাহলে দয়া করে STEAM নিয়ে আপনার ধারণাটি ব্যক্ত করুন।

৫) আপনার কি এ বিষয়ে কোন ধারণা আছে যে, এই প্রাক্-প্রাথমিক বিদ্যালয়ে আপনার সন্তান বিজ্ঞান, প্রযুক্তি, প্রকৌশল, কলা ও গণিত বিষয়গুলো কিভাবে শিখছে?

৬) আপনার সন্তানের বিদ্যালয়ে বিজ্ঞান, প্রযুক্তি, প্রকৌশল, কলা ও গণিত বিষয়গুলো পাঠদানে আপনি কি কোন ব্যতিক্রম খুঁজে পান? যদি লক্ষ্য করে থাকেন তাহলে দয়া করে ব্যতিক্রমগুলো কী তা ব্যাখ্যা করুন।

৭) STEAM কার্যক্রমে অংশগ্রহণের কারণে আপনি কি আপনার সন্তানের মধ্যে কোন পরিবর্তন লক্ষ্য করেছেন? যদি করে থাকেন তাহলে দয়া করে ব্যাখ্যা করুন।

৮) আপনি কি এমন কিছু লক্ষ্য করেছেন যে, আপনার সন্তান STEAM এর একটা বিষয় নিয়ে কাজ করার সময় অন্য বিষয়গুলোও অন্তর্ভূক্ত করে। যেমন সে যখন মাছের ছবি আঁকে তখন গণিত/বিজ্ঞানের ধারণা প্রয়োগ

করে। উদাহরণস্বরূপ মাছটি বড় নাকি ছোট, আঁকা মাছটিতে কয়টি বৃত্ত আছে, অথবা মাছের প্রাণ আছে কিনা, মাছ খাবার খায় কিনা ইত্যাদি।

৯) আপনি কি মনে করেন, আপনার সন্তান তার শ্রেণি কার্যক্রমকে উপভোগ করে। কিভাবে আপনি তা বুঝে থাকেন?

১০) আপনি কি মনে করেন প্রাক্-প্রাথমিক বয়সী শিশুদের জন্য STEAM শিক্ষা গুরুত্বপূর্ণ? আপনি কেন তা মনে করেন, দয়া করে আপনার মতামত জানাবেন।

১১) আপনার শিশু কি STEAM কার্যক্রমে অংশগ্রহণ করতে কোন প্রতিকূলতা মোকাবেলা করছে? যদি করে থাকে, দয়া করে ব্যাখ্যা করুন। (যেমন - শিশু কি এমন কিছু বলে থাকে যে, 'ক্লাসে কিছু করতে ভাল লাগে না' বা 'ক্লাসে সব কাজ খুব আনন্দ লাগে')

Appendix 8

Informed consent for participation in research activities (Educators)

Title of the research: Children's STEM Learning in Early Years: A case study from a Preschool.

Principal Investigator: Nasima Akhter Sirajee

Mobile No: 01711821282; e-mail: nasima.sirajee@gmail.com

Participant _____Contact info_____

Dear participant,

You are invited to participate in a study conducted by me under the supervision of Areefa Zafar, faculty of BRAC IED, Brac University. This study is a part of a master's thesis requirement from the Institute of Education Development of Brac University. This study intends to explore the perception and beliefs of educators (head teachers and preschool teachers) and parents on STEAM education from the perspective of a STEAM practicing preschool. This study also aims to explore STEAM practices in preschool classrooms.

Your participation will involve:

a) An In-depth Interview that will be conducted through an in-person modality, the location and time will be fixed according to your convenience. The interview session will take 40 to 60 minutes and an audio recording will be done to write the transcript.

b) Moreover, observation of STEAM classes will be made; and for each participant, two classes on different days will be observed. No recording will be done during the observation.

Risk and benefits: Participating in this study will not create any risk or harm. In addition, there are no direct benefits for you in participating in this study. However,

your participation will contribute to the understanding of STEAM, among ECD educators, researchers, and other stakeholders.

Privacy, anonymity, and confidentiality: All the information provided by you will remain strictly confidential and your identity will not be revealed to any publication or elsewhere. And for future safety, all the raw data will be destroyed after the end of the study.

Right of withdrawal: Your participation in this study is voluntary and you deserve all the rights to withdraw from this study at any time. Furthermore, you may skip answering any question that you do not want to answer. There will be no penalty for withdrawal or for not answering any questions.

You are most welcome to contact the researcher for sharing any concerns or asking questions regarding the study. The researcher's contact details are given at the top of this form.

After reading all the details above, if you agree to participate in this study, kindly give your consent by a signature in the specified space below.

Participant's Signature and Date _____

Participant's Name _____

Signature of Researcher and Date _____

Researcher's Name _____

Appendix 9

Informed consent for participation in research activities (FGD)

Title of the research: Children's STEM Learning in Early Years: A case study from a Preschool.

Principal Investigator: Nasima Akhter Sirajee

Mobile No: 01711821282; e-mail: nasima.sirajee@gmail.com

Participant _____Contact info _____

Dear participant,

You are invited to participate in a study conducted by me under the supervision of Areefa Zafar, faculty of BRAC IED, Brac University. This study is a part of a master's thesis requirement from the Institute of Education Development of Brac University. This study intends to explore the perception and beliefs of educators (head teachers and preschool teachers) and parents on STEAM education from the perspective of a STEAM practicing preschool. This study also aims to explore STEAM practices in preschool classrooms.

Your participation will involve:

a) A focus group discussion will be made where you need to join a group of 6 individuals. The moderator will ask you several questions in group discussions. The location and time will be fixed accordingly. The FGD sessions will take 1 hour to 1.5 hours and an audio recording will be done to write the transcript. Furthermore, there will be a note taker to record the notes.

b) It is to inform you that there is no right or wrong answer in this discussion. The study only intends to explore the shared understanding of individuals and would like to ensure everyone's contribution. For this reason, the request is not to interrupt others while answering.

Risk and benefits: Participating in this study will not create any risk or harm. In addition, there are no direct benefits for you in participating in this study. However, your participation will contribute to the understanding of STEAM, among ECD educators, researchers, and other stakeholders.

Privacy, anonymity, and confidentiality: All the information provided by you will remain strictly confidential and your identity will not be revealed to any publication or elsewhere. And for future safety, all the raw data will be destroyed after the end of the study. Furthermore, you are requested not to disclose or discuss others' responses after the end of the session.

Right of withdrawal: Your participation in this study is voluntary and you deserve all the rights to withdraw from this study at any time. Furthermore, you may skip answering any question that you do not want to answer. There will be no penalty for withdrawal or for not answering any questions.

You are most welcome to contact the researcher for sharing any concerns or asking questions regarding the study. The researcher's contact details are given at the top of this form.

After reading all the details above, if you agree to participate in this study, kindly give your consent by a signature in the specified space below.

Participant's Signature and Date _____

Participant's Name _____

Signature of Researcher and Date _____

Researcher's Name _____